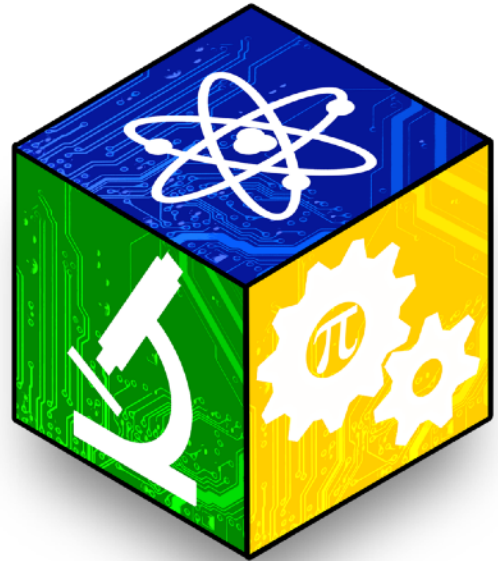


CONNECTICUT
SCIENCE &
ENGINEERING
— FAIR —



76th Annual Fair
March 4-16, 2024

Student Abstracts

Fair Categories

	Life Sciences	Physical Sciences
7th & 8th Grade	LT (1001 – 1999)	PT (4001 – 4999)
7th Grade	L7 (2001 – 2499)	P7 (5001 – 5499)
8th Grade	L8 (2501 – 2999)	P8 (5501 – 5999)
High School	LS (3001 – 3499)	PS (6001 – 6499)
High School Team	LST (3501 – 3999)	PST (6501 – 6999)

Technical Disciplines

AT = Applied Technology	EE = Engineering: Electrical & Mechanical
AS = Animal Science	ET = Energy &
BE = Behavioral & Social	EV = Environmental
BI = Biochemistry	EM = Environmental
CB = Cellular & Molecular	MA = Mathematical Sciences
CBIO = Computational Biology & Bioinformatics	ME = Medicine & Health Sciences
CH = Chemistry	MI = Microbiology
CS = Computer Science	PH = Physics & Astronomy
EA = Earth Science	PS = Plant Science
EN = Engineering: Materials & Bioengineering	

Technical Discipline Composites

Biotechnology	AS, BI, CB, EN, ME, MI, PS
Environmental	EV, EM
Engineering	EN, EE
Sustainability	EA, EN, EE, ET, EV, EM

CSEF Official Abstract and Certification

Word Count

260

2024

Fair Category

PS

Project Number

6001

Title: Developing an NLP-based Web Application to Evaluate Environmental Social Governance (ESG) from Social Networks for More Sustainable Company Practices

Student Name(s): A. Patel

Abstract:

Corporate social responsibility is vital for society's long-term well-being. ESG—or environmental, social, governance—is a rating system which evaluates how socially responsible a company is. These scores identify areas for improvement in sub-categories such as pollution, worker rights, or board diversity. While ESG can guide companies in having more sustainable practices, its current state is flawed. ESG scores are manually determined using self-reported company filings, and this leads to divergent ratings that provide mixed signals on what companies should improve. To address this, the student's previous research focused on prototyping a data-driven ESG evaluation algorithm using social networks. While the system demonstrated proof-of-concept, it was difficult to re-run and used un-optimized NLP algorithms. So, the purpose of this year's project was to create an easily accessible web app with improved NLP algorithms that could provide executives with ESG guidance. First, a graphical user interface was created in Streamlit. Next, web scrapers were integrated to collect data from Google News, X (Twitter), and LinkedIn. NLP models were then trained to filter out irrelevant data and calculate sentiment for each article/post. Finally, this sentiment data was visualized across sub-categories to identify areas of improvement. The ESG relevance algorithm displayed a 96.9% accuracy and the sentiment analysis algorithm displayed a 92.2% accuracy. Additionally, the system had low data collection times, though there were limitations for the Twitter web scraper. An accessible ESG web app can help companies identify issues people are advocating for, which can help to better integrate sustainable practices.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

AT CS EV

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

246

2024

Fair Category

PS

Project Number

6002

Title: Integrating Piezoelectric Sensors and Photovoltaic Material in an Artificial Energy-Harvesting Model Tree

Student Name(s): L. Chintapalli

Abstract:

Piezoelectricity's key characteristic of converting everyday kinetic energy into storable energy introduces a high potential in energy harvesting as it creates opportunities for cost-efficiency and accessibility. In contrast to standard forms of wind energy generators, piezoelectric materials offer flexibility in the location and convenience of integration. In an age where energy demands are rapidly increasing with advancing needs and limited room to risk the integrity of the environment, every outlet of clean energy, from simple to complex, must be enabled.

An innovative approach to piezoelectricity is the construction of an energy harvester in the form of an artificial tree. The design of the piezoelectric leaf is focused on a cantilever form optimizing the configuration of piezoelectric sensors and leaves. Three distinct types of leaves were constructed while holding their weights constant. Various trials determined what properties of leaf shapes would make the best use of the same unit of material. Trials also tested wind speed, resistance level, and mass increment. Photovoltaic cells were also explored at angles similar to the sun's hourly positions. The cells then substitute masses on the leaf to amplify the cantilever effect.

Upon investigation, it was found that the ideal conditions were for an Elm leaf to be put at a resistance of 20 ohms under a medium wind speed. Furthermore, Computational Fluid Dynamics was used to simulate the wind tunnel runs to further understand relations between experimental data and identify the most efficient leaf designs in low and high velocities.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN ET AT

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

192

2024

Fair Category

PS

Project
Number

6003

Title: Removal of Aquatic Micro Pollutants Using Functionalized Nanoparticles of Iron-Oxide

Student Name(s): J. Degl

Abstract:

Glyphosate is the most widely used herbicide in the world, and it is found in countless water supplies from drinking reservoirs to marine environments. Harmful effects on humans include links to cancer and chronic inflammation, and other neurotoxic effects. Effects on aquatic life include massive endocrine disruption and fundamental behavior alterations, possibly resulting in deviation of populations. Filtration of glyphosate is tedious and expensive, and especially disruptive to marine environments. The purpose of this project is to explore the efficiency of filtration of glyphosate by iron oxide nanoparticles, and determine optimal methods of removal. The introduction, and subsequent removal of iron oxide nanoparticles would be a cheap and clean way to remove glyphosate from marine environments without disrupting aquatic life. Different methods of functionalization of particles and particle removal were tested and compared. A sonicator was used to facilitate bonding of hexadecylphosphonic acid to the nanoparticles, and a spectrophotometer was used to take absorbance readings to measure concentration. Non functionalized particles extracted by centrifuge proved to remove and reduce glyphosate concentrations in experimentation. Results show that this method of filtration works, and shows promise to be implemented in an environmentally friendly way.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

EN EV EM

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

211

2024

Fair Category

PS

Project Number

6004

Title: Fresh vs Processed Electrolyte Amounts

Student Name(s): P. Santiago

Abstract:

My science fair project Fresh Vs Processed finds out whether freshly squeezed fruit juice or store brought fruit juice contain more electrolytes. The reason why I wanted to find this out was because of advertisements that said their drinks contain more electrolytes than other products and so I wanted to see if the same applied to companies that sell fruit juices. My hypothesis was that the processed juices would contain more electrolytes because I believed that those companies would add preservatives into their drinks like extra sugar, carbohydrates, etc. To do this experiment I bought an electrolyte testing kit that included a Multimeter that would record the electrolyte amount when connected to a straw and submerged inside the juice for three seconds.

Then after testing all juices three times and averaging up each side, it was found that the freshly squeezed fruit juice contained more electrolytes than the store brought ones by a small, but noticeable margin. In conclusion it was discovered that my hypothesis was wrong because the fresh fruit juice contained more electrolytes than the store brought juice. Upon further research I made another discovery that perhaps those companies who make juices not only add preservatives, but also remove things to make it more sour or sweet than before.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CH

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- Yes No

CSEF Official Abstract and Certification

Word Count

255

2024

Fair Category

PS

Project Number

6005

Title: Why Does My Neighborhood Have Less Trees Than Yours? Geospatial Modeling of Urban Tree Cover Inequalities in Connecticut Cities

Student Name(s): H. Witharana

Abstract:

Urban tree cover is disproportionately distributed in US cities including the state of Connecticut. Frequently, people of color dominant/low-income neighborhoods experience the highest level of inequalities in urban tree cover. The central goal of my study is to model the factors behind urban tree cover disparities in West Hartford (WH), East Hartford (EH), and Hartford (HT), Connecticut. I aimed to address two specific objectives: 1) understand what socio-economic variables drive present day tree cover inequality, and 2) utilize long-term present tree canopy cover (PTCC) trends to explore the effect of past discriminatory practices (Redlining) on present day tree cover. The first objective entailed statistical analysis based on socioeconomic variables and PTCC derived from census and urban forest data. The analysis was conducted at the census block level for WH, EH and HT. A set of explanatory variables were identified to develop regression models. The second objective entailed a geospatial analysis time series aerial imagery (1952-2021) for two candidate census blocks in the EH and WH. Results from census block level analysis demonstrated noticeable correlation between the PTCC and socio-economic variables, such as ethnicity and income level. Results further suggested a significant association between PTCC and land surface temperature and health burden. PTCC change results based on aerial image analysis provided compelling evidence to support my hypothesis of past discriminatory practices (Redlining) possibly having a potential effect on present day tree canopy cover. Overall, study findings unravel drivers behind tree inequality and help identify where future tree planting can take place.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EV EM EA

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

209

2024

Fair Category

PS

Project
Number

6006

Title: A Novel Method of Hair Dye Detection: Using Beer's Law in a Forensic Situation

Student Name(s): G. Tolomeo

Abstract:

Almost everywhere we go, we leave strands of our hair behind. This is a very important part of how detectives analyze crime scenes. When a strand of hair is found normally scientists are more worried about the DNA which it contains. The hair itself can reveal so much about a possible suspect, including if their hair was dyed and what color it was dyed to. The purpose of this experiment is to help scientists analyze hair that was left behind at crime scenes in new ways, specifically regarding its appearance. In this experiment, hair was dyed using a professional grade hair dye, and two different commercial hair dyes which could be purchased at a local pharmacy. The color of all three hair dyes was black. Beer's Law graphs were made for each of these hair dyes. After letting the dyed hair sit in acetone Beer's Law was used to determine how much hair dye came off the strand of hair. In all three hair dye solutions an average of 0.399 grams of dye was pulled off each strand of hair. This experiment shows that Beer's Law can be used to determine the amount of dye on a strand of hair no matter what brand of hair dye is used.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

CH

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

PS

Project Number

6007

Title: Best Material To Make A 3D Printed Shoe

Student Name(s): J. Ginin

Abstract:

3D printing has revolutionized the engineering world. A shoe is a necessity for mankind, but is not worldly available due to cost. A 3D printed shoe could help. To make a 3D printed shoe requires filaments. These filaments are labeled Acrylonitrile Butadiene Styrene (ABS), Polylactic Acid (PLA), High Impact Polystyrene (HIPS), Glycol Modified version of Polyethylene Terephthalate (PETG). The requirements of a shoe differ, but the fundamentals of a shoe should pass the following tests: water resistance, ground durability, flexibility and sustain pressure. This needs to be done in order to find the best material to make a 3D printed shoe. By performing the tests the capability of the shoes durability is seen. To test water resistance paper with a mass of 4.54 grams was placed inside the shoe with 25mL of water being poured above. Only the material PLA absorbed water shown when the mass increased by 0.1 ounces. To test ground durability the shoes were worn on a treadmill at a pace of 2 MPH for 15 minutes. Material ABS maintained its mass of 105g for all the trials. To test flexibility, weighted slabs around 50 newtons of force pressed down on the shoe. Every material broke except PETG. The final test started with cat-litter being poured inside the shoe then left for 3 days. Measuring width and height of the sole. ABS maintained width and height of sole measurements. The best material is PETG, it is the only material to not fail any test.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN EE MA

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

236

2024

Fair Category

PS

Project Number

6008

Title: Fiscatch: A Transformer-based Phishing Detection Model

Student Name(s): R. Jain

Abstract:

In recent years, the proliferation of cyberattacks, especially phishing, has led to a surge in security breaches and data theft. According to the FBI's 2022 Internet Crime Report, complaints have risen from 351,937 in 2018 to 800,944 in 2022. Furthermore, losses have risen from \$2.7 billion in 2018 to \$10.3 billion in 2022. This underscores the need for robust cybersecurity measures because they can steal valuable personal information like social security numbers, IP addresses, and credit card information, causing harm and financial repercussions. Countless research has been done on phishing attacks, but my research focused on incorporating advanced large language models like RoBERTa. I initially started with the NLTK Python package to mine for certain features in the text that could help determine phishing emails. Then, I utilized the RoBERTa Transformer model, which I specifically trained as a neural network to detect phishing emails. My model produced an accuracy of 96.6% in a dataset of approximately 11,000 emails. Taking this innovation one step further, I launched a website to detect phishing emails, utilizing Amazon Web Services (AWS) and Python. On this website, people can copy their email text and use my algorithm to decipher whether they are being phished. I hope that this project not only offers immediate assistance to people in identifying potential threats but also serves as a catalyst for future research efforts exploring the utilization of large language models for combating phishing attacks.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CS AT

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- Yes No

CSEF Official Abstract and Certification

Word Count

258

2024

Fair Category

PS

Project Number

6009

Title: Reinforcing the Cybersecurity of Medical Data via Software Countermeasures against Malware in Heart Monitoring Technology

Student Name(s): S. Chava

Abstract:

In our digital world, medical devices with remote monitoring, such as pacemakers, are subject to cyber attacks via technology, such as Bluetooth, WiFi, or close-contact RF, posing significant threats to users. Current solutions present, for instance hiring a cyber monitoring team, may be expensive for some consumers. In response to this threat, an affordable software could be designed to detect discrepancies in the monitoring data, alerting the user and their cybersecurity/healthcare team of a malicious attack.

This software was created and integrated with an interactive physical model, which used sensors to detect anomalies in heart data (BPM, Voltage, PSI). A Raspberry Pi collected, converted, and graphed the data (with an EKG). A Python algorithm differentiated six injected files as cyberattacks from preset medical conditions using live sensor data.

The model utilized buttons for simulating the heart's function. A DC Pump propelled ("blood") water through a tested and pressurized tube via an encoded relay, while a pressure and voltage sensor (on a CAD-designed and 3D printed T-Connector) transmitted analog data, which was digitized with an analog-to-digital converter, for inspection. A display showed the model's inputs to signify the heart's state and potential cyberattack/disease warnings, lighting the respective LEDs.

As the software ran, it successfully ascertained data related inconsistencies following common medical/electrical principles and proportionalities. Once detected, an intrusion alert would be promptly issued to the user and their respective cybersecurity team. This cybersecurity countermeasure would help secure the device and its respective data, thereby mitigating the adverse impact of these attacks.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CS EE ME

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

PS

Project Number

6010

Title: Creation of an Environment-Adaptive Reaction Algorithm Implemented on a Novel Smart Fluidic Servo Actuator to Provide a Sense of Pseudo-Exproprioception and Exteroception

Student Name(s): A. Bhattamishra

Abstract:

Everyone experiences a change in their walking gait pattern when walking on sand/unstable surfaces. While learning to walk, humans develop the ability to use sensory feedback to supplement joint function. However, the lack of proprioception and exteroception senses in prosthetic limbs limits users' adaptability to new environments. These human senses are difficult to recreate in bionic limbs, but are necessary for more sophisticated control than modern EMG sensors used with advanced prosthetics. To improve life, safety, and adaptability, recreating these senses is becoming a need. Previous work has established the capabilities/benefits of the novel SFSA (smart fluidic servo actuator) when implemented into a transtibial bionic by measuring torque, speed, current draw, and total costs, to provide an alternate, more efficient method of joint actuation in prosthetics. Due to its non-backdrivability, a unique opportunity for more robust sensory feedback and adaptation is present. This project aims to create an environment-adaptive prosthetic reaction algorithm and provide a sense of pseudo-exproprioception and exteroception. A novel method of completely decoupled reaction sensory feedback is implemented using a pair of load cells to measure reciprocating reaction force from each cylinder. The prototype was tested on four different surface types of varying stability and readings were characterized. An algorithm was developed and empirically validated the logic to correctly detect surface type. The student did all experimentation; mentor input was used for test setup validation and result analysis. This system opens the gate to further exploration into actuator-based sense mimicry.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

AT CS EE

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

PS

Project Number

6011

Title: Making Football Safer With the Smart Helmet

Student Name(s): P. Noe

Abstract:

Concussions occur when a person's brain hits their skull, and they are one of the hazards of playing football. Many concussions in football are caused by hard hits to the head, but not all concussions show severe symptoms. Symptoms of concussions include confusion, ringing ears, headache, blurry vision, dizziness, nausea, or memory loss. It's important that a player gets pulled off the field after a concussion because multiple concussions in a short period of time could cause permanent injury or death. The Smart Helmet detects how hard a player gets hit to determine if they have a concussion and need medical assistance. This experiment involved multiple tests to determine performance and utility of the Smart Helmet. These tests determined the battery life of the helmet, its range, and the compared theoretical output values with observed values. The radial range of the helmet was found to be approximately 100 feet (~ 33 yards), but that is heavily influenced by the model router that is used. Battery life was found to be 15 hours on a full charge, which is more than enough to sustain an entire game (~ 3-4 hours). Being able to provide theoretically consistent values from a great range, the Smart Helmet shows its ability to work as designed. In the future, other features such as SMS alerts could be implemented using OpenHAB. Furthermore, the range can be improved by upgrading the router model or by using Wi-Fi extenders. This design can help make the game of football safer.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

AT EE PH

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

156

2024

Fair Category

PS

Project
Number

6012

Title: Machine Learning Approach for Predicting Razor Kinematic Variables MR and Rsq in Supersymmetric Proton Collision Searches

Student Name(s): İ. Türkmen

Abstract:

This project aims to improve the accuracy and efficiency of detecting supersymmetric particles in high-energy physics through a supervised learning algorithm. Using the MultiJet dataset from CMS experiment's RunB of 2010 from the open data release, the project focuses on predicting two razor kinematic variables, MR (representing an overall mass scale) and Rsq (indicating energy flow), calculated from the momentums of "megajets" (sets of jets) in the proton-proton collision events for searching supersymmetric particles. The 21726 observations are split into a training (75%) and validation (25%) set. The algorithm is trained using information on jet vectors, scalar sums, jet counts, and event-related parameters. Employing neural networks with rectified linear unit (ReLU) function techniques, including avoiding overfitting, with mean square error, this study achieves 96.75% accuracy in predicting MR and 80.3% accuracy in predicting Rsq. The high accuracy levels achieved in this study demonstrate the effective use of machine learning in high-energy physics.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

CS PH

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

235

2024

Fair Category

PS

Project Number

6013

Title: Probing Solar Flare dynamics via Explainable AI techniques

Student Name(s): P. Yadav

Abstract:

This paper introduces a novel procedure for visualizing and understanding the knowledge acquired by convolutional neural networks and identifies several features that precede solar flares using those methods. We trained a Convolutional Neural Network (CNN) on solar images obtained from the Helioseismic and Magnetic Imager (HMI) and the Atmospheric Imaging Assembly (AIA) instruments installed aboard the Solar Dynamics Observatory (SDO). The forecasting model is designed to classify solar flares 12 hours into the future into three distinct classes based on their intensity (X, M, and C).

After training, we generate attribution visual heatmaps using seven different attribution methods: GradCam, Guided Backpropagation, guided GradCam, Vanilla saliency, Occlusion sensitivity, ScoreCam, and integrated gradient. By examining the activation heatmaps produced by these models, we find that the neural network identifies significant features for solar flare prediction: the polarity inversion line. We then analyze the heatmaps using binary masks and feature importance for a forest of trees to better study the PIL. Additionally, we identify novel pre-flare patterns in the EUV images by training images of different AIA bands to predict solar flares and analyzing their heatmaps. Subsequently, we examine the heatmaps to find that the results from feature importance are consistent with the attribution method heatmaps. To investigate the bias of the model, we also study how the model's architecture - accuracy, number of convolution layers, and the activation function - changes the way the model learns certain features.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

PH CS AT

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

169

2024

Fair Category

PS

Project Number

6015

Title: Inertial Movement Control System: Use of Reaction Wheels as an in-flight Steering Mechanism for Rockets

Student Name(s): T. Armstrong

Abstract:

Reaction wheels have been present in spacecraft since the 1970s, but were only used for their gyroscopic effect, or to make minor adjustments to maintain orbit. For major movements or adjustments, spacecraft have used auxiliary thrusters, which can be unreliable or expend their fuel load. Reaction wheels, despite their vast range of abilities, have never been used in this role. Here, it is demonstrated that reaction wheels not only are capable of this role, but that they excel in areas in which traditional methods have failed. To do this, a rocket was constructed which featured reaction wheels as a method of steering. By flying the rocket and propulsively landing it, reaction wheels' capabilities in this role could be showcased. Through a combination of static testing and in-flight demonstration, reaction wheels' ability to control a rocket in the same capacity as traditional methods was demonstrated. According to these findings, using reaction wheels, spacecraft would be able to control themselves more reliably and for a more extended period of time.

**Technical Disciplines Selected by the Student
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EE MA ET

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

251

2024

Fair Category

PS

Project Number

6017

Title: Creating a Novel Decision Tree-Based Change Point Detection Machine Learning Algorithm Employing Unsupervised Learning for Real-Time Earthquake Detection

Student Name(s): I. Yan

Abstract:

Earthquakes occur when tectonic plates release energy and move suddenly, causing devastating damages to surrounding areas. Resulting seismic waves provide valuable information for detecting earthquakes and their locations. Because of the variability and large amount of data, manually labeled detections are incomplete and subject to bias, highlighting a need for unsupervised learning. Current models are not sensitive enough and do not provide real-time detections. This project created a decision tree-based machine learning algorithm that used unsupervised learning for detecting earthquakes in real time. The algorithm was trained on seismic wave data from the STanford EArthquake Dataset (STEAD). The decision tree-based algorithm, which used a hierarchical tree structure to categorize data, automatically detected changes within the distribution of data itself, removing the need for learning from labels. The multidimensional data were split at each node of the decision tree based on projected values along the principal direction, which resulted in a sorting that exposed the distribution of data points. When new data was analyzed continuously, significant differences in the distribution of data indicated change points of earthquake occurrences. The algorithm was tested on different magnitude earthquakes in different locations. It was more accurate and more sensitive than existing research, while providing detections in real time. It was able to detect earthquakes of magnitude one up to five seconds in advance at a 88.3% accuracy. By accurately detecting earthquakes in real time at a high sensitivity, this algorithm can help experts understand natural phenomena better and significantly mitigate earthquake damages.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

AT CS MA

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CSEF Official Abstract and Certification

Word Count

253

2024

Fair Category

PS

Project Number

6019

Title: Reinforcement Learning Optimization of Placement of Public Vehicle Charging Stations using a Novel Parking Demand Model

Student Name(s): M. Wies

Abstract:

As environmental concerns escalate, the shift toward plug-in electric vehicles (EVs) are necessary to mitigate carbon emissions. Widespread optimized locations of charging stations, which support existing EVs and promote their adoption, is impeded by the lack of travel data that prior research relies on. This study created a novel parking demand model based on publicly available features in OpenStreetMap, rather than proprietary or non-existent travel data. The demand model was then successfully implemented into a Reinforcement Learning (RL) model that optimizes the placement and capacity of charging stations by considering budget constraints, parking demand, and user convenience. Analysis of the RL model in urban versus rural regions, using Bridgeport and Warren respectively, revealed that dense urban networks are challenging: the optimized plan of chargers for urban areas is more accurate than rural networks in real-world applications, yet they require more computational power due to the increased possible number of placement combinations. At-home charging stations offer increased, overnight convenience, reducing the reliance on public charging stations. Considering Level-2 and DC-charger ports (outputs of 6kW and 50kW respectively), each charger type shows a well-fit linear regression. State-wide, 27.3 less Level-2 charging ports and 3.35 less DC-ports would be needed to support the EV population, per 1% increase in the %EV-owners who charge at home. Summarizing, this research expands the scope of charging placement optimization to the global scale by creating a flexible tool using open data for future research in this area of study.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ET CS MA

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

240

2024

Fair Category

PS

Project Number

6020

Title: Developing and Testing a Laminar Airfoil Utilizing CFD to Implement Into General Aviation

Student Name(s): A. Huber

Abstract:

Over the past few years, anthropogenic carbon emissions have steadily increased. One major contributor is the fuel inefficiency of aircraft, mainly due to drag, the force acting against an object moving through the air. Drag originates from friction between air molecules and the wing's surface. Fortunately, optimizing the airfoil, the wing's two-dimensional cross-section, offers a potential avenue for significant drag reduction. Laminar flow is the continuous parallel flow of air over an object. It is crucial for aerodynamic efficiency and airfoil design. Slotted Natural Laminar Flow (SNLF) airfoils are being developed to delay the transition from laminar to turbulent flow, increasing the laminar flow over the airfoil and improving aircraft efficiency. This study designed and tested an SNLF airfoil using Fusion 360 and Ansys Fluent. The design aimed for potential implementation in the Cessna 172 Skyhawk due to the aircraft's global success. The Cessna 172 currently uses the NACA 2412 airfoil. Both the designed SNLF and NACA 2412 airfoils were simulated under Cessna 172 cruise conditions at a Reynolds number of $4.92 \cdot 10^6$. The simulations' meshes were validated using experimental wind tunnel data from the literature. A Mesh dependency test was done on both meshes to classify them as mesh-independent. Results were compared between the NACA 2412 and SNLF airfoil to evaluate the performance of the designed airfoil. Implementing this airfoil onto Cessna 172, the #1 globally purchased aircraft, reduces anthropogenic carbon emissions and increases overall performance.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

ET AT PH

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

115

2024

Fair Category

PS

Project
Number

6021

Title: Manipulating Node-wise Gradient Directions to Prevent Catastrophic Forgetting

Student Name(s): M. Tsai, X. Zhang

Abstract:

Sequential task learning without forgetting is a critical challenge in deep learning, often referred to as continual learning or lifelong learning. While existing regularization-based methods primarily emphasize node importance evaluation, they often overlook optimization strategies for neural networks, potentially hindering performance and underutilizing network capacity. To address this, we propose a novel optimization framework that synergistically combines node importance evaluation with gradient descent regularization. This framework leverages a regularization-based method to assess node importance, which subsequently dictates the determination of optimal gradient directions for all neural network nodes. Experiments conducted on the CIFAR-100 dataset demonstrate that our approach effectively enhances regularization-based methods and maximizes the utilization of fixed-capacity neural networks.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

CS

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

186

2024

Fair Category

PS

Project Number

6022

Title: Making Clothes Fire-Retardant

Student Name(s): D. Viguilla

Abstract:

Because fire poses numerous hazards and dangers, various efforts have been made to reduce the effect of fire and flame on clothing. Fire retardants were created to make fire less effective or weaker on garments. An example of this is a borax solution, which is made up of borax, boric acid, and water. The goal of this experiment is to determine if the borax solution can make certain types of clothing fire-retardant. The procedure begins by cutting various types of clothes into testable pieces, followed by the preparation of the borax solution. The pieces were then submerged in the combined solution and dried. To then test the cloths, they were lit on fire. The average time it took for them to catch fire and the average time it took for the pieces to self-extinguish were recorded and compared. The results of the experiment show that once the pieces were ignited, it took longer for the treatment group to catch fire; but their fires burned out faster than the control group. These results suggest that the borax solution aided in making the clothes fire-retardant.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CH

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

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 vertebrate animals controlled substances

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

231

2024

Fair Category

PS

Project
Number

6023

Title: ROLE OF GRAVITY IN OXYGEN GAS REMOVAL IN POLYMER ELECTROLYTE MEMBRANE WATER ELECTROLYZERS

Student Name(s): J. Hall

Abstract:

90% of current energy needs are supplied by fossil fuels, which greatly exacerbate the climate crisis by producing greenhouse gas emissions. Hydrogen energy offers one viable way to circumvent this, with its high energy density and ease of transport without energy loss. Hydrogen PEM electrolyzers that produce hydrogen run well on high flow rates of water, but when run on lower, less resource-intensive flow rates, their performance suffers. We decided to see if we could use gravity to help augment electrolyzer performance at a lower flow rate so that less water will be wasted when it simply passes through the cell without reacting, in turn allowing for cheaper operating costs and lower water bills. After preliminary break-ins and baseline low flow rate tests, the cell will be run in inverted and planar orientations, with the anode facing up and then with the anode facing down. Currently the testing has not been completed as we have observed some complications in the testing involving unexpected performance metrics that do not align with the commonly accepted knowledge of electrolyzers at this time. Future studies will involve analyzing why a lower flow rate (well below optimal) yielded higher performance. Additionally, we will run the same test but with water channels of altered size and geometry so that bubbles do not become stuck as easily and water surface tension does not play a role.

**Technical Disciplines Selected by the Student
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EE ET

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CSEF Official Abstract and Certification

Word Count

226

2024

Fair Category

PS

Project Number

6024

Title: Developing a Quadrant Wind Tunnel Design on Trains to Generate Renewable Energy and Decrease Consumption of Fossil Fuels by Utilizing Movement-Induced Wind Produced by Trains

Student Name(s): S. Kunichetty

Abstract:

According to the U.S. Energy Information Administration, 95% of energy used by the transportation industry is generated by fossil fuels, which release harmful CO₂ emissions into the environment. To increase use of renewable energy in transportation, train-induced wind energy provides a valuable opportunity because trains create reliable wind sources from their constant movement over long periods of time. In current research, power generation sources are placed externally to the train, like placing windmills along train tracks to produce power. Instead, I propose the quadrant wind tunnel system, a novel energy generation system that is part of the train itself. Attached to the top corners of a train car, rotor assemblies use wind flow from the train's continuous motion to generate electrical current powering the train. I created a mathematical model of the quadrant wind tunnel system to optimize design parameters based on power generated and costs saved. To test possible parameters, I used the train route from New Haven to Grand Central, the most popular train route in Connecticut. With the quadrant wind tunnel system, it is estimated that 126 kWh of energy is produced per trip per car, saving \$7.7 million dollars per year, 6.1% of Metro North's energy costs. The proposed quadrant wind tunnel design has the potential to reduce long run fossil fuels usage and create a more cost-efficient transportation system.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

ET EE CS

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 vertebrate animals controlled substances

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

252

2024

Fair Category

PS

Project Number

6025

Title: Deep learning-based drug response prediction algorithm about synergistic and antagonistic responses of cell lines and drug combinations.

Student Name(s): J. Chen

Abstract:

Cancer, a disease characterized by uncontrolled cell growth, has numerous types and often demands drug combinations to increase efficiency and reduce the side effects of the treatment. This combination needs advanced strategies to predict their effects: synergistic or antagonistic. The traditional approach relies on actual experiments; the huge cost of money and time makes the efficiency relatively low. Therefore, I integrated various deep-learning models to predict the synergy effect. GINConvNet combines a Graph Isomorphism Network (GIN) with a convolutional network, significantly outperforming other models in predicting the synergistic and antagonistic responses of cell lines to drug combinations. GIN identifies structural equivalences in graph-structured data (drugs and their molecular structures) regardless of label differences. This model processes drug and cell representations independently in dual tower architecture, employing the multiplication of drug concentrations to enhance interaction predictions. Its performance is evaluated using metrics such as root mean square error (RMSE), mean squared error (MSE), Pearson's r , and Spearman's ρ . The dataset is from NCI-ALMANAC, encompassing over 5,000 drug combinations across 60 cell lines, and was used for training and validation. GINConvNet demonstrated the lowest RMSE and MSE, which means higher accuracy of prediction, superior capability in capturing the complex interactions between drug combinations and cell lines, and strength in graph classification and similarity comparison tasks. This model might help clinicians tailor cancer treatments, potentially leading to more effective and personalized therapeutic strategies with relatively fewer side effects.

Keywords: Drug-drug interaction, Graph Isomorphism Network, graph convolution network, deep learning, synergy, antagonism.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CBIO ME CS

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2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

243

2024

Fair Category

PS

Project Number

6027

Title: Analog Neuron Circuit with Oscillatory Firing

Student Name(s): K. Lee

Abstract:

The field of neuroprosthesis concerns neuroprostheses, devices that use electrodes to interface with the nervous system and work to restore functions lost from neural damage. This project works on developing a neuron-mimicking analog circuit whose architecture can be utilized in neuroprosthesis and mimicking neural behavior. This project involved emulating four main aspects of neuron behavior: voltage accumulation, action potential, depolarization, and a leaky path.

The voltage accumulation was implemented using an Op-Amp integrator where the output voltage acted as the circuit analogue of a neuron's membrane voltage. The leaky path was implemented by raising the integrator's offset voltage as it leads to a constant decrease in integrator output without other inputs. The action potential was implemented by sending the integrator's output into an Op-Amp comparator where the reference voltage for the comparator acts as a neuron's threshold voltage and output of the comparator acting as the action potential. Depolarization was implemented by connecting an NMOS transistor in parallel to the integrator's accumulating capacitor and sending the comparator output to the transistor's gate. This simultaneously resets the integrator's voltage after reaching the threshold voltage and turns the comparator's outputs into spikes.

This circuit successfully mimics the spiking behavior of an individual neuron and by implementing another integrator a neuron unit was able to cause another to spike; however, the recreation of oscillatory neuron firing exhibited inconsistent behavior, and future work will involve making this consistent and decreasing the unit's operating frequency.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

AT EE

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

172

2024

Fair Category

PS

Project
Number

6028

Title: Is there Investigations into the Link Between Water Quality and Social Inequity.

Student Name(s): C. Barria Lopez

Abstract:

Water is an important resource and it is important that everyone has “clean” water. Connecticut has many different communities and this investigation focuses on the quality of water from many communities in and around Hartford to see if there are any disparities related to population, race, or overall status of a town.

This project will investigate whether there is inequality in our water supply around Connecticut. Samples were obtained from 20 tap water supplies from towns around Connecticut. The tap water samples were tested using a test strip and plotting the pH and the hardness on a graph. Hartford, East Hartford, Manchester, New Britain, Windsor Locks, South Windsor, Weathersfield, Canton, Bloomfield, Danbury, Newington, and Rocky Hill all have similar pH and hardness even when there are differences in race and opportunities in that town. It was found that Southington's water sample had higher numbers than the rest. This is interesting because Southington is very close to New Britain and the sample tested from New Britain had the second-highest pH and hardness.

**Technical Disciplines Selected by the Student
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EM EV

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

224

2024

Fair Category

PS

Project Number

6029

Title: Detection and Prediction of Dark Matter through Weak Gravitational Lensing Effects and Deep Learning

Student Name(s): Y. Cho

Abstract:

This project aims to address the properties of dark matter, a substantial but elusive component of the universe's matter, by employing innovative methodologies that surpass traditional techniques. In my research project, I investigated the enigmatic nature of dark matter by employing a fusion of weak gravitational lensing and advanced deep learning methods. By integrating neural score matching and other sophisticated deep learning algorithms, I aimed to refine the precision of dark matter maps derived from weak gravitational lensing data. This approach surpassed conventional methods and provided a more intricate understanding of dark matter's impact on cosmic structures. My project encompassed a thorough analysis of dark matter theories, a comprehensive review of gravitational lensing as a detection technique, and an exploration of the novel application of deep learning in astrophysical research. Through meticulous modeling of the lensing effect and preprocessing of astronomical images, I ensured the reliability of my analyses. Leveraging both empirical data and theoretical models, I applied a deep-learning-assisted approach to reconstruct dark matter maps, showcasing significant advancements in astrophysical research. My findings not only yielded detailed maps of cosmic regions but also unveiled intricate patterns of dark matter distribution, particularly around massive clusters. This project represents a substantial leap forward in unraveling the mysteries of dark matter, underscoring the potential of integrating machine learning in the comprehension of the cosmos.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

PH CS

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

247

2024

Fair Category

PS

Project Number

6030

Title: Using a Sodium Alginate Derived Porous Carbon Material to Increase the Capacitance of a Cellulose Matrix

Student Name(s): I. E Silva

Abstract:

In recent years, carbon biomass materials have been seen as promising electrode materials due to their high conductivity, molecular stability, and their low cost. Sodium alginate, a compound commonly found in a variety of kelp species, is a carbon biomass material that is very easy to obtain and is known to be highly conductive in its pyrolyzed state. This project aims to use a pyrolyzed form of sodium alginate to develop a capacitor made solely of compounds found in kelp. To achieve this, the seaweed must first undergo the sodium alginate extraction, which is comprised of 3 basic steps: Acidic Breakdown using 0.5M HCl, Alkaline Extraction using 5% Na₂CO₃ solution, and an Ethanol rinse. After extraction the alginate must air-dry overnight before pyrolyzation may begin. To achieve a porous carbon material the alginate must be pyrolyzed at 500 – 600°C for about 5 minutes. Using a blast furnace made of fire bricks and ceramic insulation, about 547°C was achieved. Using the sodium alginate derived porous carbon material (SADPC), a capacitor like system was made using 0.1 grams of SADPC and 0.1 grams of seaweed as a dielectric material. It was able to hold 1.5 volts of electricity for about 6 seconds after the power source was turned off. Before being turned off the power source was on for 28 seconds. When compared to the control model made with only seaweed the outputs were very similar, meaning that both models were equally effective in maintaining energy flow.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EN EE ET

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2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

252

2024

Fair Category

PS

Project Number

6035

Title: A Novel Approach for a Biomimetic Undersea Generator to Harness Natural Ocean Currents

Student Name(s): P. Kakkar

Abstract:

The race to find reliable renewable energy sources has become a daunting, yet crucial, task for humanity in these past few years; however, the solution has been right in front of us this entire time: the untapped energy found within the vast ocean. This study's primary focus is the use of a biomimetic turbine design that can harness the steady motion of waves on the ocean floor.

The control for this investigation is the pre-existing turbine design that is being used by well-known organizations such as the U.S. Department of Energy. Alongside unique biomimetic designs, other testing variables will be the number of blades/fins on each turbine and the wave speed.

The first part of this investigation was to design turbines based on animals with optimal aerodynamics. The chosen designs were based on a Swordfish's caudal fin of swordfish and the pectoral fin of humpback whales. The optimal number of fins for each turbine was found to be 3 based on preliminary simulations. The second phase of the investigation was manufacturing the turbines using a 3D printer. A uniform flow source was used from a jacuzzi jet to test the power generation of the turbines. From the results, the pectoral humpback whale-inspired turbine generated 32% more power than the control turbine. Similarly, investigations of the biomimetic turbine compared to the caudal design showed a 24% increase. The results from physical testing agree with the CFD modeling which examined the rotational speed, torque, and power production of the turbines.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ET EA EN

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

256

2024

Fair Category

PS

Project Number

6036

Title: Evaluating Hyperparameter Tuned Machine Learning Classifiers for Pancreatic Cancer Detection via Urinary Biomarkers

Student Name(s): N. Ananth Iyer, N. Ananth Iyer, N. Ananth Iyer

Abstract:

Pancreatic cancer, though accounting for only 3% of all cancers in the US, is highly lethal. Early detection is critical for effective treatment, with up to 44% recovery when identified before tumor maturation. Current diagnostic tools, mainly blood tests, often lack sensitivity for early detection with accuracies of up to 87%, thus highlighting the need for a new approach to diagnostic tests. This study explores urinary biomarkers as a promising alternative, specifically creatinine, LYVE1, REG1B, and TFF1. Hyperparameter tuning is employed to enhance the accuracy using a 590 sample-based dataset from the Spanish National Cancer Research Center. Gradient boosting models (XGBoost and LightGBM), a Random Forest Classifier, a support vector machine, and a 1D CNN-LSTM model were examined due to their predicted compatibility with the dataset. The finalized model training shows that, in detecting early-stage pancreatic cancer, XGBoost and LightGBM perform equally well with an accuracy of 91%. The Random Forest Classifier had an 87% accuracy while the support vector machine had an 80% accuracy. Interestingly, the 1D CNN-LSTM model achieved a 78% accuracy. With results from Menoufia University showing a 97% accuracy for the 1D CNN-LSTM model, the specific parameters and dataset size needed for the model come into question. Furthermore, extensions diving into the efficiency of gradient boosting models in datasets can expand the future development of detection accuracy. Ultimately, these results suggest that urinary biomarkers, particularly creatinine, LYVE1, REG1B, and TFF1, can serve as effective alternatives for early-stage pancreatic cancer detection when evaluated by hyperparameter-tuned models.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

C BIO CS MA

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

128

2024

Fair Category

PS

Project Number

6037

Title: Speech to Text: An iOS App to Help the Hard of Hearing

Student Name(s): N. Scrofani

Abstract:

My project aims to develop assistive technology for people who are deaf or hard of hearing. The design goal was to find a simple, readily available technology that would allow someone who is deaf to read what is being said to them. In addition, it would enable the user to use technology to turn text into speech.

Of the 331 million people in the United States, 41 million struggle with hearing loss. Only 500,000 deaf or hard of hearing people use American Sign Language (ASL). Communication can be a barrier for people who struggle with hearing loss.

Since 136.97 million people use iPhones, which are portable, easy to use, and have enhanced cybersecurity, my project uses an iPhone and an online app to provide easily accessible communication tools

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CS

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

247

2024

Fair Category

PS

Project Number

6039

Title: Development of an Autonomous Drone with Image Recognition Capabilities to Detect Diseased Corn

Student Name(s): A. Ku

Abstract:

Corn is one of the most widely produced crops in the world, and has widespread use as food, flour, and oil. But it is also susceptible to a large range of diseases from northern corn leaf blight, gray leaf spot, southern rust, eyespot, tarspot, Anthracnose leaf blight, etc. To help farmers increase yield, this project has developed an autonomous drone capable of detecting and classifying these diseases in realtime in the field. For more efficient training of neural networks, three diseases have been chosen: northern corn leaf blight, gray leaf spot, and southern rust. Images taken from the onboard GoPro camera are passed through a CNN model to be classified. The particular model created for this project was made with Keras, and utilizes a single 32x32 convolutional layer followed by six 64x64 convolutional layer finally ending with a softmax classifier which marks the image as having the three diseases or as a healthy control plant.

The model reached an accuracy of 98.65% on fresh inference data running on the onboard Pi, showing that effective classification of diseased corn was achieved. This can greatly impact agriculture as the techniques used in this project can be applied to create staple crops to increase yield as well, and compared to current techniques, which mainly include satellite imagery, or manual labor, this approach offers a low-cost and efficient alternative. Another possible extension could involve the use of swarm robotics as larger fields may be more effectively surveyed by multiple drones.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

EE PS CS

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

PS

Project Number

6040

Title: Ino-vasive Eating

Student Name(s): G. Lopez

Abstract:

Invasive insects cost the global economy around 70 billion dollars annually. This comes from crop loss caused by damages and plant disease. My goal is to provide a clean source of food to prevent crop loss while also feeding people. Before I could start making the insects into more appetizing food, I first had to research insects that had good nutritional value and would be able to sustain people as a food source. I found that crickets are high in protein, as much as 73%. Crickets are already eaten around the world but despite this people think eating bugs is unappetizing so I decided to put them in something more appealing. I baked them into cookies and lollipops so you could see them clearer. The cookies turned out great, the crickets looked like chocolate chips and could only be noticed if you looked closely. This visual aspect helps people that have never eaten bugs before so to them the food would look more familiar. The lollipops were able to display the bugs so that if people wanted, they could get a clearer look at what they were eating. After making the food, I found that insects don't have to be gross and can be easily incorporated into foods. There is no limit to how many dishes insects can be added to for additional nutrients. It would be beneficial to investigate and see how many people would be open to eating insects before and after they know their value.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

242

2024

Fair Category

PS

Project
Number

6041

Title: Analysis of Green Solvent Mixtures to Determine Their Use in Nucleopeptide Solid Phase Peptide Synthesis

Student Name(s): M. Bierowski

Abstract:

Restrictions on dimethylformamide (DMF) have been imposed in the European Union due to its hazardous properties, inspiring a search to find greener solvents for fluorenylmethoxycarbonyl (Fmoc) solid phase peptide synthesis (SPPS). This project compared synthesis yields, swelling capabilities, and nucleoside solubilities of dimethyl sulfoxide and ethyl acetate (DMSO/EtOAc) and dihydrolevoglucosenone and diethyl carbonate (Cyrene/DEC) on the synthesis of the guanosine-containing nucleopeptide gs-GKFF-OH. It was hypothesized that DMSO/EtOAc will be comparable to the use of DMF in SPPS for synthesizing the nucleopeptide gs-GKFF-OH. Methods included synthesis of the nucleopeptide, which followed standard Fmoc SPPS procedure including resin swelling, deprotection of the terminal amino acid, rinsing, activation, and coupling of each amino acid until the nucleopeptide was fully synthesized. Results were measured using high performance liquid chromatography and MALDI-Tof mass spectrometry to determine the purity and synthesis yields and swell tests were performed to determine resin swelling capabilities. Results were inconclusive due to solubility issues and discrepancies in methods when synthesized with Cyrene/DEC. However our results showed promise for DMSO/EtOAc due to its higher yields in comparison to Cyrene/DEC and DMF and better solubility and swelling capabilities. As applications using nucleopeptides continue to grow, there is a need for further research into green solvents for nucleopeptide SPPS to shift drug synthesis and its other therapeutic applications towards greener and more sustainable materials to adapt to new regulations and the changing climate crisis.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

BI

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

180

2024

Fair Category

PS

Project
Number

6042

Title: Exploring Gravitational Forces in Comparison with Acceleration on Different Elements of a Model Roller

Student Name(s): N. Simpson

Abstract:

Roller coasters exhibit a range of g forces, rapidly changing velocity, and acceleration, which in turn could be harmful to riders. Despite the intensity of thrill coasters, their design maintains a riders consciousness due to a balance of g forces and design elements. Using the creation of a custom 3D design and printed model of a roller coaster that features a hill, drop, loop, and banked curve, a cart will be run through the course with an accelerometer. The accelerometer will provide data on the combined effect of acceleration and g forces. In addition, the proposed safety of thrill coasters featuring intense changes in g force and acceleration can be further verified and understood. This study is expected to bring to light the relationship between g forces and acceleration on the different aspects of a roller coaster. With acceleration and g forces having the potential to cause a loss of consciousness, the results of the model roller coaster will be sized up and compared with data from a variety of real thrill coasters and data on human g force tolerance.

**Technical Disciplines Selected by the Student
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EE

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- Yes No

CSEF Official Abstract and Certification

Word Count

221

2024

Fair Category

PS

Project Number

6043

Title: A 2-DOF Pneumatic Shoulder Rehabilitation Device Based on Soft Materials

Student Name(s): M. Ren

Abstract:

Motivated by the increase in shoulder related surgeries and the subsequent shortage in post operative rehabilitation. This work presents an innovative pneumatic shoulder rehabilitation device designed to mimic the natural movement of the joint and facilitate a dual range of rehabilitation exercises. Powered by individual inflation through an air pump with a maximum air pressure, and observed through a pressure sensor, the device contains three modules' spines with seven modules in each spine to enable the 2DOF movement. Currently, the device is set to compete two basic shoulder rehabilitation movements: vertical abduction, horizontal extension, and flexion. The development process of the device began with the development of the heat-sealing process as it and the material of the air modules were the crucial aspects for the module withstanding the required air pressure of up to 80 kPa when completing movements. Subsequently, 3D structures and spine designs were assessed to maximize the mutual compression force. Following assembly, the device's control system was programmed using Arduino IDE and integrated with a Bluetooth module for convenient user manipulation via a smartphone. After development, a test performed demonstrated a commendable vertical range of 56.4° and a horizontal range of 109.2°. This range highlights the promising ability of the shoulder rehabilitation device to complete the two 2-DOF predetermined movement as it meets its quantitative benchmarks.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EE EN ME

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

254

2024

Fair Category

PS

Project Number

6044

Title: A Deep Semi-Supervised Domain Generalization Approach for Epileptic Seizure Prediction using

Student Name(s): S. An

Abstract:

According to the World Health Organization, nearly 50 million people suffer from epilepsy, one of the most common neurological disease. Epilepsy is characterized by abnormal brain activity, leading to recurrent seizures. Each seizure manifests as sudden, uncontrolled bursts of electrical activity in the brain, and the injuries and restrictions on daily life underscores the urgency of finding effective methods for epileptic seizure prediction. With the use of deep learning techniques, early predictions of epileptic seizures, an unsolved problem, are attempted in this paper. Previous research has limitations of being sensitive to noise as it is dependent on specific electroencephalogram (EEG) devices and datasets, a serious issue this paper solves. In this paper, a semi-supervised based domain generalization method to develop an accurate seizure prediction system is proposed. It consists of two phases: representation learning and transfer learning phase. To achieve high precision, the proposed method utilizes a representation learning approach. Here, a feature-swapping mechanism that effectively disentangles seizure-related features is introduced. During transfer learning, the pre-trained network is trained to output the probability of whether the input EEG indicates a seizure or not. The proposed model achieves state-of-the-art performance, with an accuracy of 90.53% and 94.88% on the NICU and Epileptic Seizure Recognition datasets respectively in within-dataset evaluations. It outperforms the previous methods by 19.35% in cross-dataset evaluations. This robust improvement opens up promising possibilities for real-world clinical applications. The proposed feature disentangling method is also expected to contribute to developing reliable medical tools.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ME AT EN

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 vertebrate animals controlled substances

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

232

2024

Fair Category

PS

Project
Number

6045

Title: A Novel Head Tilt Alerting Device Built Using an MPU6050 Gyroscope and Accelerometer, Vibrator Motor, and Flutter iOS and Android Mobile Application for the Treatment of Torticollis

Student Name(s): S. Srinivasan

Abstract:

Torticollis, or “twisted neck” condition, is an abnormal shape or neck rotation formed due to underlying or acquired causes. While it comes in varied forms, such as congenital torticollis, it is prevalent as it has an incidence of one in 250 newborns, and 90% of people experience one episode. If left untreated, torticollis can develop into harmful ailments such as spinal misalignment.

The research aims to develop a practical and feasible alerting device to reduce the head tilt caused by torticollis. The application, inspired by the shape of ear devices such as hearing aids, was designed to measure the patient’s head tilt and alert them if it exceeds a configuration limit through minor vibrations of the device. The mobile application was created to authenticate the patient and log the count of alarm data on a daily basis. Analysis of the technology demonstrated that the application was very effective in the gradual decrease in head tilt and alerts, ultimately decreasing the possibility of acquiring future medical ailments and conditions.

The main technologies in the project's development include Arduino technologies for the hardware and the Flutter framework, Dart language, and Firebase Database for mobile applications. The Bluetooth communication protocol was also paramount in the connection and functionality between the hardware device and the app.

This easily implementable solution is recommended for treating Torticollis, and further research will be done to improve the current application.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

AT CS EE

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

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2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

223

2024

Fair Category

PS

Project Number

6046

Title: An Evaluation of Biochars Surface Area and Porosity Capacity to Remediate Heavy Metal Contaminated Aquatic Systems

Student Name(s): S. Clark

Abstract:

Biochar is a granular, charcoal substance used to reduce nutrient pollution in sediments and water bodies. It is synthesized through pyrolysis, which takes an organic substance and burns it without oxygen. Biochar is a useful way to reduce nutrient pollution in water bodies, but research has not been conducted on whether the application and carrying technique affects biochar's efficiency in absorbing metals. This project studies the flow rate, surface area, and total exposure of biochar through changing the size, shape, and porosity of the mesh. The maximum sustainable yield is found by comparing the effort required per unit to the application technique. Two different types of mesh were used: a clear, silk screen mesh with a solidity ratio of 49%, and a dark gardening mesh with a solidity ratio of 59%. The data indicated that both zinc and copper solutions required a far less amount of effort in relation to the concentration of heavy metal pollutant retrieved from each solution. It was also shown that the clear mesh has an overall better sorption of heavy metals. Due to the higher concentration of elements in the biochar with the clear mesh, a lower solidity can affect the concentration of pollutants absorbed. A higher flow rate and porosity of the mesh also aids in the amount of heavy metal pollutants absorbed from a given solution.

**Technical Disciplines Selected by the Student
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EM EN EV

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

253

2024

Fair Category

PS

Project Number

6048

Title: Single Cell Multi-omics Analysis of Glioblastoma: Identification of Differentially Expressed Genes and Diagnosis of Isocitrate Dehydrogenase Mutants

Student Name(s): S. Jonnalagadda

Abstract:

Glioblastoma multiforme (GBM) is the most common type of malignant tumor found within the central nervous system and is characterized by the uncontrolled growth of glial cells, leading to the development of tumors in the brain. Despite existing therapy, the life expectancy remains low for those diagnosed. In this study, I conducted genomic analyses with the goal of deepening the understanding of GBM biology while also enhancing diagnostic accuracy, particularly in the identification of Isocitrate Dehydrogenase (IDH) mutants, a significant subtype of GBM known for its comparatively higher survival rate compared to GBM/IDH wild type tumors. First, I performed differential gene expression analysis using DNA methylation fingerprints from glioma tumor cells, revealing significant upregulation of genes such as AFF3, OSM, and downregulation of genes including ACVR1 and PLAT. Gene Ontology enrichment analysis highlighted the function of these genes in the regulation of biological processes, revealing the role of these genes in GBM pathogenesis. Next, I integrated multi-omics data (DNA methylation and RNA-seq) to develop predictive models for accurate diagnosis of IDH mutants. ML models such as K-nearest neighbors, logistic regression, XGBoost, and Support Vector Machine, achieved promising results in distinguishing between IDH mutants and GBM. Notably, the ensemble method outperformed other models with an AUC score of 0.96, indicating robust diagnostic capability. The presented models shed light on potential biomarkers like AFF3 and provide insights into the biological processes underlying GBM progression. The predictive models are a promising tool for accurate diagnosis and can aid in personalized treatment strategies.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CS CBIO CB

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

252

2024

Fair Category

PS

Project Number

6049

Title: Talent vs. Luck: Success in a Capitalistic Society

Student Name(s): K. Mausjima

Abstract:

Many individuals who have achieved significant success attribute their accomplishments to their talent or effort. However, the Ig Nobel Prize-winning research conducted by Alessandro Pluchino and colleagues found that the wealthiest and most successful individuals are not the most talented, but rather those who are the most lucky.

While I acknowledge the importance of luck as highlighted by Pluchino's research, I believe that talent plays a more significant role than their model suggests. My disagreement stems from the definition of talent used in their model, which I believe leads to an inaccurate conclusion. However, I argue that success is not merely a serendipitous encounter, but rather the outcome of actions taken. Therefore, I propose an action-oriented definition of talent. Talent should be seen as the capacity to take a variety of actions, which can create opportunities for success. By redefining talent this way, we can develop a more nuanced model of the interplay between talent and luck in determining success. The improved model would not only account for the role of lucky events but also recognize the importance of the actions that individuals can take because of their talent.

In this simulation, we will represent the research from Mr. Pluchino's research, however, changed the definition of talent. Lucky events are won according to talent and double assets, and Unlucky events are avoidable by talent and reduce assets by half. The model's quality can be confirmed by observing that the wealth distribution by income group is representing the real life democratic.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

MA

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

223

2024

Fair Category

PS

Project
Number

6050

Title: Homemade Biodegradable Plastic: Manufacture, Durability and Biodegradability

Student Name(s): C. Burke

Abstract:

Plastic pollution is a major problem hurting the wildlife and environments of our beloved planet. I wished to help my own family take steps to the goal of increasing sustainability by making biodegradable plastic. This project included 4 trials of changing and trying out different recipes and solutions to try and find one that would meet the requirements of a utensil. It took figuring out how much of each ingredient was used, the heat of the stove, the place it was stored, and how it should be stirred while heating, for me to meet my goal. The goal included making a utensil usable to eat ice cream, yogurt, soup, cereal, and make other foods. The strength of the biodegradable plastic was compared to a normal plastic utensil by 2 trials of attaching string and a bag to the utensil clamped on the edge of a table and adding pennies till it broke. Although it didn't do as well as the normal plastic, it was able to hold up to 42 g of pennies, which is plenty for normal use. The biodegradation of the plastic was tested by adding the plastic utensil to three different environments. Then, four measurements (cm) were taken in different parts of the utensil. After two weeks these same measurements were taken again to reassess how much the plastic biodegraded.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

243

2024

Fair Category

PS

Project Number

6051

Title: On the Properties of Quadrilaterals Determined by Triangle Centers

Student Name(s): K. Lee

Abstract:

The diagonals of a convex quadrilateral determine four triangles. Within each triangle, select a triangle center (e.g., incenter, centroid, circumcenter, orthocenter, etc.) that will define a new quadrilateral.

Is there something interesting to be said about this quadrilateral? What if the initial quadrilateral has some particular property (e.g., it could be cyclic, tangential, orthodiagonal, equidiagonal, etc.)? Does that property transfer to the central quadrilateral? Or maybe the central quadrilateral enjoys some other property?

This type of problem has been considered before, with origins that could be traced as early as 1850's. However, until very recently the research was limited to the case when the centers were among the familiar ones: incenter, centroid, circumcenter, and orthocenter. In 1993 Clark Kimberling extended the notion of triangle center to include a much wider class of points associated with a triangle. There are currently more than 61,000 such entries in the online Encyclopedia of Triangle Centers (ETC).

In a recent paper, Rabinowitz and Suppa investigated the first 1000 centers listed in ETC in the context of the original question and discovered many new results. Our research finds simpler proofs of some of their statements and discovers new results.

For example, one of our results is the following:

Let ABCD be a convex quadrilateral. Then, the quadrilateral formed by the circumcenters of triangles BCD, CDA, DAB, and ABC and the one formed by the 9-point centers of the same triangles are similar and have opposite orientations.

Technical Disciplines Selected by the Student
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MA CS

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

261

2024

Fair Category

PS

Project
Number

6052

Title: Synthesis of Porous Polymer Sponge Matrix using Modified Sodium Alginate Clay Compound for Adsorptive Removal of Microplastics and Oil from Contaminated Water

Student Name(s): S. Mohanraj

Abstract:

Many water sources, including drinking water, contain microplastics and oil. Both contaminants are harmful to us and the environment, yet current removal methods are inefficient, expensive, and/or not environmentally-friendly.

Through synthesizing a clay-alginate sponge matrix with an ionic liquid (IL), an efficient method to remove microplastic and oil contamination from water will be devised.

Montmorillonite clay (MMT) is naturally-abundant, safe, and inexpensive, with notably great adsorption properties and high surface area, essential for an efficient water filtration system.

My past research has confirmed pure MMT's effectiveness in removing microplastics and oil, prompting my current research for optimization. Sodium alginate (SA) is a safe commonly-used substance that can increase the clay's adsorption affinity for pollutants due to its backbone structure with excess carboxyl and hydroxyl groups. Loading the sponge matrix with an IL further increases adsorption as well as stability, as ILs have shown promise in organic pollutant removal. The sponge matrix with the IL loaded clay-alginate compound will be synthesized using both freeze-drying and dip-coating methodologies.

Research analyzing removal capabilities of MMT with SA and a loaded IL was conducted using ultraviolet-visible spectroscopy analyses, with scanning electron microscopy to investigate the matrices' surface structures. The sponge matrix with SA, MMT, and IL indeed yielded the highest results, removing 77.87% of PETE microplastics and 81.71% of gasoline oil at 20°C with a 60 min treatment period.

A prototype for a household water filtration system using the SA+MMT+IL cross-linked polymer has been developed and is currently being tested for optimization.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM EN AT

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

PS

Project Number

6053

Title: Reduced Carbon Dioxide Emission and Increased Energy Efficiency Via a Newly-Designed Superconductive Cryogenic Brushless DC Motor

Student Name(s): I. Ambastha

Abstract:

Aircraft discharge about 800 megatons of carbon dioxide into the atmosphere yearly. To reduce CO₂ emissions, two approaches warrant investigation: a new form of sustainable fuel (e.g., hydrogen), and a new propulsion system that is more fuel efficient, which is the purpose of this research project. Winding a brushless DC motor with high-temperature superconducting (HTS) tapes can reduce motor losses significantly, thereby increasing motor efficiency. This requires a novel motor design because of the challenges of maintaining cryogenic temperatures in the stator. To keep liquid nitrogen around the stator, a casing was engineered and inserted between the rotor and stator of an existing motor selected for this prototype. This allows the superconductors to stay under 77° Kelvin / -321° Fahrenheit, without interfering with the rotor. In the final design, the HTS tapes were hand-wound in a delta-winding configuration for the stator to be compatible with the electronic speed controller from the original motor. To confirm that the retrofitted stator would function, experiments were performed using an oscilloscope to measure the back electromotive force (EMF) in the stator. Then, to measure the losses, both the cryogenic motor and original motor were evaluated, both in liquid nitrogen. Combined results suggest that the cryogenic motor has five times less resistance and up to three times fewer losses. Because the retrofitted motor is significantly less lossy and resistant than the original motor, this research project has demonstrated that a more efficient, cryogenic motor is possible using high-temperature superconducting tapes.

**Technical Disciplines Selected by the Student
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EE AT ET

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- Yes No

CSEF Official Abstract and Certification

Word Count

234

2024

Fair Category

PS

Project Number

6054

Title: A Clean Brew: Mycotoxin Mitigation with UVC Light and Activated Charcoal

Student Name(s): R. Doshi

Abstract:

This study evaluates activated charcoal (AC) and UVC light for mycotoxin mitigation in brewed beverages, focusing on AC's absorption and UVC's photodegradation abilities. Mycotoxins, found in various foods, pose significant health risks, including cancer, nephrotoxicity, and immunosuppression. This research aims to reduce pre-consumption levels of Aflatoxin and Ochratoxin in brewed coffee addressing mold growth from packaging to storage, with consumer-friendly methods.

UVC and AC effectively reduced mycotoxin levels, both separately and together. Variables evaluated were AC size and exposure time for optimal reduction. Initial tests confirmed ochratoxin and aflatoxin presence in beverages using LFA strips. Quantitative analysis involved controlled Aflatoxin and Ochratoxin solutions, analyzed with the VertuTouch analyzer, allowing for efficiency and reduction calculations and comparisons across different AC sizes and UVC exposure times, further validated by HPLC.

Results indicate UVC is the quickest and most effective for degrading mycotoxins, reducing OchratoxinA by 75% and AflatoxinB1 by 78% within 15 minutes. This performance surpasses AC which only achieved a 44% reduction in Aflatoxin and 7% in Ochratoxin at 15 minutes. Although AC has a consistent absorption capacity over extended periods, and combining methods is slightly quicker, UVC alone offers the most substantial benefits.

UVC proves to be the most rapid and efficient at reducing mycotoxin levels through direct photochemical degradation of the solution based studies, indicating a promising approach for immediate pre-consumption treatment in beverages and for the broader food industry.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

BI EN ME

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

PS

Project Number

6055

Title: Multivariate Time Series Forecasting of Future Stock Prices With Tree-Based Machine Learning Model

Student Name(s): C. Cao

Abstract:

The stock market is a complex financial system known to fluctuate often, leading to much uncertainty regarding the predictions of stock prices. Millions of people have been seeking and developing better prediction tools. New machine learning techniques can be used to increase the efficiency and accuracy of their predictions, enabling people to optimize their returns. This experiment constructed reasonable stock price prediction models for the SPY ETF, based on its historical data and eight chosen factors that could impact its prices from 2013 to 2023, and evaluated each trained model to determine the most successful one. The trained LightGBM model resulted in a root mean square error (RMSE) of 2.969 - less than 0.75% of the SPY prices. LightGBM's feature importance ranking was utilized to rank the importance of features for SPY, with the five highest-scoring factors being retained and three less important ones being dropped. The resulting LightGBM stock valuation model was trained based on those five factors and had a RMSE of 2.997, which was almost as accurate as the eight factor version. A multiple linear regression model was also constructed and analyzed based on eight factors, but it only resulted in a RMSE of 14.299. Of all the models, the LightGBM model trained on 8 features performed the best, providing the most accurate prediction of stock prices - which is a crucial piece of insight for those making transactions in the stock market. These same techniques can also be applied to solve other time series problems.

**Technical Disciplines Selected by the Student
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MA CS

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

245

2024

Fair Category

PS

Project Number

6056

Title: Ferrofluid: A Sustainable Option for Printing?

Student Name(s): P. Shenoy

Abstract:

NASA originally created ferrofluids to move rocket fuel from the combustion chamber at zero gravity. However, ferrofluids are now used in a wide variety of applications other than the originally intended purpose. This experiment investigates the feasibility of using ferrofluid ink as a reusable alternative to conventional printer ink. The experiment measures the absorption and extraction of ferrofluid ink from different types of paper using neodymium magnets (300N) at varying distances. It is hypothesized that magnetic paper absorbs ferrofluid ink best, ferrofluids can be extracted from printer paper best, and the optimal height the magnetic needs to be to remove ferrofluid is 2 cm. The first test concluded that ferrofluid was best absorbed by magnetic paper. Using an ANOVA it was determined there was a statistically significant difference between magnetic paper and construction and printer paper ($p < 0.01$). The second test showcased that the magnet best extracts the ferrofluid at a distance of 2 cm. The 2 cm was the optimal distance between the magnet and the paper but there is only a significant distance between 2 cm and 5 cm ($p < 0.05$). The third test concluded that the ferrofluid is best removed from magnetic paper. There was a statistically significant difference between magnetic paper and printer and construction paper ($p < 0.001$). The experiments concluded that magnetic paper was the best at absorbing ferrofluid and extracted from the magnetic paper the best. People can use ferrofluids to make paper more reusable by extracting magnetic ink.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EE AT CH

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

172

2024

Fair Category

PS

Project
Number

6057

Title: Are We Safe?

Student Name(s): M. Solano Soto

Abstract:

In the world we live in, technology is an essential part of our lives, which is why we are no strangers to exposure to electromagnetic radiation.

The goal of this experiment was to discover which household electronics produce the greatest amount of electromagnetic radiation and whether the levels of radiation may be harmful to health. My hypothesis was that the microwave would be the electronic device that would emit the most radiation and so be the most harmful to health.

My method was to use a radiation meter to record the Volts per meter and Microtesla levels of all the electronics, which were: A microwave, a Wi-Fi router, a laptop and a television. For 2 minutes I recorded the radiation of each electronic device and repeated this process 3 times to ensure reliability of results for each device.

The results of my experiment revealed that the laptop is actually the one that emits the greatest amount of radiation, but the levels of radiation are not enough to cause damage to health.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

CH

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

254

2024

Fair Category

PS

Project
Number

6058

Title: Detection of Nanoplastics within Complex Environmental and Food Resource Matrices via Machine Learning

Student Name(s): H. Jin

Abstract:

The pervasiveness of nanoplastics within the environment underscores the need for robust and accurate methods for their identification and classification. The lightweight and small nanoplastics (NPs) can bypass biological barriers and disperse throughout the environment, posing significant health risks to humans and aquatic life. Typical detection of nanoplastics has relied on cumbersome filtration, and subsequent coloration of the plastics for visualization, once they have been painstakingly separated from their matrix, including water, fish, sand, and soil. Raman spectroscopy, however, offers an alternative, as it effectively detects these particles without the need for separation, with its high resolution ($<1\mu\text{m}$). Unfortunately, accurate identification and classification are challenging because of the faint Raman scatter of NPs and signal interference from background noise of the matrix-sample. To address this challenge, this project proposes a method integrating machine learning (ML) with Raman spectroscopy. Multiple ML models were first trained with Raman spectra of $50\mu\text{g/mL}$ suspensions of PE, PTFE, PS, PMMA, and PVC NPs, and tested against validation data. While ML models achieved an average accuracy of $>96\%$, the Support Vector Machine Classification model reached 99.58% accuracy in NP-identification. These ML models were then validated via separate analyses of NPs in soil, sand, salmon, and water. In each case, the NPs were rapidly and successfully identified within their resident matrix, while remaining in their glass bottle. Regarding the detection of NPs in water, this new Raman-ML model successfully detected as little as $1\text{E}5$ particles/L, which surpasses new, published detection limits of only one month ago.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM EN CS

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 vertebrate animals controlled substances

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

117

2024

Fair Category

PS

Project
Number

6059

Title: How to modify starch-based bioplastic to reduce its ecotoxicity?

Student Name(s): A. Shi

Abstract:

Biodegradable starch-based plastics such as PLA is commonly used in plastic mulch films but is more prone to break down into microplastics than conventional plastic, causing ecotoxicity in the environment. Thus, this research aims to modify corn starch plastic for less degradability to reduce its ecotoxicity by assessing the effects on its property. Different vinegar concentrations, preparation techniques and plasticizer was used, then mechanical testing and degradation test was conducted. The result showed that the high vinegar sample had the least degradability while xylitol and sucrose samples had the most degradability. Further experiments could test higher concentrations of sucrose and conduct longer degradation tests. This research is important for reducing plastic negative impact on the environment.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN CH

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

202

2024

Fair Category

PS

Project
Number

6060

Title: Magnetohydrodynamic Salt Water Generator:

Harnessing energy from flowing salt water without moving parts

Student Name(s): S. DiVasto

Abstract:

The growing concern over climate change has advanced the need for a source of consistent clean energy to replace fossil fuels. This research examined magnetohydrodynamic (MHD) principles as a method of generating renewable energy from salt water. Furthermore, the possibility of recovering electricity from desalination plant waste was explored. Three main, as well as an experimental, prototypes were constructed utilizing 3D printing. These prototypes were tested in a flow channel and measured for changes in power output. Each module had several variables adjusted, including the magnetic field, salinity, flow rate, and electrode size, to determine how they affected power output. Using these tests, it was found that power output of the prototypes was substantially influenced by flow rate, magnetic field configuration, and salinity. A positive correlation was found between flow rate and power output. As the flow rate increased, power output increased as well. However, the magnetic field strength and salinity produced inconsistent results. These factors were determined to possibly be influenced by other variables such as salt ion friction, area of generator inlet, and magnetic field orientation. Future research and practical applications should be further explored, such as an analysis of magnetic field configuration, field experimentation, and large scale prototype development.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

ET AT

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

258

2024

Fair Category

PS

Project Number

6061

Title: How Would Less Electricity Usage Impact Surrounding Temperature?

Student Name(s): I. Verma

Abstract:

This project investigates the effectiveness of energy-efficient cooling technologies in addressing environmental issues related to traditional air conditioning systems. It focuses on energy consumption, greenhouse gas emissions, refrigerant usage, waste generation, and the ozone layer impact to provide insights into the potential benefits of these technologies. The Eco-Cooler investigates the feasibility of energy-efficient cooling technologies as a sustainable alternative to traditional air conditioning methods. The investigation started with a thorough literature review on energy-efficient cooling technologies, their environmental impacts, and advantages over traditional air conditioning systems. This research informed the design and implementation of experiments to evaluate the performance of different energy-efficient cooling technologies. The experiments tracked energy consumption, greenhouse gas emissions, refrigerant usage, waste generation, and ozone layer impact. The investigation provided valuable insights into energy-efficient cooling technologies, showing significant energy savings of up to 50% compared to traditional systems. Greenhouse gas emissions were substantially reduced, and there was minimal refrigerant leakage with eco-friendly options. Sustainable cooling solutions also decreased waste generation. The investigation confirmed these technologies have a minimal impact on the ozone layer, contributing to its preservation. The project findings strongly support implementing energy-efficient cooling technologies to address environmental issues in air conditioning. These technologies achieve significant energy savings, reduce emissions, minimize refrigerant leakage, and contribute to ozone layer preservation. With diverse applications in residential, commercial, and industrial sectors, they reduce energy consumption and carbon footprints. Policymakers can use the findings to develop regulations and incentives. Future investigations can explore new technologies and drive innovation in sustainable cooling.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM ET EV

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

239

2024

Fair Category

PS

Project Number

6062

Title: Machine Learning Based Melanoma Detection System via Image Classification

Student Name(s): A. Jerfy

Abstract:

Melanoma, the most severe form of skin cancer, is almost always deadly if left untreated. While it comprises a small minority of skin cancer diagnoses, it has the highest fatality rate. Current detection requires a visit to a clinic to receive a physical examination or biopsy, which some people don't have access to. I have created a detection method that will effectively be accessible to anyone with a phone, computer, or similar device. A user interface was made using PyCharm, and VGG16 architecture, in which Python3 is utilized to identify whether or not an image submission is melanoma. The AI is trained on 6,000 images from the HAM10000 dataset from harvard.edu, which consists of 10,000 images of melanoma, to train the neural network for detection. The code considers variance in skin tone and crops the image so as to limit computing power needed. Transfer learning is utilized so that the data can be made into a more comprehensive imageset for the network. The AI iterates through the database, comparing it to the submitted image and picking up on similarities. If there are enough characteristics of melanoma in the submitted image, it is identified. The code will be incorporated into an application eventually, in which people can take a picture of a lesion for accurate and simple detection of melanoma. The AI is currently able to detect melanoma with an accuracy of 92.1%, tested on a set of 2,000 images.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CS AT

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

236

2024

Fair Category

PS

Project Number

6063

Title: Early Detection of Parkinson's Disease using a Computer Vision Model

Student Name(s): S. Gorre

Abstract:

Parkinson's disease is a genetic disease that causes people to have uncontrollable movements that are irreversible. Currently, treatments exist that mitigate the spread and effects of Parkinson's disease; as such, early treatment is crucial. However, it is difficult to accurately identify Parkinson's patients until they show significant symptoms of the disease. Recent studies have found that hand drawings can be a powerful indicator of whether a patient has an early form of Parkinson's disease. Coupling this finding with novel machine learning techniques, I tested multiple image machine learning models, such as a 7 layer convoluted neural network, random forest classifier, and model VGG16 on 102 hand-drawings of Parkinson's and non Parkinson's patients. For the testing, I trained the model with the training dataset and tested the model with a validation dataset. After each trial, I created a graph to see the training and validation accuracy in correlation to the number of times the dataset was trained. There was constant fine-tuning with each model as the learning rate, epochs, and optimizer significantly impacted the results. Through model VGG16, we achieved 96.67% accuracy on the test set, which was significantly higher than any other model we tested and researched. These findings can be implemented in the current healthcare industry to more accurately identify Parkinson's patients. In the future, we hope to obtain more data by working with a local research university to further test our algorithm.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CS CBIO

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

253

2024

Fair Category

PS

Project Number

6064

Title: An Investigation of Stone Reusual Construction Techniques Used in the Pueblo Community From 800-1200 AD In Southwestern United States Based on Stone Length-Width Ratios

Student Name(s): E. Trudel

Abstract:

The American Southwest has a rich history with the Ancestral Pueblo. They lived in Great Houses, which consisted of many rooms and kivas, which are religious semi-subterranean structures and served as centers for politics and economics. This study focuses on the reuse of stones in these structures, a concept passed down orally in the American Southwest and briefly explored in a few articles. It aims to quantify the concept. We turned to the classic archaeology term for stone reuse, Spolia, to delve deeper. We predicted that length-to-width ratios in stones at the Haynie Archaeological Site would show evidence of Spolia construction techniques in ancestral pueblo. Haynie is located in southwestern Colorado and is maintained and utilized by the Crow Canyon Archaeological Center. Then, a data set was compiled with different length and width measurements (cms) of stones within the site. A total of 8 structures were documented, which were broken up into 11 more focused structures, seven based on room walls and four based on kivas. The earliest stones were from Middle Pueblo I(800-850 CE), and the latest were from Late Pueblo II(1100-1140 CE). Box and whisker plots were created and provided means and medians of varying structures, which helped establish interpretations. The results indicate that stones with similar length-thickness ratios were used in Pueblo I and Late Pueblo II kiva and room walls. This interpretation suggests possible stone reuse between these two periods. Further analysis using a more comprehensive range of attributes could enhance this interpretation.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

BE EN EV

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

223

2024

Fair Category

PS

Project Number

6065

Title: Ferric Modified Bamboo Biochar as a Passive Lead Remediation Tool in Contaminated Coastal Wetland Sediment

Student Name(s): K. Hall

Abstract:

Lead (Pb) is a toxic metal that is damaging to sensitive ecosystems and, outside of current expensive and invasive methods, is virtually irremovable from soil. Coastal wetlands play a distinct and crucial role in biodiversity maintenance and fortifying coastline resilience. Coastal wetlands are sinks for atmospheric compounds, resulting in the fixation of Pb through atmospheric deposition. Biochar is generated through the pyrolysis of organic compounds. Abundant research indicates that incorporating iron (Fe) onto biochar's active surface may enhance its sorption capacity by increasing surface area and electrostatic presence. Studies suggest that Fe-modified biochar (FeMBC) may reduce heavy metal concentration in specific soils, however its context-dependent effectiveness necessitates further optimization for diverse soil types. Ten sediment samples of varying Pb concentration were treated using both FeMBC and conventional biochar (generated from the same bamboo feedstock) applied at a mass ratio of 1 gram treatment to 10 grams sediment. Analyses of Pb concentration were conducted using an X-Ray Fluorescence Analyzer. Both treatments resulted in an average reduction of Pb in sediment samples. There was a significant statistical difference ($p < 0.05$) between the effects of FeMBC and conventional biochar. FeMBC led to an average Pb reduction of about 17% overall. FeMBC reduced Pb in samples $Pb > 400$ ppm by 56% ($p < 0.05$). FeMBC could be applied as an effective in situ Pb treatment

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EM EN AT

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

165

2024

Fair Category

PS

Project Number

6066

Title: A Mathematical Analysis of the Variables Impacting the Performance of Wind Turbines as the Energy Converts From Kinetic to Mechanical to Electrical

Student Name(s): L. Kozerefski

Abstract:

This project is a mathematical analysis of the variables impacting the performance of wind turbines as the energy converts from kinetic to mechanical to electrical. The first part of trials was using the equation $(\frac{1}{2}) (\rho) (A) (V^3)$ to determine how different inputs of variables impact the total coefficient of power for the New England area. Air density has a small impact on the results because of its linear properties. Blade swept area is squared and limited by the maximum size possible and wind velocity has the greatest impact due to its cubed function but is also limited by location and inconsistent flow. A turbine model was built to look at scaling. The power input was provided by a fan with three levels of wind and the output was measured with a multimeter in volts and power was calculated by measuring resistance of the motor. Once that was collected the efficiency of the model was calculated and determined to be very low which was expected.

**Technical Disciplines Selected by the Student
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MA EE ET

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

243

2024

Fair Category

PS

Project Number

6067

Title: Researching the Effectiveness of Engine Oil After Combined With Cooking Oil

Student Name(s): B. Gendason

Abstract:

Engine oil and cooking oils may seem similar, but there are a number of differences that separate the two, most notably the composition of the oil and its origins. Viscosity is an important component in producing the right engine oil, the perfect high viscosity index number will allow it to keep its viscosity level over a large range of temperatures. Vegetable oil has been used before in similar experiments, but may not be the oil most suited for use in an engine after being combined with motor oil. Most of my preliminary research will be on viscosity levels, burn points, and speeds, but will also include studying the similarities and differences between the production of motor oil, biofuels, and cooking oil. For this study, I tested and combined different types of cooking and vegetable oils together with engine oil. To determine whether combinations of motor and vegetable oils will perform adequately on an engine, I examined the physical and chemical characteristics of synthetic motor oil, and canola, vegetable, and olive oil. I first performed experiments such as testing burn point and temperature to get information under the same conditions the combustion of oil will occur. The first test consisted of heating the oils at a constant rate to observe their reaction under high heat and pressure. I used a controlled flame and a beaker to contain the oils, additionally ensuring safety by observing the oils at all times with eye and skin protection.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

EE ET CH

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

211

2024

Fair Category

PS

Project Number

6068

Title: Origami-Inspired Paper-Based Multiplex Device for Water Contamination Monitoring

Student Name(s): J. Liu

Abstract:

Water quality issues are particularly dire in developing nations, where limited resources compound the health risks posed by contaminated water. Prolonged exposure to heavy metals such as lead and copper leads to severe health consequences, including neurological disorders and cancer. In regions where access to advanced laboratory facilities, financial resources, and skilled personnel are limited, there is a critical need for simple, portable, and affordable solutions. While current chemical testing strips offer rapid analysis, they fall short due to subjective colorimetric results, lack of filtration, and limited testing capabilities. To address these challenges, a paper-based microfluidic device inspired by origami folding is introduced. This device allows for filtration and simultaneous assessment of multiple contaminants from a single water drop. A quantitative analysis of the colorimetric results of the testing strips using RGB (Red, Green, Blue) values yields equations for copper ($R: 0.0893x - 17.9$, $R^2: 0.904$), lead ($R: -3.88x + 852$, $R^2: 0.904$), hardness ($G: -3.44x + 563$, $R^2: 0.98$), and nitrate ($B: -3.76x + 761$, $R^2: 0.914$). By transferring this data to an app and combining the novel origami-inspired device, an accurate, convenient, and user-friendly solution for on-site water quality assessment is offered, addressing critical needs in resource-limited settings and enabling rapid identification of contaminants to safeguard community health.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EV AT EM

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

256

2024

Fair Category

PS

Project Number

6069

Title: THE SUB-DIURNAL FLUCTUATIONS IN THE ISOTOPIC COMPOSITION OF XYLEM WATER IN DECIDUOUS TREES

Student Name(s): K. Tierney

Abstract:

There exists an open assumption that the isotopic composition of water retained by tree xylem (δ XYLEM) reflects the composition of root water uptake when a tree transpires. Routine, longer-term monitoring of stable isotopes, ^{18}O and ^2H , enables ecohydrologists to develop sustainable land use strategies, understand climate change impacts, and protect ecosystems. Understanding sub-daily fluctuations of δ XYLEM will help determine if prior studies have built-in flaws in the non-standardization of time sampling. This study aimed to discover if δ XYLEM varies significantly throughout the day. On July 24th and November 15th, ten maple and ten oak trees from the UConn Forest were cored twice each day, at 10a.m. and 2p.m. Using heating and cooling strategies, a Cryogenic Vacuum Extraction Setup extracted the cores' xylem water. These samples underwent cavity ring-down spectroscopy to measure the ratios of δ XYLEM. Double-sided paired t-testing revealed variable δ XYLEM fluctuation depending on species, time of year, and isotope. Further analysis of samples displayed no significant δ XYLEM fluctuation across all deciduous trees. Isotope ratio changes within an individual indicated that extreme δ XYLEM ratios are not likely to persist due to homogenization. Statistically significant data proved that there is fluctuation, notably in ^2H ; however, the statistical differences are small enough that the analysis methods for larger time-scale projects will not be impacted, therefore validating all ecohydrological studies involving δ XYLEM analysis. Larger, diverse samples would allow for an improved depiction of the deciduous tree population and species-oriented fluctuations. There are plans to observe the fluctuations of springtime δ XYLEM.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EA PS

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

247

2024

Fair Category

PS

Project Number

6070

Title: Synthesis of Conductive Optical Lenses for the Observation of Variable Refractive Indices

Student Name(s): C. Galla

Abstract:

The application of electrical energy and induction of changes to refractive indices of different mediums could drastically impact the development of modern optical science. To explore the properties of these variations, two lenses of different natures have been synthesized. First, a simple 50 mm diameter glass plano convex lens was coated in a tin oxide layer, by spraying a solution of methanol and tin(IV) chloride pentahydrate onto the surface at 600 degrees celsius. Additionally, an acrylamide-based hydrogel was synthesized to observe the conductivity of a water based medium. These lenses were tested using a vernier light sensor apparatus, using a green laser light of 532 nm to pass through conductive medium. Data demonstrates dynamic linear results showing a strong inverse correlation between the voltage present in the lens, and the lux reading of the light sensor. Testing in hydrogels seemed to be dominated by an internal thermal flux, while the tin oxide coating showed results consistent with the kerr effect. Across 24 minute trials, increasing from 0 volts to 15 in 5 volt intervals, Lens 2, yielded a correlation coefficient of -0.926, and Lens 4 yielded a correlation coefficient of -0.924, both denoting a strong relationship that describes the lens displaying a variable refractive index. Further research in this topic will open the door to more developed optical technologies, involving more dynamic refractive properties that allow for modularity in controlling the movement and position of light, impacting both the field of optics and consumer industry.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EE AT PH

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

259

2024

Fair Category

PS

Project Number

6071

Title: Reduction of Polyethylene and Polypropylene Waste Footprints via their Scalable Conversions into Useful Surfactants

Student Name(s): Z. Haque

Abstract:

Currently, ~72% of all plastic winds up in a landfill. Only 9% of plastic produced is recycled, and much of it is recycled into low-quality material with limited application for reuse. These plastics are discarded into our environment, do not chemically degrade, and pose a significant health risk. Thus, it is critical to develop mechanisms through which common APET and PET plastics can be converted into useful products. APET-plastics include household plastic products such as water bottles, bags, and milk cartons, thus this research has far-reaching applications. Building on recent literature by Xu, this research converts APET-plastics into surfactants to be used in soaps in two steps. First, APET conversion to fatty acids, and second, conversion of fatty acids to surfactants via oxidation and saponification. In the first phase, 5g of plastic water bottle was pulverized and heated at 270oC for ~10 minutes; the resulting polymer smoke was collected and found to be polyolephins/waxes. ~1.7g of wax was produced, resulting in ~35% yield. The remaining solid material was identified as APET plastic, which can be repurposed (i.e. polyester fiber) via existing recycling methods. These polyolefins/waxes were then oxidized via combination with Mn-distearate and saponification using 0.1M KOH. Outside of addressing the critical issue of plastic waste, this research improves on status-quo fabrication of soaps in two ways. First, it provides a more sustainable alternative to tallow and vegetal oils, and second, it requires high heat/energy for a shorter period of time than existing research, making it more applicable and scalable.

Technical Disciplines Selected by the Student
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EM EN AT

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

230

2024

Fair Category

PS

Project
Number

6072

Title: Clonal Evolution of Non-Small Cell Lung Cancer Reveals TP53/EGFR Maintenance and SETD2 Selection in Metastases

Student Name(s): P. Hayashi

Abstract:

According to the World Health Organization, almost 10 million people die of cancer annually, equating to about one-sixth of all deaths. Approximately 90% of these deaths are a result of metastatic cancer, highlighting the importance of metastasis focused research. As cancer cells evolve over time, certain cells gain the ability to disseminate from their primary tumor and metastasize to a distant organ. Understanding which cancer cells metastasize and the routes they took to get there would aid in our understanding of metastasis and the development of novel therapeutics. We investigated the genetics of metastatic cells by identifying the genes that are selected for in metastasis. To do so, we inferred the clonal evolution and migration histories of non-small cell lung cancer (NSCLC) patients, the most common cancer type seen at Memorial Sloan Kettering Cancer Center (MSKCC). By preprocessing large datasets and utilizing recently developed machine learning techniques, we generated highly accurate clonal evolution trees that facilitate the search for mutations correlated with metastasis. By compiling the genes found in our results, lists of mutations were categorized by various data points, such as the anatomical site and mutation type (primary or metastasis). We identify one gene, SETD2, as significantly associated with metastasis, as well as possible explanations for this link. We've identified a previously unknown gene that could aid future researchers as a potential therapeutic target for metastatic NSCLC.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

CBIO CS

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

246

2024

Fair Category

PS

Project
Number

6073

Title: Repurposing Agave Waste through the Creation of a Biodegradable Polymer

Student Name(s): J. Cunningham

Abstract:

This study aims to engineer a series of agave-based bioplastics to reduce the global plastic footprint. This project was established to explore eco-friendly alternatives to plastic to mitigate pollution in aquatic ecosystems. Plastics were designed and manufactured with agave fibers to increase tensile strength and elasticity while keeping the saltwater degradation rate constant compared to the fiberless control. The first stage of this project was to use water water-retting process to separate the agave central stem from the sisal fibers. This process was carried out in a pressurized cooker at temperatures of 325° F at a pressure of 63 kPa. Once this process is finished, the fibers will be left out to dry. The next stage is the creation of the plastic infused with the fibers. After this plastic was made, it was tested against a controlled plastic with no fibers using a saltwater degradation test and a tensile strength and elasticity test. Data would be collected in many different categories, including mass, surface area, tensile strength in grams, and total stretch before failure. The results reflected how the agave fibers infused in the plastic added great strength. On average, the agave fiber plastic samples were 283% stronger than the control without fibers. Furthermore, the fibers increased elasticity by over 2 times compared to the control. Finally, on average, these sisal fibers, also known as agave fibers, could withstand 40g per square centimeter, while the control could only withstand 12.5g per square centimeter.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

PS EN BI

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

246

2024

Fair Category

PS

Project
Number

6074

Title: Adaptable Soft Robotic Mold for Low Temperature Metals

Student Name(s): T. Gerlach

Abstract:

Soft robots are flexible objects with pockets of air or water within them. When these pockets are inflated the object flexes and actuates. Soft robots are often made out of silicone resin cured in molds. Coincidentally many low melting temperature metals (zinc, pewter, etc.) tend to be cast in molds made out of silicone. My project is to develop a mold for low temperature metals that can change shape and produce multiple differently shaped metal objects via the use of soft robotics.

I created the mold and its prototypes by pouring a silicone resin in a 3D printed mold of my own design and letting it cure. When the silicone came out of the plastic mold it was approximately the shape of the final silicone mold with air pockets and tubing included with a few modifications required. I tried two different kinds of resins (MoldMax60 and EcoFlex 00-30). MoldMax60 was too stiff to inflate. After the mold was cast in EcoFlex 00-30, I poured molten pewter into it with different air pockets inflated to create the desired shape, in this case it was different numbers on a seven-segment display.

The mold successfully created different numbers but there were many bubbles in the metal that made the difference less noticeable and some of the air pockets popped in later tests. I was able to create a metal mold that could produce differently shaped metal pieces via soft robots albeit with a few difficulties along the way.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN AT EE

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 vertebrate animals controlled substances

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

246

2024

Fair Category

PS

Project Number

6075

Title: Identifying Policy Failures, Reformation, and Bridging the Gap of Engagement

Student Name(s): D. Padua

Abstract:

In 2023, Reuters found that from the 45 countries they surveyed, an average of 47 percent of a country's population does not interact with the news. This generates a large gap of knowledge for many when it is time for elections, and many will choose to not participate or cast ballots uninformed. The goal of this project is to create a system for individuals and countries to easily identify areas of struggle for a country and areas of excellence for a country to provide areas of concern and possible solutions that can be adopted from other countries. Most of the information is data compiled into a spreadsheet from US News & World Report's Best Country Rankings for 2023. A correlation of attribute scores and GDP-PPP was done along with a model for each attribute. Then residual calculations for the top-ranking countries for country performance analysis for each attribute. This was repeated for a binomial model. From these calculations, attributes that would not have immediately been identified from ranking or score, such as a good job market, committed to social justice, educated population, cares about human rights, well-developed public education, and many others. From these findings further research can be conducted on the issue which was done for the country attribute of "cares about human rights". In the future this can be applied to other countries around the world and the information can be summarized and distributed to voters leading up to or during elections.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

BE MA

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 vertebrate animals controlled substances

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

231

2024

Fair Category

PS

Project Number

6076

Title: Next-Gen Wearable Headband To Mitigate Damages to Head And Send SMS Alerts along with Images

Student Name(s): R. Karunaratne

Abstract:

Alarming CDC statistics highlight Traumatic Brain Injuries resulting from falls as the leading cause of mortality in older individuals (≥ 65) and those afflicted with neurodegenerative diseases, particularly Parkinson's and Alzheimer's. We report a significant advancement in mitigating the impact on the head during falls and triggering an emergency alert through a high-tech headband. In our endeavor, we collaborated closely with healthcare professionals, including physicians, nurses, and caregivers experienced in managing individuals prone to falls, like Parkinson's patients and others with similar diseases. Drawing from their feedback, we created the Impact Absorbing And Alerting (iAAA) headband, incorporating lightweight, shock-absorbent foam materials, springs, a buzzer, and electronics. Initial testing on a BOB dummy demonstrated the effectiveness of the iAAA headband in absorbing impact and triggering buzz alerts to notify anyone in the immediate vicinity. Based upon this success, we improved the headband to create the iAAA-PLUS (iAAA+) model, combining the former iAAA with a Raspberry Pi, a lightweight sound sensor, and a pi-camera. In addition to the attributes of the iAAA band, the enhancements in the iAAA+ band allow it to notify caregivers remotely by dispatching text messages, including photos and precise fall timestamps. This upgrade marks a significant leap in addressing the critical challenge of fall-related injuries among older adults and individuals with neurodegenerative ailments, offering a holistic solution that combines impact mitigation with advanced alert capabilities.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

ME EN CS

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

191

2024

Fair Category

PS

Project Number

6077

Title: Novel Decentralized Air Circulation System

Student Name(s): A. Parimi

Abstract:

Approximately 20 percent of all energy usage in the US is residential, and out of this, 50 percent is for heating and cooling. Making HVAC systems more efficient and effective would not only help homeowners save on their energy bill and reside more comfortably, but would also help address the problem of climate change through reduced emissions. My system not only utilizes the hot air that is near the ceiling as a result of thermal stratification, but is also decentralized, giving the option for each room to be powered by a different heating source if required. For example, even in two adjacent rooms, one room might be powered by solar heating, while another could be powered by a heat pump. Because the heat source is easily replicable for each room, with the development of more futuristic and suitable heat sources, the heat source in the home can be updated accordingly. Through a test conducted on a physical model, I found that my system not only was able to sustain the heating in the rooms for longer, but also reduce the variation of heat within the room, making HVAC more energy-effective.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

ET EE MA

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

240

2024

Fair Category

PS

Project Number

6078

Title: Utilizing Ground and Space-Based Sensors to Track Trajectories of Vehicles/Dangerous Objects and Monitor Climate Change/Environmental Issues

Student Name(s): R. Wempen, N. N/A, N. N/A

Abstract:

As the number of satellites in low and high earth orbit increases beyond the 10,000 mark and the concentration of space debris increases exponentially, the risk to satellite launch and orbital operations is similarly increasing. This strains the ability of existing systems and algorithms to analyze the data, even before taking into account orbital drift and errant meteorites. Nevertheless, recent sensor technology leaps are poised to make a permanent change in this landscape, resulting in an immediate demand for new and updated simulations to apply the technology to existing problems. To address this demand, a simulation was developed to design an appropriate satellite launch trajectory and orbital path based on chosen mission and operational parameters, and then track a simulated launch from liftoff to final orbit within the designated satellite constellation. After successful orbital positioning, the simulation then continues operating on a designated mission to track evidence of climate change on the ground, from identifying wildfires to tracking flooding, while utilizing its sensors to simultaneously protect the satellite from external threats, including other satellites in decaying orbits, space debris, and exo-orbital threats including meteors and asteroids. As additional simulations working together come online utilizing existing data gathered by satellites, projects such as this one have the potential to both significantly benefit communities threatened by wildfires and flooding by creating an early warning system and to provide the scientific community with an additional tool against the threat of climate change.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EV PH EA

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

PS

Project Number

6079

Title: Using Biomimicry to Harvest Energy from the Sinusoidal Motion of an Eel

Student Name(s): V. Haran

Abstract:

Wind turbines, commonly used as a source of renewable energy, are not as effective in low and more variable wind speeds. To better capture energy at lower wind speeds, piezoelectrics were incorporated to convert physical vibrations from the wind into electrical energy. Multiple bluff body designs were incorporated to direct the wind to maximize energy output. The piezoelectric eels were tested using different parameters including, thickness, material, distance from the bluff body, and the number of piezoelectrics.

The first phase of this project involved designing three bluff bodies and the piezoelectric eels using Fusion360 and fabricating each using 3D printers. Data was initially collected in the wind tunnel by placing a single piezoelectric eel behind a bluff body at varying speeds. Power, max power, energy, and voltage readings were recorded. It was found that all bluff body designs performed best in 10m/s wind flow. In this range, the angular bluff body performed 7.6 times better than the circular bluff body and 5.8 times better than the triangular bluff body. These readings are after optimizing the distance the piezoelectric eel is placed from the bluff body to negate the dead zone.

The second phase of this investigation was to simulate the relationship of wind on the bluff body/piezoelectric eel assemblies using computational fluid dynamics software such as Autodesk CFD-Ultimate to support the wind tunnel data. Ongoing simulations are used to calculate convergence between low and high pressures which directly influence the piezoelectric eel's power generation and frequency.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN AT ET

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

198

2024

Fair Category

PS

Project
Number

6080

Title: Utilizing Ozone-Based Oxidation for Pesticide Detoxification in Aquatic Environments

Student Name(s): A. Deutsch

Abstract:

Ozone's oxidizing capabilities render it a promising avenue for developing sustainable wastewater treatment methods. Overflow events in sewer systems often result in untreated wastewater entering aquatic ecosystems directly, bypassing conventional treatment processes. This study aims to devise an ozone-based treatment system tailored for such scenarios, aiming to expedite pollutant removal compared to traditional methods. Triclopyr and gamma-Cyhalothrin, common pollutants found in aquatic environments, underwent direct ozone treatment in ten trials with varying exposure times. Fourier Transform Infrared (FTIR) spectroscopy analyzed molecular changes post-treatment. The Triclopyr scans showed C-O alcohol bonds present at wavelengths between 128.55 and 1191.01. This grouping had been bonded to C-O-C ether bonds present at 1089.98. The scans after treatment concluded that alcohol bonds were breaking from the ether groupings. In the gamma-Cyhalothrin trials, redox degradation was observed again at the alcohol and ether bonds, similarly between wavelengths 725.84 and 650.0, aromatic ortho and meta bonds had also been degraded. These results underscore ozone's potential to efficiently degrade volatile contaminants in wastewater, offering promise for enhanced treatment strategies. By targeting key molecular bonds, ozone treatment can effectively mitigate the introduction of pollutants into aquatic environments during overflow events.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EV CH EM

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

256

2024

Fair Category

PS

Project Number

6081

Title: Genetic Engineering of Cryobacterium to Increase Silica Content and Enhance the Glacial Albedo of Black Arctic Oceans

Student Name(s): J. Bernstein

Abstract:

Arctic glaciers are rapidly melting due to climate change, leading to dangerous rises in sea levels. This phenomenon is exacerbated by the absorption of incident solar radiation by arctic dark water, which increases sea-temperatures, accelerating the melting process in a negative feedback loop. While the use of silica microbeads on arctic ice was previously proposed, this solution is not easily scalable or plausible. Thus, a novel, environmentally-safe, genetically-engineered strain of Cryobacterium, native to Arctic ice, was developed herein to better reflect solar radiation, and protect glaciers. Cryobacterium were first transformed to express silicatein and sillafin, proteins that facilitate biomineralization, through the use of calcium chloride and heat shocking. Reflectance spectroscopy demonstrated a 2.5x increase in UV and visible light reflectance for the new biomineralized bacteria (versus wild-type), after integration of dissolved silicon. Engineered Cryobacterium also exhibited resistance to thermal changes caused by visible illumination and demonstrated successful formation of protein-glass complexes through fluorescence analyses. Silicon uptake was confirmed through a UV-Vis silicomolybdate colorimetric assay combined with SEM and EDS analyses. Finally, the presence of biomineralized Cryobacterium led to a 1.5x increase in UV-Visible light reflection of ice, suggesting that biomineralized Cryobacterium could potentially slow or reverse polar ice melting, and disrupt the warming trend and rise in ocean water levels. Notably, the biomineralized Cryobacterium showed 1.16x greater reflectivity than wild-type Cryobacterium, which could increase Arctic ice albedo from 47% to 54%, potentially undoing 30 years of decline in arctic ocean ice coverage and the increase in ocean temperature.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

EN EM

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

253

2024

Fair Category

PS

Project Number

6082

Title: Simulating CMB temperature signal to analyze the effects of noise

Student Name(s): B. Qin

Abstract:

As cosmologists probe the early universe to understand its nature, the development of precise ground-based telescopes has become increasingly important. The cosmic microwave background (CMB) is radiation redshifted from the first light in the universe. It may contain primordial gravitational waves, which would provide evidence for inflation, the theory that the universe started as a tiny, dense ball of matter that expanded rapidly. This project analyzes the effects of environmental and instrumental noise on the precise measurement of the CMB, with the final result of simulating a realistic CMB temperature signal. A raw CMB temperature map from a power spectrum is generated from the NASA Code for Anisotropies in the Microwave Background. Foreground maps of point sources and the Sunyaev-Zeldovich effect are added. A noise map comprising beam convolution, white noise, atmospheric noise, and 1/f noise is created and overlaid to complete the simulated CMB temperature signal. In the process, each type of noise is overlaid individually onto the signal at three different values to examine its independent effects. The resulting simulated CMB signal's power spectrum is found to be biased high compared to the accepted power spectrum from the Planck satellite. A better understanding of the noise affecting ground-based telescopes will enhance current and reveal new measurements of the early universe, specifically the energy level required to induce inflation and thus available in the universe. The next steps of this research would be to investigate how to reduce noise in large ground-based telescopes with thousands of detectors.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

PH

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

222

2024

Fair Category

PS

Project Number

6083

Title: An Interactive Manipulator with Anti-falling Mechanisms

Student Name(s): A. Hao

Abstract:

A surgeon and their assistants are under an immense amount of stress during surgery. Because of this, they are more prone to mistakes than they normally would, which could jeopardize the life of a patient. Thus, there is a necessity to help lower the chances of calamity. This can be done through robots, who are mechanical and unfeeling and are unlikely to make mistakes in high-pressure situations. My project, a robot manipulator prototype capable of transporting sensitive items, hopes to help with this. Whether it is a bottle, scalpel, or organ, it will be able to transport them safely with no risk of damaging the object in transit. To accomplish this, it uses a system of sensors that allows the claw to adjust its grip strength automatically, eliminating the risk of crushing an object. It is also capable of adjusting its strength mid-transit if it detects the object slipping, to ensure the object cannot fall. It has a smart system to ensure the object is successfully delivered so that even if the surgeon doesn't secure the object, letting the slide, the claw will be able to detect this and save the object in time. In the future, I hope to optimize its grip strength and increase the pressure sensitivity, to where it can conform to an item with 99% accuracy.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

EE ME

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

PS

Project Number

6086

Title: Exploring the Efficiency of Plastic Consumption by Tenebrio Molitor Larvae Using FTIR Spectroscopy

Student Name(s): Z. Monschein

Abstract:

Plastic is not biodegradable and most plastic products are disposed of and end up in landfills or oceans, polluting the natural environment. Tenebrio Molitor larvae have the biological ability to break down most plastic polymers, meaning mealworm plastic consumption is a potential future form of plastic degradation. However, not enough is known about this process's efficiency and environmental risks. In this ten-week experiment, larvae were fed plastic and starved for a 24-hour period each week to collect their frass. This experiment aimed to measure the rate of mealworm consumption of three different plastic polymers (polystyrene, polyethylene, and polyurethane), both separately and mixed with bran. Polystyrene mixed with bran had the highest consumption rate with an average of 0.682 mg per week, with polyethylene and bran at 0.515 mg per week. Mealworm time to pupation was also observed. The groups that consumed bran matured as normal, but the pure plastic diets stunted the growth of the groups consuming them, creating an abnormally long time to pupation. Frass collected halfway through the experiment was tested for microplastics using FTIR spectroscopy. Analysis determined that the frass of the larvae on pure plastic diets had an 87-97% ID match to the plastic polymers, indicating plastic remaining in their frass. However, the larvae on a mixture diet had very little, if any, polymer remaining, demonstrating that the bran helped their digestion and that biodegradation through plastic consumption is an environmentally safe method of degrading plastic. Scanning electron microscopy images complemented these findings.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EV CH MI

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

187

2024

Fair Category

PS

Project Number

6088

Title: Measuring the Effect of Road Usage Frequency on the Concentration of Heavy Metals and Petroleum in Roadside Soils

Student Name(s): N. Twitchell

Abstract:

In the use of automotive travel, many factors contribute to particulate pollution in the local environment. Fuel consumption releases trace amounts of heavy metals, such as nickel, into the local air, which then settles in the soil due to surface runoff. Other parts of automotive travel release heavy metals, such as tire and brake wear, oil consumption, and road abrasion. In addition to this, leaking oil or any other petroleum based product is also distributed into the environment by some cars. The deposition of such metals and pollutants into the soil is highly detrimental for the local environment, and can negatively impact other important resources, such as drinking water due to leaching. Because of its constant growth and development, automotive traffic load is increasing day by day, thus increasing the amount of metals and other pollutants being distributed into the environment. In order to view the impact of increasing traffic load on soil composition, studying the soil on roads with varying usage would simulate this development. In this simulation, we are given information of how the further increase in road traffic could affect the quality of soil.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EM EV

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

Yes No

CSEF Official Abstract and Certification

Word Count

122

2024

Fair Category

PS

Project
Number

6089

Title: Synthesis of Novel Calixarenes as Fluorescent Sensors for Ions

Student Name(s): C. Guo

Abstract:

Anion detection is important in the environmental and clinical arenas. For example, detection methods are needed for phosphate and nitrate, as these are pollutants in waterways. Also, the detection of nitrite is important in medical diagnostics. The project aimed to use calix arene and the principles of supramolecular chemistry to work toward a convenient detection method for anion pollutants. It included the synthesis of modified calix arenes and their characterization using IR spectroscopy. Lanthanides were then added to the calix arene to produce fluorescence as a result of host-guest interactions. The functionality of such interaction was evaluated for determining the next step of anion binding, which would change the color of the fluorescence and thus serve as a way for detection.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CH AT

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

252

2024

Fair Category

PS

Project Number

6090

Title: Investigating the Usage of Computer Microstructure Generation Techniques in the Synthesis of Novel Scale Independent Structures

Student Name(s): C. Zuraw

Abstract:

Computer microstructure modeling is a powerful technique within computational research that allows for the replication of structures—using computer programs—based on existing data. This project expands upon established microstructure generation frameworks (Robertson and Kalidindi's NGRF-LSI and LGD-Generation frameworks), incorporating methods focused on changing the specific characteristics of the generated structures while maintaining both local and global statistics. Such changes included modifying the shapes of individual features, as well as changing the percentage composition of said structures. Alkaline battery anode images (zinc powder suspended in gelled electrolyte) micro-CT data was sourced from Duracell for use as a case study. Of the two models selected, the NGRF-LSI model served as the base model for which experimental modifications were made. The modification of these models largely consisted of four steps: (1) converting data to be compatible with the acquired frameworks, (2) implementing a percent composition coefficient by changing the global measured statistics (while keeping local statistics constant), (3) modifying the shapes of individual particles by influencing local statistics, and (4), incorporating a rotation parameter by modifying local statistics via matrix transformations. The model was used to successfully generate realistic structures of the alkaline battery anode, with varying percent compositions and different particle shapes/orientations. To evaluate the accuracy of these changes, statistical analyses were used, which included finding the percent white composition, and employing T-tests to determine the effectiveness of these implementations. These changes have potential applications in modeling powdered/particulate structures—especially that of zinc in alkaline batteries.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CS EN

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

241

2024

Fair Category

PS

Project Number

6091

Title: Determining PCB Surface Finish Effect on Signal Loss at High Frequency Application

Student Name(s): L. Chang

Abstract:

As wireless communication advances into the 5th and 6th generation mobile networks (5G and 6G), printed circuit boards (PCBs) in portable devices must match this progress. The focus is on surface finishes over copper circuitry, crucial for faster data transfer rates and higher frequencies. The surface finish applied over the copper circuitry is now gaining more attention. Testing is required to discover which current model of surface finish is most suitable for technology in order to set a foundation to evolutionize surface finishes. To determine the most suitable surface finish for advanced technology, the project tested various models for high-frequency exchange while minimizing signal loss. The hypothesis was surface finishes without electroless nickel would be less suitable due to increased signal loss, favoring nickel-free options. The experiment utilized Immersion Iron (ImFe), Immersion Tin (ImSn), Electroless Nickel Immersion Gold (ENIG), and Electroless Nickel Electroless Palladium Immersion Gold (ENEPIG). The mentor guided the project, providing information on surface finishes. Using software simulation, the project modeled chemical compositions, testing compounds: Cuprospinel - Immersion Iron, Stannite - Immersion Tin, Auricupride - Electroless Nickel Immersion Gold, Veszylite- Electroless Nickel Electroless Palladium Immersion Gold. Avogadro measured distances between molecules to assess uniformity and signal loss. The experiment's implications allow mobile technology to progress efficiently without hardware constraints, facilitating simultaneous advancements in both software and hardware for new-generation technology. This allows for a more efficient and systematic approach in advancing both software and hardware at the same time.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EE AT CH

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

PS

Project Number

6092

Title: Autonomous Ping Pong Robot Player with Object Detection and prediction

Student Name(s): A. Burbank

Abstract:

Can robotics be used as a replacement for human players in Ping Pong? I will find this out through creating a Ping Pong robot that will successfully return a Ping Pong ball hit by a human player. This is done through having multiple arm-like segments, each controlled by its own motor. The robot sees the ball with a multiple camera system that will track the ball and predict its location in real time. I first designed the Ping Pong robot in Solidworks, then 3D printed my design on a smaller scale. With the model, adjustments were made until the design had minimal, inconsequential flaws. With this complete design I will go to a metal manufacturer and have a full sized model made out of aluminum. A mix of ROS(Robot Operating System) and python coding will be used to control the robot. Basic functions like moving will be coded into the robot first, then more complicated things like tracking the Ping Pong ball movement will be completed. Object detection is done using faster RCNN with an accuracy of 90%. After all of the functions are incorporated improvements will be made to increase speed and efficiency for a better outcome. The robot will be incapable of the goal at first but improvements will be made until it does work. When the robot is complete I think that it will be capable of replacing a human player on a low level being able to return a ball back across the table.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EE

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

246

2024

Fair Category

PS

Project Number

6093

Title: Beyond Traditional Forecasting: A Machine Learning Study in Enhancing Stock Market Predictions

Student Name(s): A. Lim

Abstract:

The world has recently seen an influx of the use of artificial intelligence. Its rapid growth, dubbed the “AI Revolution”, has changed the traditional ways of collecting, processing, and applying data, and researchers have been scrambling to find more ways to utilize AI to increase efficiency. The finance industry has long sought a way to accurately predict the stock market, as its complex volatility and importance in aiding analysts to produce financial gains make it an attractive area to apply AI in. This study will compare different types of machine learning models and investigate the uses of external data in the accuracy of these models, contributing to future research on more accurate and precise predictors, specifically for the stock market. The predictive accuracy of three ML models were analyzed and compared to each other, and additional features (second company’s stocks, sentiment analysis, and an approach to time series) were incorporated to test whether or not they could enhance the model’s forecasting ability. The linear regression model proved to be the most accurate, almost always having the lowest percent error and the heaviest weight in each method of approach, and the time series approach was the only feature that significantly enhanced the linear model. The design of the linear model and the time series approach made them a better fit for predicting compared to the other models and features; however, more complex uses of the other features can be used to continue enhancing the models’ predictive capabilities.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

CS MA

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

254

2024

Fair Category

PS

Project Number

6094

Title: Building an app to diagnosis Skin Cancer through the use of introducing an nth-bilinearity term in a Weight Dimensionality Reduction Neural Network.

Student Name(s): A. Mayorga

Abstract:

In this research we introduce a novel neural network architecture called Weight Dimensionality Reduction Neural Network (WDR-NN), which incorporates nth-term bilinearity into the training process. We did this by introducing different forms of dimensionality reduction primarily from the mathematical disciplines of Riemann Geometry, Differential Topology and Spectral Analysis. We use UMAP, Autoencoders, Discrete Wavelet Transform. After decomposing the data, we then feed it to a separate layer which then connects with the other layers which were connected to the other components of the data. We then apply this network to diagnosing different forms of cancer which include Breast Cancer, Skin Cancer and Lung Cancer. Inspired by results of (“He et al. 2015”), we incorporated Resnet 150 as a preprocessing technique to our (WDR-NN) with the WDR-NN being more relevant. The integration of these 2 models consistently outperforms traditional models such as Least Discriminant Analysis, Support Vector Machines and Convolutional Neural Networks. We yielded on average a 96-98% accuracy when diagnosing a patient for Skin Cancer as compared to a 80% accuracy for a Convolutional Neural Network and Resnet by itself on the same task. We also did a statistical analysis on the model and we found that for Breast Cancer, the strongest diagnostic factor for Breast Cancer is the overall size of a given tumor. We implement this model via an app which the general public can access. One can take a picture of their skin and based on image analysis, the app will diagnose the likelihood of skin cancer.

**Technical Disciplines Selected by the Student
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AT CS MA

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

PS

Project Number

6095

Title: Using Convolutional Neural Networks to Classify Mars Imagery taken by the HiRISE Camera

Student Name(s): A. Doshi

Abstract:

A convolutional neural network (CNN) is a machine learning technique which was used in this project to create a framework that classifies Martian imagery. It categorizes images into separate surface landmarks, such as Impact Ejecta or Slope Streak. The key components of constructing this framework include: loading the data into the Python environment, separating the data into training and validation portions, creating a basic neural network, analyzing the outputs (e.g., training/validation accuracy, training/validation loss), and refining the CNN to better suit the data. After completing this process, it was determined that the most effective model consisted of 4 2-dimensional convolutional layers, 1 dense layer, and a layer size of 64 neurons. A successful framework was also created which, when modified, can be used as a template for any image classification problem. Out of the multiple models tested, there was a clear distinction between which models were suitable and which had issues with accuracy or overfitting (when the CNN memorizes the training data). In order to better evaluate the effectiveness of each model, a basic linear regression was created which compared the association between the accuracy and categorical cross entropy loss (a measure of the distance between the prediction and the true value). This allowed for a visual representation of how the loss changes as accuracy increases. The models which achieved correlation coefficients close to -1 were generally more optimal for the classification. This CNN also has the potential to categorize Martian surface imagery from other datasets.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

CS PH AT

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

61

2024

Fair Category

PS

Project Number

6096

Title: Can Carbon Footprint Tracking Reduce Your Foodprint?

Student Name(s): J. Quaynor

Abstract:

This project investigates whether providing individuals with information about their environmental impact through a carbon footprint tracking app can lead to a reduction in the carbon emissions associated with their food and dairy choices. Participants will track their food consumption before and after using the app, and statistical analysis will determine if increased awareness leads to a decrease in carbon footprint.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CS AT

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- Yes No

CSEF Official Abstract and Certification

Word Count

252

2024

Fair Category

PS

Project Number

6097

Title: DETICKT IT: A Machine Learning-Based Application for Real-Time Tick Identification and Spatiotemporal Disease Risk Assessment

Student Name(s): A. Kolb

Abstract:

There is an alarming increase in the population of ticks and tick-borne diseases (TBDs), with 475,000 cases reported annually, some of which are fatal. Due to limited training, healthcare providers and the public cannot always accurately identify ticks and their associated infections, leading to delayed diagnoses and treatments. Additionally, the prevalence rates of different disease-causing pathogens vary based on geographic locations. To facilitate the identification process and provide an expedited risk assessment of TBDs, a machine learning-based iOS application, DETICKT IT, was created. The app features a ResNet50V2 (transfer learning) deep convolutional neural network (CNN) built in Python for combining real-time tick-species identification with a novel “window” algorithm and a location-based tick-risk assessment by embedding the Centers for Disease Control and Prevention’s (CDC’s) spatiotemporal tick and pathogen surveillance statistics. With DETICKT IT, users can now receive an immediate and accurate analysis to determine whether they are at risk of contracting a certain TBD. The app is able to accurately identify the ten most common tick species in North and South America: American dog tick, Asian Longhorned tick, Brown dog tick, Eastern blacklegged tick, Western blacklegged tick, Groundhog tick, Gulf Coast tick, Lone star tick, Rocky Mountain wood tick, and soft tick, with an overall accuracy of 97% and precision, recall, and F1 score metrics of 0.96, 0.97, and 0.96, respectively. This freely accessible app shows promise in assisting tick bite victims with their decision to seek further medical assistance, particularly those with underlying health conditions.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CS ME CBIO

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

243

2024

Fair Category

PS

Project Number

6098

Title: Modeling Interactions Between the Neocortex and the Basal Ganglia During Temporal Sequential Learning Using a Hierarchical Temporal Memory Artificial Neural Network

Student Name(s): A. Yun

Abstract:

Action-timed sequential learning is thought to emerge from neural activity between the basal ganglia and neocortex of the human brain. Neurologists are uncertain of how the basal ganglia, a subcortical structure, provides a temporal signal for sequences to emerge, which is a known phenomenon in sequential learning. Current brain imaging tools lack the resolution to analyze this neural network activity precisely, and current neural network models of sequence learning violate biological local and online learning rules, thus making them inaccurate models. Hierarchical Temporal Memory (HTM) is a biologically constrained machine intelligence framework; however it only models neural connections on the cortical level and not the subcortical level, which is where the basal ganglia is located. A biologically plausible model of the basal ganglia was published in 2022, but it was connected to a recurrent neural network (RNN), which violates biological constraints of the brain. Using Python 3.3, an HTM network was trained to learn sequences and then was connected to the published 2022 basal ganglia model that regulated action timing. The network was trained on the sequences learned by the previously-published RNN-basal ganglia model, and data on accuracy of sequence prediction and accuracy of action-timing was collected. The procedure was conducted solely by the student researcher, with guidance from the mentor. The HTM-basal ganglia model demonstrated similar results to the RNN-basal ganglia model, supporting its use as a more biologically plausible model of action-timed sequential learning.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

CBIO CS AT

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

227

2024

Fair Category

PS

Project Number

6101

Title: Mechanistic Analysis of the Driving Factors of Ventilation within Macrotermes Michaelseni Termite Nests

Student Name(s): L. Meier

Abstract:

The complex nest architecture of the fungi-cultivating Macrotermes termite species has been widely studied for its demonstrations of air ventilation. Mechanistic analysis of ventilation dynamics in Macrotermes nests can give insight into more effective ventilation systems for human architecture with the purpose of limiting the need for expansive energy use of air conditioning, and its subsequent fossil fuel release, in buildings. This study aims to isolate two different theories for ventilation within the African termite species Macrotermes michaelseni and replicate them within two respective models to take steps towards implementing termite architecture within human designs. The first model will demonstrate a ventilation theory based on alternating day and night temperature cycles and the second model will demonstrate a different theory based on wind. The models will be placed outside, with each respective mechanism intended to function automatically, and temperature, air velocity, and wind speed/direction will be measured in each model over time. It is expected that while each model will maintain the ability to circulate air, the model based on the diurnal temperature cycles will be more efficient with stronger airflow. Along with clearly demonstrating how the mechanisms of each theory function and showing which one is more efficient, this study also takes steps towards implementing termite architecture into human designs by presenting two baseline models for inspiration that could be adapted into actual buildings.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EE AS

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- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

211

2024

Fair Category

PS

Project Number

6102

Title: Vision Through AI: Assisting the Visually Impaired By Building AI Smart Glasses

Student Name(s): D. Jerome

Abstract:

The project aimed to develop assistive technology for visually impaired individuals using AI. The design goal of the project was to create AI-powered glasses that enhance the accessibility and quality of life for visually impaired individuals by providing real-time audio descriptions of their surroundings through object recognition. The hands-free, voice-activated device captured and analyzed images through a Raspberry Pi, sending them to Google Cloud for object recognition. Results were relayed back audibly, activated by voice commands. The AI glasses, configured with a Raspberry Pi, camera module, used Python, Thonny, PicoVoice AI, Google Cloud API, and (Google Text-To-Speech) gTTS. Testing involved trials with four objects—apple, shoe, toothbrush, and guitar—showing accurate identification with variations in response times. The apple and guitar showed consistent identification, while the shoe had accurate but varied responses. The toothbrush posed challenges due to its size and less distinct features. The Results highlighted the AI system's potential and the need for refinement, especially for objects with less distinct features. Environmental factors, like lighting, affected performance. The project underscored the importance of continuous improvement in AI algorithms for broader applicability in assisting visually impaired individuals. The AI-powered glasses, with a 5.903-second average response time, worked and were an overall success.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CS

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

PS

Project Number

6103

Title: WonderLimb: A Children's Smart Prosthetic Designed To Maximize Functionality, Comfort, and Affordability

Student Name(s): S. Reddy

Abstract:

Every 1 in 1,900 babies is born with a congenital limb difference, and millions around the world require prosthetics, yet, only 5% have access to appropriate tools. Prosthetics cost tens of thousands of dollars and force families to spend exorbitant amounts on prosthetics that must be replaced every couple years. The prevalence of congenital limb differences necessitates the development of a children's prosthetic design that addresses issues of functionality, comfort, and cost.

WonderLimb is a prosthetic designed to accommodate children's susceptibility to damage, rapid growth, and need for haptic perception. Leveraging 3D printing and accessible materials, WonderLimb enhances durability while significantly reducing cost. An arduino circuit using pressure sensors measures the resistance between the user's residual limb and sensors; if the pressure is between 0-213 volts, a motor proportionately enlarges the palm and shrinks it for 214-1023 volts. By doing so, WonderLimb reduces skin irritation and hyperhidrosis that occur from the wrong fit of a prosthetic while increasing the prosthetic's usage period. Furthermore, haptic sensors attached to the fingers detect when a user touches an object; a vibration motor proportionately vibrates the user's limb, returning haptic sensation.

A balloon, replicating a limb, was used for testing. The balloon was enlarged and shrunk and the prosthetic proportionally rotated to either enlarge or shrink the prosthetic. The prosthetic was then used to pick up a pencil with varying levels of force, each which returned varying vibrational feedback.

WonderLimb maximizes anthropomorphic features, functionality, affordability, and comfort, advancing prosthetic development and accessibility.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EN AT ME

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

236

2024

Fair Category

PS

Project Number

6104

Title: Patient Appointment Preparation Tool

Student Name(s): L. Nair

Abstract:

The aim of this project is to leverage artificial intelligence and technology solutions to enhance patient experience and assist medical professionals in accurate diagnosis of medical issues in an efficient manner. Medical professionals have limited time during patient appointments. Given the limited time, conveying all symptoms can be challenging for patients. Yet, in diagnosing rare diseases, even minor symptoms like a headache can be crucial for pinpointing the root cause. Having patients convey detailed and relevant information before an appointment can go a long way in accurate diagnosis of diseases in an efficient manner.

Chatbots are emerging as a new reliable form of communication in many areas. This chatbot will be a part of the patient appointment check-in process. The patient is asked by the chatbot to enter the reason for the appointment. Based on the input provided by the patient, the chatbot will ask for any related symptoms. The chatbot intelligently detects related symptoms from the dataset fed into the chatbot.

The chatbot is built using the tool Rasa. The programming language used is Python. HTML, CSS and JavaScript are used for the front-end and integration to Python is done using Flask. After all the data is entered, all the information the user entered is emailed to the provider. This will help the provider have as much information as possible before a patient comes to the appointment which can help in accurate diagnosis.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

AT ME CS

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

219

2024

Fair Category

PST

Project Number

6501

Title: Utilizing the Efficiency of Piezoelectricity for a Novel Electronics Cooling Mechanism

Student Name(s): A. Anand, J. Thokchom

Abstract:

An estimated 50,000 kWh is used for cooling an average sized data center every single year. Overall, every data center collectively uses energy that amounts to about 0.04% of our global power consumption. Most of the power draw used in these cooling systems tends to come from fans. These fans not only use a lot of energy to run, but they also wear out quickly due to friction between their spinning components. Our project aims to leverage the piezoelectric effect to convert electricity to mechanical energy extremely efficiently to create piezoelectric fans, while still maintaining the same cooling performance. This was accomplished by using existing piezoelectric transducers to rapidly compress and decompress a cantilever beam that was tuned to vibrate at the electrical input to maximize its amplitude, which in turn maximized efficiency and performance. The airflow that was measured from our piezoelectric fan was not only comparable to the axial fan that was used, but it was actually performing better by 11%, on average. This was while drawing 38.4% less power than the axial fan. This solution provides a large reduction in electricity usage as well as an increase in reliability due to having no components that generate friction. This technology has the potential to increase cooling efficiency worldwide, and has novel applications in a variety of fields.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EE AT ET

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2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

207

2024

Fair Category

PST

Project Number

6502

Title: Construction of a Low-cost Liquid Handling Device with 3D Printing for Polymerase Chain Reaction

Student Name(s): C. Moon, J. Moon

Abstract:

Although a field still in its infancy, robots and automated devices have been adopted in an increasing number of laboratories to make the workflow more efficient. However, the expensive cost of the liquid handling devices exasperates the disparity between laboratories. To address this issue, this research devised a method to develop an accurate, low-cost liquid handler. The method can be shared via the internet in the form of open source programs and 3D designs, allowing convenient recreation of the model anywhere. The machine was tested for its accuracy and precision with a 0.1mg analytical balance. The systematic error was 5.10% at 5 μ L and the random error excluding the outlier resulted in 4.87% at 5 μ L, resulting in an accuracy of 94.90% and a precision of 95.13%. In the test PCR and subsequent gel electrophoresis analysis, both hand and machine pipetted DNA bands were clear, indicating the machine's capability to accurately perform PCR. The machine was also extremely economical compared to high-cost liquid handlers in the market that ranged from \$9000 to about \$60,000, costing only around \$250 in material. In future research, this can be used in underfunded laboratories as an economic alternative to expensive liquid handlers to assist in the repetitive PCR process.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EE AT

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

PST

Project Number

6504

Title: Camera Obscura and Painting

Student Name(s): E. Sanchez Rendon, J. Thompson

Abstract:

In this project, three ways of manipulating light were applied to create a practical tool, our main objective was to test how the optics field of physics and art can collaborate for our progress.

Light is both a wave and a particle, so it can be manipulated if its characteristics are taken into account. In our experiment a light source was used and projected through a hole. The property of refraction comes into play when light passes through both the hole and the convex lens. Here the image was inverted twice, giving us the position we want. After this, the light reaches the flat mirror (which is in a 45 degree position) to be reflected onto the tempered glass. At this point the image of the object projecting the light was visible and could be used to the artist's advantage. Our team's artist was then able to trace the image on transparent paper.

Light is one of the many physical properties of components that surround us. It is one that is most present in our daily lives. This leaves us with the question if wonders can be done with this everyday property, how far can we go if we immerse ourselves in the unknown?

Here we present more than just a discovery. It is actually a vision. It has been impressive how long we have come with the tiny understanding we have acquired. So let us continue to experiment and discover, as our future is founded on our present.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

PH

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

228

2024

Fair Category

PST

Project Number

6506

Title: Optimizing the Efficiency of a Hydraulic Ram Pump for Integration into a Pumped Storage Power Plant

Student Name(s): A. Sharp, C. Sharp

Abstract:

Pumped storage hydroelectricity is a popular tool to store energy by allowing water to flow from an upper reservoir down to turbines at a lower elevation and pushing the water back up when electricity demand is low. However, it remains an unreliable source of energy when the electrical grid is strained, since it requires an input of electricity to function properly. This project proposes the integration of a pumped storage system with a hydraulic ram pump, a device that utilizes hydraulic shock to move water to a high elevation without the use of electricity. Doing so would create a reliable energy storage system that could operate without input from the grid. A physical hydraulic ram pump was used to determine the factors affecting the system, and then two simulations were created: one using SymPy API to model mathematical expressions, and another using XGBoost, a gradient boosting library, to model data at an industrial scale. Experimental trials show the potential for an increase in 5% to 10% efficiency for each ram pump installed. The XGBoost model was applied to the Rocky River Pumped Storage Power Plant, which showed a 4.5% increase in efficiency, saving approximately \$50,000 annually. Overall, this project highlights the potential that integrating hydraulic ram pumps and pumped storage power plants could serve in boosting energy efficiency even in times when the electrical grid is under duress.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

ET PH MA

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

254

2024

Fair Category

PST

Project Number

6507

Title: TOAST: A Computational Approach to Optimized Magneto-Inertial Fusion

Student Name(s): J. Shiju, A. Nadimpalli, D. Stoyanov

Abstract:

The use of nuclear fusion as a source of energy has been an idea since the dawn of the atomic science. However, fusion projects have been limited by the amount of resources required to run (often unsuccessful) trials. As such, we propose the use of Theoretical Optimization Algorithm for Sustainable Technology (TOAST) to devise a Magneto-Inertial Fusion (MIF) device. Typical devices struggle to fuse the lighter elements that are optimal for energy production; our proposed MIF device creates extremely high temperatures (~100 million Kelvin) and pressures using solid-state electromagnets to accelerate Deuterium and Helium-3 plasma. The resulting self-sustaining compact toroid allows for plasma to fuse, releasing significant amounts of energy. We have implemented machine learning to find the minimum value of the toroidal radius, based upon the Grad-Shafranov Equation, alongside the magnetic flux, based on the theoretical pressure function (a product of the Beta and Alpha values). TOAST then uses these inputs to determine the magnetic flux profile, which can then be used to find a theoretical temperature and density based on the Lawson criteria. In order to formulate a computational model, we compared our algorithm using the relationships listed above to current experimental data. After computational accuracy was achieved, we found that a radius of 13.5762 m and alpha/beta values of 102.3877/22.9586 were optimal for reaching a temperature of 125.34 million kelvin and a density of 6.75×10^{17} particles/m³. This data can be implemented in future designs with experimental data to maximize energy yield.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

ET EE PH

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

PST

Project Number

6510

Title: Creating a Biodegradable Mylar Substitute in Order to Reduce the Amount of Sea Animal Deaths Through Balloons

Student Name(s): S. Mensi, L. O'Donohue

Abstract:

The purpose of this project is to create a biodegradable mylar balloon in order to reduce sea animal deaths due to balloon consumption. Plastics in the ocean is a project that the public is extremely aware of, and a negative connotation has been associated with plastics. However, balloons are often associated with celebration, which leads to less awareness about the threat they pose to animals. Mylar balloons pose a threat to animals because they appear as prey to many species of turtles and seabirds. If an animal consumes a mylar balloon, it blocks their digestive tract, leading to a slow and painful starvation. The process began with research on different methods of synthesizing a bioplastic. We researched and attempted various different combinations of materials. The plastic that turned out the best involved a combination of corn starch, glycerin, water, and vinegar. We combined these materials in a variety of ways in order to synthesize three different bioplastics. One of the bioplastics contained gelatin, as we researched gelatin bioplastics and concluded that it could be a viable plastic. The next step in the process was to create samples of each different type of plastic. After creating samples of each bioplastic, the next step was to brainstorm different ways to test the tensile strength and biodegradability Plastic #1 outperformed both other plastics in terms of tensile strength and biodegradability. Unfortunately, the next step in the project was left incomplete due to difficulty in sealing the biodegradable mylar exterior to the bioplastic.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EM

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

252

2024

Fair Category

PST

Project Number

6511

Title: Potential Impact of Watershed Runoff and Tidal Inundation on the Hydrologic Profile of a Coastal March

Student Name(s): C. FitzGerald, T. Maines

Abstract:

As the coastline is developed, increased threats from human activity will be seen on critically sensitive habitats in the way of soils (Suir and Berkowitz, 2021) as well as nutrient build-up (Krask et al, 2022). Beacon Hill Preserve is no different, and the fringes of this preserve are home to the historically significant Shoreline Trolley Museum. Concerns have arisen about threats, from watershed flushing (nutrients) and tidal inundation (algae), to their tracks. This study was designed to evaluate relative impacts from each and model likely threats to these tracks. A series of 8 sites along the western ends of the tracks (fringe of Beacon Hill Preserve) were repeatedly profiled for temperature, salinity, ammonia, nitrate, dissolved oxygen and conductivity and clarity. Analysis of water profiles overlaid on tidal charts revealed a consistent pattern of ammonia peaks occurring on ebb tides. Flood tides ammonia levels were substantially lower in magnitude ($p < 0.05$). Slack low tide profiles showed a strong tendency for ammonia build-up at site 4, a standing pond known to flood during spring high tides. This data, along with correlations to rainfall in the area suggest chemical run-off from the watershed adjacent to the marsh appears to be the source of nutrient issues. Algae overgrowth is thought to be coming on flood tides and tidal inundation bringing macro and micro algae which is likely blooming in response to the elevated ammonia levels. This may explain the frequent decreases in ammonia post peaks. However, this needs further analysis moving forward to confirm.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EV CH EA

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

261

2024

Fair Category

PST

Project Number

6512

Title: Quantum-Assisted Machine Learning on Maize Yield Prediction Report

Student Name(s): H. Chaine, Y. Zhuo, L. Chen

Abstract:

In response to the diminishing yield of maize due to global warming and the increase in the unpredictability of environmental patterns worldwide, this study investigates the impact of climate variability on maize crop production in Connecticut. With annual increases in greenhouse gas emissions exacerbating the effects of global warming, Connecticut has witnessed increasing adverse weather conditions, leading to substantial economic losses for local farmers and businesses. Despite these challenges, maize remains a cornerstone of Connecticut's agricultural staples. This study proposes a novel quantum-assisted machine learning approach to address these issues to predict optimal maize yields based on real-world environmental conditions [5]. Compared to classical neural networks, quantum neural networks (QNNs) have been proven to outperform their classical counterparts in their ability to process data with more efficiency and solve more complex problems [9], [10]. Using a data set incorporating maize yield records and environmental variables from 1984 to 2020, exploratory data analysis reveals insights into maize distribution and CO₂ concentration peaks. The Least Absolute Shrinkage and Selection Operator (LASSO) regression was then used to identify significant predictors, such as longitude (p-value < 2×10^{-16}), precipitation (p-value < 3.54×10^{-4}), temperature change (p-value < 3.20×10^{-8}), carbon dioxide concentration (p-value < 1.32×10^{-14}), and cultivar usage (p-value < 7.17×10^{-6}). The Quantum Neural Network (QNN) model demonstrates decent efficacy in predicting maize yield, validated through examples from the testing set and Mean Squared Error value of 22.26. Overall, this study emphasizes the urgent need for adaptive strategies to mitigate climate change impacts on maize production.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CS EV MA

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

237

2024

Fair Category

PST

Project Number

6513

Title: Mitigation of Pharmaceutical Contamination Through Advanced Water Treatment Techniques: A Study on Reverse Osmosis and Carbon Filtration

Student Name(s): A. Sharma, A. Rajan

Abstract:

All over the world, in 38.26% of countries, most commonly in poverty-stricken regions, most bodies of water including sewage waters, fresh water, and riverine environments are contaminated with active pharmaceutical ingredients (APIs). The APIs include harmful chemicals, like Carbamazepine and Metformin, which are most frequently detected in pharmaceutical compounds within these environments. Carbamazepine, for example, is known to cause chronic toxicity to a variety of aquatic organisms. Most water filtration systems don't decontaminate these common pharmaceutical chemicals that enter and affect the drinking water living organisms this water reaches and can be detrimental to their health and cause further health conditions and even mortality. Our procedure tested how to remove these APIs and their negative effects by testing a wastewater treatment plan as a base and incorporating materials used to thoroughly filter through API. We tested the effect of elements that stand as a placebo of medication with many APIs and tested the effect on one's blood sugar as a standard and how that would change after going through the filtration system to mitigate the effect. We found that water with sucrose typically spiked the blood sugar levels while ingestion of filtered water resulted in lower/neutral blood sugar levels. Many pharmaceutical items have a similar effect on blood sugar levels, meaning that if our filter can filter out the placebo of these chemicals, in a real-world application, it can filter out more dangerous chemicals.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EA ME EV

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 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

242

2024

Fair Category

PST

Project Number

6514

Title: Jobs, Internships, and Opportunities App

Student Name(s): J. Joe, S. Joe

Abstract:

The Job, Internship, and Opportunities App (JIO) is a prototype app that allows students and adults to find jobs, internships, and programs around them as a more efficient means of strengthening resumes and finding jobs faster while also being accessible as an app. Finding jobs as an adult and even in high school can be stressful. That is why the JIO app uses Google as a search engine, allowing users to have as many results as the internet can provide. JIO is a block code-based app created through MIT App Inventor using prior knowledge and other informational sources. It uses a Cloud Database to store information and includes an account creation, search, and favorites page. To test the effectiveness of JIO, a trial and survey were conducted with seven people whose ages ranged from 10 to 49. The volunteers answered questions about how the app helped their search, what could be improved, and its usefulness. The responses show that about 70% understood the efficacy of the app but thought it was not exactly necessary. The majority said the app is simple but could have more features tailored to the user's preferences. Overall, an application in which a user can access multiple sources detailing jobs and internships is helpful but must be more customizable. Although MIT App Inventor has some limitations, a different coding method would increase this app's potential. A larger testing group would also provide more accurate data and feedback.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

CS AT

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 vertebrate animals controlled substances

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

232

2024

Fair Category

PST

Project Number

6515

Title: The Effect of Surface Texture of a Spoiler on the Efficiency of Formula 1 Race Cars

Student Name(s): W. Davis, P. Davis

Abstract:

Formula 1 race cars are one of the fastest kinds of cars out there. Most Formula 1 cars have an average speed of 210-230 mph, but what if someone told you that they can go much faster than that just by changing 1 minute detail. This project has studied the shapes and textures of a spoiler and how they can impact their efficiency on a Formula 1 race car. The goal of this project was to discover which shape and texture would have the most increase to the maximum speed of one of those cars.

To conquer this goal, airfoils were manufactured using 2 different design software's and then 3D fabricated on a 3D printer. These airfoils would consist of 3 sets of 6 different shapes, with each set having its own texture: smooth, stripes, and dimpled. Once printed, they would be placed into a wind tunnel above a scale which would provide a measurement of the downwards force in grams and then converted to Newtons.

Through conducting the experiment, it was discovered that the spoiler that showed the best results was from foil #3 with dimples. In the end, this experiment provided the data that showed the foils with the dimples had almost double the amount of downward force than the control, while the foils with the stripes were a less than a quarter of the downward force from the control.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EE ET EN

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

233

2024

Fair Category

PST

Project
Number

6516

Title: Water Testing with Ease: Creation of a Handheld Device for Water Analysis in Recently Flooded Areas

Student Name(s): W. Pallone, T. Bancroft

Abstract:

The goal of this project was to create a handheld device for the purpose of testing post flood waters, making sure it was safe to enter in time of crisis and in search of a route to escape in life or death situations. Attempting to debunk the "48 Hour" rule, was the goal set in place. The "48 Hour" rule is an unofficial rule meant to keep people out of water for two days in flood zones post storms. Run-off and bacteria are collected in these bodies of water leading to unsafe swimming and playing conditions. The process began with writing the code on a Raspberry Pi microcomputer. RGB color sensors were coded to analyze the color of test strips once the sensor had been in contact with water. Using feedback from the RGB sensors, the code generated a concise and easily comprehensible response that indicates either a pass or a fail. As the project progressed, there were numerous challenges faced, including originally getting the Raspberry Pi working, finding a way to efficiently but effectively program a code, and making sure everything fit into place while correctly designing a "home" for all the equipment. The final product of this project is a handheld device that proficiently tests post flood waters to ensure the safety of children and people of all ages swimming, while eliminating the ambiguity of the current testing strips.

**Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)**

EV AT CS

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2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

250

2024

Fair Category

PST

Project Number

6517

Title: Eco-Filter

Student Name(s): N. Kandawala, N. Joyner, D. de Oliveira

Abstract:

The purpose of creating a homemade water filter is to provide a sustainable and environmentally friendly solution for purifying water. By using ground materials, such as gravel, sand, pebbles, and charcoal will help these filters effectively to remove contaminants from water sources. This is a great way to ensure access to clean water in areas where there are limited resources. It also reduces the reliance on traditional energy sources in some areas that do not have access. A water filter was created using a plastic water bottle, and various natural materials, such as: pebbles, gravel, activated charcoal, coarse sand, and regular sand. A cheese cloth was used in some trials, as well as a coffee filter, for extra filtration. These materials are prominent in this experiment. The materials were layered, some trials having only a couple of the materials, while the others included all of them. We did this in order to find out what materials work best together in order to filter water efficiently. After the materials were layered, water was poured through the bottle containing the materials, which would come out from the bottom of that bottle and land into another bottle. After having done multiple trials, the trial containing all the materials worked best in filtering the water. The other trials which only had a portion of the total materials led to the water having a stained color. In conclusion, all the natural materials were not required to be used together, in order to create potable water.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

EE AT

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

257

2024

Fair Category

PST

Project Number

6518

Title: Using Regression Models to Predict the Season Scores of Basketball Teams

Student Name(s): E. Huang, L. Jiang, J. Jin

Abstract:

The objective of this experiment was to develop and compare models to predict the season record (win-loss ratio) of various sports teams. For this project, we limited our scope to basketball teams within the National Basketball Association (NBA). We built off the work of Dean Oliver—a prominent basketball statistician who identified the four most impactful factors in basketball: effective field goal percentage, offensive rebound percentage, free throw rate, and turnover rate—by using each of his factors, although weighing each factor differently. Two predictive modeling techniques were employed to create these models: multiple linear regression and ridge regression. While multivariable linear regression models observe and process past data to formulate a linear relationship between chosen variables, ridge regression introduces an additional feature—a penalty variable that minimizes the magnitude of the coefficients in the linear equation at the cost of accuracy, reducing the statistical variance. For this reason, we hypothesized that ridge regression would produce a better-fitting model compared to multiple linear regression on average. Team statistics were acquired from the official NBA website for our experiment. Additionally, we built upon his philosophy by introducing the opposing teams' statistics into our model. We formed our models using Python and Microsoft Excel. The data showed that our eight-factor linear regression model was more accurate than the eight-factor ridge regression model, contrary to our hypothesis. Both models were significantly better than our four-factor models and Oliver's proposed model. We believe that ridge regression was unsuccessful due to the shrinkage of variables reducing accuracy.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

MA CS

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2. Student independently performed all procedures as outlined in this abstract. Yes No

3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

245

2024

Fair Category

PST

Project Number

6519

Title: Amplifying Voltage Production in Piezoelectric Discs Utilizing Glycerol Mixtures with Zinc Oxide and Quartz

Student Name(s): V. Bathula, D. DiTunno, K. Odobashi

Abstract:

This experiment researches piezoelectric materials, which are able to produce voltage in response to mechanical stress. Specifically, the three materials investigated were PZT (lead zirconate titanate; $\text{Pb}[\text{Zr}_x\text{Ti}_{1-x}]\text{O}_3$), Zinc Oxide (ZnO) mixed with Glycerol ($\text{C}_3\text{H}_8\text{O}_3$) on a 2g:1 ml ratio, and Quartz (SiO_2) mixed with Glycerol ($\text{C}_3\text{H}_8\text{O}_3$) on a 2.5g:1 ml ratio, with the null hypothesis that PZT, the most commonly used material, will yield the most efficient results. By dropping a 10-gram weight onto a copper disc, containing either the Glycerol and Quartz mixture, Zinc and Glycerol mixture, or just PZT, voltage outputs were recorded, and the means and standard deviations for each material were calculated. While PZT yielded a higher mean of voltage production, it was only two percent higher than that of the Quartz and Glycerol mixture. Moreover, Quartz is far less expensive per pound than lead zirconate titanate, making it more cost-efficient while still producing a voltage output only slightly lower than that of PZT. While doing this experiment, several limitations required revisions to the processes conducted, such as having to resort to glycerin as a binding agent for the powders, after initially planning to use ethanol or water, which were impossible to use because of their lower evaporation points. The results of this experiment demonstrate that piezoelectric quartz can be used in a wide array of everyday applications, such as energy storage and generation, with a cost-effective and practical integration into these uses.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

EE ET

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 vertebrate animals controlled substances

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

249

2024

Fair Category

PST

Project Number

6520

Title: Acid Rain? Such a Pain!

Student Name(s): E. Blanchfield, R. Shukla

Abstract:

The problem being addressed is how acidic precipitation affects fresh bodies of water and aquatic ecosystems within the United States. Acidic precipitation is created when nitric oxides are mixed with water and oxygen forming acidic pollutants in our atmosphere. When the pollutants are precipitated, they have obstructive effects on aquatic life. Our solution is called "soil supplements", the supplements consist of limestone and calcium deposits that act as a buffer in environments containing limestone bedrock. The deposits revert acidic water to a basic pH, making it sustainable for aquatic life. During our investigation, we worked alongside environmental specialist, Jeffrey H. Folger, testing water from the Connecticut River to determine its acidity. On the logarithmic pH scale, a pH below 7 is acidic, the obtained pH was 4, showing highly acidic results. We conducted a lab testing our temporary solution utilizing pH strips, and soil derived from private land in South Windsor. Our control group was soil that remained untempered, and our experimental group was tempered soil that had added vinegar to decrease the pH, representing highly acidic areas. Limestone-rich soil neutralizes the acid reactions in highly acidic soil due to its alkaline nature. To test our solution we added the supplements to the tempered soil changing it from a pH of 3 to 6, proving our solution's effectiveness. Implementing our solutions in bodies of fresh water will restore ecosystems. A beneficial extension to our experiment would be testing our supplements on a suffering ecosystem to observe their effectiveness.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EA PS EV

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

Yes No

CSEF Official Abstract and Certification

Word Count

194

2024

Fair Category

PST

Project Number

6522

Title: The Efficiency of Toroidal Propellers on Plane Engines

Student Name(s): T. Carney, P. Crosby

Abstract:

The project aimed to evaluate the efficacy of toroidal propellers versus conventional models by quantifying their thrust output. All propellers, crafted from PLA+ filament, were subjected to testing on a rig comprising 3D printed components, electrical apparatus, a 2500 KV motor, and a scale. Upon reaching specified wattage, the motor was promptly deactivated by the server tester. Utilizing propellers with varying blade counts facilitated a comprehensive dataset enabling direct comparison of blade count and surface area against thrust generation. Analysis of the relationship between blade count, surface area, and thrust across traditional and toroidal propellers offers insights applicable to aircraft engines. Results indicate toroidal propellers generally outperform traditional ones in thrust generation, with fewer blades correlating with greater force. However, it emerged that toroidal propellers might not maintain this efficiency with the higher blade count typical in aircraft turbines. Notably, examination of mass versus blade count graphs reveals that as blades increase, traditional propellers escalate in mass more rapidly than toroidal counterparts. Consequently, at lower blade counts, toroidal propellers might lack cost efficiency compared to traditional ones. Conversely, at higher blade counts, such as those found in plane turbines, toroidal propellers exhibit superior efficiency.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

EE

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3. This project was conducted at a Registered Research Institution. Yes No

4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

141

2024

Fair Category

PST

Project
Number

6523

Title: Sonic Converter

Student Name(s): O. Ferguson, E. Love

Abstract:

Our hypothesis revolves around transforming noise generated in loud environments into a sustainable source of energy. the procedures followed to make this possible were:

1. Connect Alligator clips to jak connector
2. Place a large bass Drum in front of the speaker's diaphragm
3. Hit drum watch as constructive interference happens between the two as shown on the Oscilloscope

with our procedure, the data collected was that without Constructive Interference there were fewer lines shown meaning there was no energy being shown on the Oscilloscope. But when drum is hit, the waves being shown become much larger. Because of all this, The outcomes of our project conclusively demonstrate the usefulness of this innovative approach. Despite encountering challenges during our project, such as devising alternative methods to showcase the light emitted by the drum, we persevered through testing to achieve valuable results.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project)

EE EM CS

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

239

2024

Fair Category

PST

Project
Number

6524

Title: The Effect of Spatial Orientation of Panels in a Three-Dimensional Solar Tower

Student Name(s): S. Sundararaman, J. Andrew

Abstract:

Solar panels are a reliable source of renewable energy. One of the challenges is the amount of space that they take up on the ground. This investigation focuses on the orientation of a group of solar panels with respect to the amount of space it takes up on the ground.

Each of four solar panels was exposed to a bright light and the voltage and current of each was recorded to be sure all of the panels behaved similarly. The first set of experiments had the solar panels laid side by side on the ground, similarly to how they are found in the community. It was found that when the horizontally laid panels were placed without an incline, they had the maximum voltage of 8.2 V. The second set of experiments had the panels positioned vertically off the ground, with one panel placed approximately 6 cm above the other. It was found that when they were placed at an angle of 60 degrees, they had a maximum voltage of 8.4 V.

The area needed for the horizontal panels was 47.5 sq in and thus the amount of energy per square inch is 0.173 V whereas the vertical panels took up only 11.9 sq in and thus the amount of energy per square inch is 0.706 V. It is apparent that stacking the solar panels in a vertical manner will increase the amount of energy per unit area by 400%.

Technical Disciplines Selected by the Student
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ET EE CS

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4. Is this project a continuation? Yes No

5. My display board includes photographs/visual depictions of humans (other than myself or my family):

- Yes No

CSEF Official Abstract and Certification

Word Count

248

2024

Fair Category

PST

Project Number

6527

Title: Railgun Launcher

Student Name(s): R. Rajasekaran, S. Michaelson, L. Hamilton

Abstract:

The main objective of this project is to implement a new technology, called a railgun launcher, into airports to create an efficient and environmentally friendly way for commercial aircraft to depart. Because a railgun uses electricity to launch planes instead of fuel, there will then be a significant reduction in carbon and other harmful gas emissions. This project stemmed from the discovery of a company called Zipline. Zipline, which initially delivered medical supplies to hospitals in Rwanda, and has since expanded. The notable success of Zipline paved a way to reduce aviation emissions worldwide.

In order to commercially launch planes using electricity, the runway will have to be made significantly longer. Large metal rails will be installed to the runway and attached to a capacitor. After the plane is moved onto the rails it will generate a magnetic field. When the force on the plane is increased, the airplane will experience a significant amount of acceleration, propelling it into the air at a high velocity.

During the launch, a remarkable process will undergo where 120 megawatts of energy is converted into a powerful electromagnetic field that extends along the entire track. If the plane increases its speed to 200 mph, the aircraft will then be able to take flight, and it has the possibility of reaching 575 mph.

The possibility of aircraft being able to depart efficiently and effectively using the electric railgun device will open up a new realm of aviation where the environment will be safe.

Technical Disciplines Selected by the Student
(Listed in order of relevance to the project)

EE ET EA

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4. Is this project a continuation? Yes No

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- Yes No