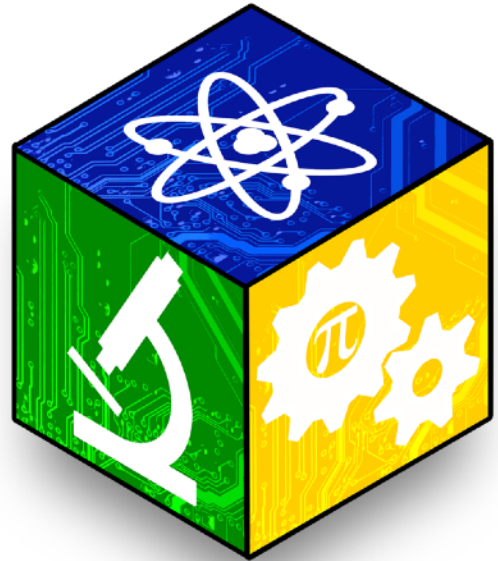


CONNECTICUT
SCIENCE &
ENGINEERING
— FAIR —



75th Annual Fair
March 6-18, 2023

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

248

2023

Fair Category

PS

Project
Number

6001

Title: A Domestic Violence Alerting Device comprised of an Analog Sound Level Meter, OLED Display, and iOS and Android Mobile App built using Flutter

Student Name(s): S. Srinivasan

Abstract:

Domestic violence is an enormous issue since, in the United States, around 10 million people are victims yearly. However, very few applications send for help when a domestic violence incident occurs since most support systems are meant to help victims cope after an incident occurs.

This project is a continuation of one submitted last year. Consisting of a hardware device and software mobile application, this project reduces the impact of domestic violence by sending an alert to the victim's contacts or the police. The analog sound level meter measures the environment sound level, and if it exceeds the decibel threshold configured, the alarm is triggered. The victim can then turn off the alarm if it is a false alarm. Otherwise, a text alert will be sent to the victim's contact list or police.

Multiple technologies are used to build this project, such as the Firebase database to store information, the Twilio Service to send SMS alerts, Arduino for the hardware device, and Flutter to build the iOS and Android mobile applications. There are many advances to the project, such as an Android and iOS app with professional UI. The app also includes email verification, decibel threshold settings, and contacts configuration.

The relationship between distance and the sound level was tested to find the best range for configurable decibel thresholds. An audio of screaming was recorded and played at one foot increments from the device. Based on the results, the decibel range was set to 65 to 85 decibels.

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

CS AT 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

252

Fair Category

PS

Project Number

6002

Title: Creating and Building an Ardupilot based Autonomous Drone to Provide Security to People, Businesses and School Campuses

Student Name(s): E. Babajanyan

Abstract:

Unmanned Aerial Vehicle technology is growing in usage by companies and governments. These are either for agriculture, mining, video streaming, and even carrying heavy weight. Drones are now being used for military and high-level security applications but aren't publicly accessible. The drone was developed to scan for human posture and violent interactions using a custom computer vision algorithm and landmark-based tracking. In the design process, a BeagleBone Blue board was utilized to run Ardupilot, an open-source firmware written in C for mission-based autopilot systems along with a Raspberry Pi 4 was used to handle posture detection and alert systems by running the algorithm on boot. To test the drone's reliability and accuracy, four tests were employed. The first test was flying the drone to a distance goal of one thousand meters. The second test was flying the drone in autonomous mode for as long as it stays in the air with a battery life goal of eighteen minutes. The third test was a simple look at how the drone centers or positions itself comfortably from users to fly ten feet in the air, minding surroundings. The last test was a ten-trial accuracy test of the algorithm's predictions with at least an 80% prediction goal. Drones are emerging as a new reliable form of security. People in all regions and settings can have access to drones that require little or no supervision while securing our buildings and facilities, alerting officials, and preventing violence, all while being cost-effective.

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

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

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

Fair Category

PS

Project Number

6003

Title: Improving photoelectric conversion efficiency of the solar cell with aerogel-coated surface

Student Name(s): Y. Che

Abstract:

Aerogel, with its extraordinary physical and chemical properties, has the potential to revolutionize numerous industries, ranging from aerospace to biomedicine. While previous research has focused on the application of outstanding heat-insulation and improving mechanical properties of the aerogel, my study focuses on the nature of its structure: high porosity. Knowing that conventional aerogel has a light transmittance of 69% at a thickness of 30mm, I aim to explore the property of aerogel thin film and design a new anti-reflective layer for solar cells. I prepared the aerogel from scratch, by dissolving tetraethoxysilane ($\text{SiC}_8\text{H}_{20}\text{O}_4$, referred to as TEOS) in ethanol (EtOH) and then using a two-step acidic-basic catalyzed procedure to make silicate sols. Following gelation, I chose the thin film processing method to remove the solvent, which is less dangerous and more economical compared to the conventional supercritical drying techniques. After that, I covered the monocrystalline silicon panels and C-60 solar cells with the processed thin film of aerogel. The solar cells were then placed under constant glowing white fluorescent light for measurement of the output voltage. As a result, there is an increment in the output voltage for both coated C-60 and monocrystalline silicon solar cells. Acknowledging uneven surface for aerogel thin film, poor surface integration between aerogel and solar cell, and potential contact resistance and artificial errors during measurement, future research is necessary by applying more refined preparation techniques, testing setups, and environment.

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

CH EN 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

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

Fair Category

PS

Project
Number

6004

Title: The MacroEnvironment

Student Name(s): F. Formica

Abstract:

The water cycle, also known as the hydrological cycle, is a vital component of the Earth's atmosphere. It involves the movement of water through various states, including evaporation, precipitation, and transpiration. The purpose of this study is to recreate the functions of the water cycle within a fish tank in order to investigate the potential for artificial hydrological systems. To do this, a fish tank with a cooling plate on the top and a heating pad on the bottom was assembled to simulate the various processes of the water cycle. The tank has three functions, to heat the water and produce evaporation, cooling the evaporated water at the top of the chamber to cause condensation, and for the droplets to become heavy enough to produce precipitation. An ecosystem was set up inside the tank that consists of a hill of sand on the right side of the tank to simulate a continent, and a pool of water on the left side of the tank, to simulate the ocean. The water vapor from the ocean should float to the top of the tank, and condense to the glass sheet on the top of the tank due to adhesion. This process will continue until the water droplets on the top of the tank get too heavy for the adhesive properties of the water, and fall to the surface as precipitation.

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

EA

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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

Fair Category

PS

Project Number

6005

Title: Determination of the Equilibrium DNA-Binding Constant of the Psoralen Compound 6E

Student Name(s): A. Balas

Abstract:

Psoralens are potent agents used to treat hyperproliferative skin diseases such as psoriasis and cutaneous T-cell Lymphoma.¹ When activated with UVA radiation (320-400 nm), intercalated psoralens react with pyrimidine bases in DNA. The photoadducts block DNA replication. Previous studies show that the binding affinity of psoralens to DNA governs therapeutic effectiveness.² The purpose of this experiment was to determine the binding constant of the novel psoralen 6E and compare its constant to that of other psoralens. 6E was synthesized by our collaborators at Duke University. Binding constants were determined by measuring fluorescence intensity quenching when 6E intercalates with AT-40, a short synthetic oligonucleotide. The fluorescence intensity (f) was used in formula to determine the binding constant by plotting this quantity versus the reciprocal of the AT-40 concentration. In the resulting Scatchard plot, the binding constant was calculated by dividing the intercept by the slope. Binding constants for two other commercially available psoralens, aminomethyltrioxsalen (AMT) and 8-methoxypsoralen (8-MOP), were determined using the same method. The values that were determined for AMT and 8-MOP matched the trends for their published binding constants.³ The results showed that the 6E binding constant was ~7-fold greater than that of AMT and ~70-fold greater than that of 8-MOP. The significantly greater resulting binding constant suggests that psoralen 6E is viable for use in phototherapy and would be expected to be more effective than currently used 8-MOP.

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

BI CH 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

212

Fair Category

PS

Project Number

6006

Title: Testing the Effectiveness of ThermaCork Insulation for an Outdoor Shelter

Student Name(s): M. Negron Figueroa

Abstract:

The idea of this project was inspired by my cat. She loves the wintertime and watching the snowfall. However, the best way for her to do so is on our back porch where it's always freezing. I then started wondering how many animals and even people have to endure the harsh winter conditions without knowing there are simple ways to stay warm. I chose to compare double bubble insulation and ThermaCork. ThermaCork is a 100% natural, renewable, recyclable, and biodegradable product made from the outer bark of an oak tree, a species called *Quercus suber*. I did so by recycling two milk crates, I insulated one using nothing but double bubble insulation. The other, I insulated using ThermaCork. There was a lightbulb in each as a heat source and both milk crates were completely sealed by foil duct tape. For testing, I ran multiple experiments. I would turn the lights on in both and record the temperature every ten minutes for the first half an hour. For the second half an hour I turned off the heat source and would once again check every ten minutes to see which one would conserve the heat better. ThermaCork was proven to be the best option for isolation as it conserved the heat much better.

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

ET 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

250

Fair Category

PS

Project Number

6007

Title: Determining the forces received during multiple head impacts in High school American Football

Student Name(s): M. Li

Abstract:

Football players receive concussions at a higher rate compared to other sports. This is because they use their heads as armored weapons to hit each other. Despite this, there has not been much research that examines high school player's head impacts even though they account for the largest percentage of sports-related concussions. This project determined the magnitude of head impacts that different players receive. In football, lineman refers to a position player who is usually bigger and does not touch the ball while a skilled player is usually smaller, faster, and touches the ball more. The hypothesis was that skill players receive higher magnitude impacts because they collide at higher velocities. The independent variable was the player's position, and the dependent variable was the force, momentum, and kinetic energy calculated. Data was collected through Hudl, a website used to post and watch game recordings. 3 skill and 3 linemen positions were selected. Game footage was analyzed and each time a position received a head impact, the duration and velocity leading into the impact was recorded. A head impact referred to anytime the player's helmet contacted another surface. Once collected, data was analyzed with help from mentor Mark Horstemeyer to calculate the force, kinetic energy, and momentum of the impacts. The data supports the hypothesis as skill players did receive greater magnitude impacts. This project can provide information to football helmet designers about the impact velocities and impact locations on which football helmets should be able to protect the wearer.

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

PH 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

288

Fair Category

PS

Project Number

6008

Title: Concurrent Removal of Rising, Soluble Ocean Carbon Dioxide and Oil-in-Water Contaminants via Multi-Functional Remediation Framework

Student Name(s): N. Park

Abstract:

The oceans absorb nearly a third of airborne CO₂ emissions, while concurrently, 1.3 million gallons of crude oil are spilled into oceans every year. Both issues continue to detrimentally affect marine biodiversity, and the future of human health. This research provides a highly efficient/practical method for the concurrent removal of CO₂ and soluble oil-in-water contaminants through the creation of a Multi-Functional Remediation Framework (MF-RF) utilizing hypercross-linked polymers (HCPs), synthesized from Styrofoam. First, styrofoam HCPs were synthesized through a one-pot Friedel–Crafts reaction according to Dong et al. HCPs alone remediated 88% of the 1.7g/L-soluble-benzene in seawater (via measure of benzene's fluorescence). Regarding CO₂ 95% of the contaminant was removed, or 3.12E-5M [CO₂]=[H⁺] (via pH measure). For the MF-RF, HCP-sponges were constructed on 8x1.3x0.7cm of melamine, with PTFE adhesion, and 450mg HCP for pollutant removal/capture. Air-tight modeling of the sponge benzene/CO₂ remediation were subsequently constructed. HCP-sponges remediated 92% of the 1.7g/L-benzene contaminant, and 95% of CO₂ (3.12E-5M[CO₂]=[H⁺]). Realistic concurrent oceanic experiments with a 0.1pH difference and maximum solubility of benzene highlight 92% remediation of oil, with only 12.6min needed to reach suitable oceanic pH. High-load concurrent removal experiments with 100x more CO₂ demonstrate 71% remediation of oil and 85% remediation of CO₂. Via recycle/reuse studies, the MF-RF may be reapplied in contaminated water until its capacity is reached (5.99g oil/HCP-sponge and 3700ppmCO₂/HCP-sponge). Stability studies demonstrate prolonged MF-RF integrity, as a marine-safe, easy-to-use oil and CO₂-remediation tool, which is simply lowered into contaminated water, left until saturated, and then lifted out for contaminant recovery/recycling.

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

EM EN AT

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

256

Fair Category

PS

Project Number

6009

Title: A Novel Centrifugal Baffle Design and Arrangement for Spiral Redirection of Heat Exchanger Flow

Student Name(s): E. Pinto

Abstract:

Heat exchangers are crucial in transferring energy in the form of heat from two fluids while keeping the fluids heterogenous. However, many current heat exchangers follow a smooth bore design, which conveys an efficiency no greater than 80%; this suggests that about 20% of that energy is released into the surrounding environment as waste heat. I proposed a coupling design which redirects the flow in a spiral pattern to increase the number of contact points between the fluid and the heat exchanger; this design can be retrofitted onto existing heat exchangers. I sketched out the baffles, then transferred these sketches into a CAD drawing to form the angle pitches for each baffle. One of three variations were arranged 40° from one another on along the coupling. These three designs were used to create a solid three-dimensional shape called concaves separated by 6mm vertically and 120° along the outline of the coupling. Design evaluations were based on water temperature exchange and thermal transfer within the exchange piping. The control for this design proved to be the most effective in heat exchange with a delta T° of 5.7°C, while the delta T° of designs 1-3 was 4.1°C, 3.5°C, and 3.7°C respectively. It can be noted that the control transferred the most heat. Based on these findings, I developed improved design which redirects the flow without segments. But rather, a tapering continual solid spiral. The novel coupling is able to exchange 11-15°C into the piping system without losing significant heat within the water.

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

EE AT PH

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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

247

Fair Category

PS

Project
Number

6010

Title: Line Follower Car

Student Name(s): E. Li

Abstract:

Over five million car crashes occur in the US every year, 94 percent of these accidents are from human error. The goal is to create a functioning car model that will be able to follow a line autonomously. A basic car structure with sensors was put together and coded to follow a series of commands that are affected by the pattern of the floor the car is driving over. The code contains if statements and when the conditions are met, will execute to give intended output. The car should be able to move forward consistently and use a turning function, when necessary, to stay on the line. The process of putting the different system components together included testing each component individually first. The conditions that are needed to activate certain parts of the car were turned off to ensure that those parts would work. Then the conditions were turned back on and the isolated parts were tested under different circumstances. Once all the parts of the car were found functional they were put together. The ideal result was a car that could follow various line patterns. Comparing different testing results to the wanted results help find errors in the car. Knowing that each individual part of the car functioned as intended made it easier to isolate the errors found once it was tested together. The car was found to be mostly successful and the faults along the way help inspire future modifications to get the desired outcome.

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):

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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

257

Fair Category

PS

Project Number

6011

Title: Eco-Navigator: Novel Routing Software for Wind-Assisted Ships Optimized to Reduce Greenhouse Gas Emissions and Generate Fuel Savings

Student Name(s): T. Ewald

Abstract:

Wind-assisted shipping has the potential to become a cleaner and more energy efficient alternative to traditional shipping by reducing greenhouse gas emissions while generating fuel savings to ship operators. Ship engines lose up to 70% of fossil fuel energy as heat and other losses, leaving only 30% for propulsion. By contrast, Flettner rotors and sails deliver 100% of harnessed wind-power to the hull of the ship, equivalent to effective power generated by an engine. Optimizing a route to maximize propulsion from wind-power presents two challenges: (1) it requires modeling complex aerodynamic and hydrodynamic forces and (2) the major shipping companies prioritize time to destination rather than efficiency and reduction of emissions because of economics. To solve this problem, I created Eco-Navigator, novel software that uses NOAA weather forecasts to predict wind-optimized routes for cargo ships with Flettner rotors and provide ship owners with a practical tool for calculating the economic value of fuel and emissions reduction. Eco-Navigator uses Dijkstra's algorithm to select the path that minimizes total work (physics definition) based on the voyage and ship specifications. The code determines total work by calculating the forces acting on the ship and rotors and optimizing the spin of the Flettner rotors using gradient descent. Eco-Navigator's simulations predicted an average of 30.8% fuel and CO2 emissions savings per trip. The potential impact of Eco-Navigator is the reduction of emissions leading to improvements in human health, protection of ocean ecosystems and property, fuel savings, and consideration and uptake of wind-assisted technology.

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

CS ET AT

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- Yes No

CSEF Official Abstract and Certification

Word Count

252

Fair Category

PS

Project Number

6012

Title: Challenging the AMC10: An Examination of its Increasing Difficulty

Student Name(s): A. Kalia

Abstract:

The Mathematical Association of America (MAA) hosts the American Mathematical Competitions (AMC10 and AMC12) every year, which aim to enhance the mathematical skills of young problem-solvers. These competitions are the first step in the process of selecting the United States Team for the International Mathematics Olympiad. However, recent reports have indicated a decline of over 40% in participation on AMC10 tests in the last few years.

This investigation considers the success rate data published by MAA for each question on AMC10, which represents the percentage of students who answered the questions correctly. This allowed me to trend the question level accuracy for the last decade that clearly indicated that fewer students are answering the questions correctly.

Secondly, I analyzed the key mathematical topics tested in each question for the past 20 years, which resulted in a primary dataset. I discovered that the problems have evolved to be more complex, requiring advanced skills and problem-solving techniques to solve them accurately.

Lastly, I identified schools with the highest number of top scorers on the AMC10. To conduct further demographic analysis, the zip codes of the 5 highest-performing school districts were cross-referenced with census data. All of the five zip codes exhibit a clear socioeconomic gap by displaying considerably higher median household incomes and median home values in comparison to the national averages.

These support my hypothesis that the tests have become progressively challenging, discouraging students who lack access to high-quality instructional materials leading to a decline in student participation.

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

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

228

Fair Category

PS

Project Number

6013

Title: The Diversity of Cichlid Fishes

Student Name(s): Y. Chu

Abstract:

The diversity of cichlids may be the result of a phenomenon called adaptive radiation. In order to adapt to their surroundings and quickly prey on new food sources, their body and head of cichlids exhibit extremely diverse morphologies, which may allow them to achieve great success in specific diets in specific habitats. Because the cichlid's varied head shape is related to a number of factors, I chose one of the possible factors – diet. Based on the cichlid's diet, my goal was to work out how the length, width, and depth of the cichlid head associate with diet?

In order to achieve the goal, I first placed eighteen landmarks on different types of cichlids' CT scans by using MeshLab. Then I used numerous statistical analyses to assess differences between and among groups and to examine possible associations between diet and head shape and extract linear measurements from the landmarks (i.e., a t-test, analysis of variance and a Tukey honest significant difference test, and a linear regression). According to my research results, cichlids with diets such as fish, insects, or plankton will require longer heads because fast prey will need to be chased down and quickly captured. Secondly, cichlids with diets such as plants will require wider heads because a shorter head allows the cichlid to get closer to the algae and pluck relatively more algae from the rock.

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

AS

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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

Fair Category

PS

Project
Number

6014

Title: An Image Deblurring Model Using Artificial Intelligence

Student Name(s): Y. Zhuo

Abstract:

Image is a medium to visually retain information in a 2-dimensional form. However, undesired blurry images can commonly occur for various reasons, such as camera shake, movements of objects in the images, and image compressions. Necessary information or details of the images are therefore lost in this process, limiting applications of these images for solving real-world problems. Inspired by Convolutional Neural Networks for Direct Text Deblurring by Hradis et al., this project aims to design a blind deconvolution model to deblur blurry images. The model presented in this project (L20 CNN) has 20 convolutional layers, followed by a rectified linear unit activation function (ReLU) for the first 19 convolutional layers and a Sigmoid function for the last layer, at most 512 channels per layer, and mean squared error (MSE) as the loss function to estimate the error between AI generated deblurred images and actual sharp images. A dataset containing blurry and sharp text images and the GOPRO Dataset, which contains dynamic scene blurry and sharp images filmed by the GOPRO Hero Black camera, are used to train the model. L20 CNN demonstrates the ability to deblur images. This model is compared and analyzed with three existing artificial intelligence models (L15 CNN by Hradis et al., Multi-scale CNN by Nah et al., and DeblurGan by Kupyn et al.) for strengths, weaknesses, and their real-world applications. In future studies, larger datasets will be used to train and test the model to obtain better results.

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

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

207

Fair Category

PS

Project Number

6015

Title: Research on sound production through mechanical design for pedestrian safety during low-speed driving

Student Name(s): Y. Cho

Abstract:

Electric cars, due to their lack of engine noise, pose a threat to pedestrians during low-speed driving. The objective of this research is to design and create an instrument that generates a louder sound during low-speed driving, which can be attached to electric cars to reduce the risk of accidents. Initially, a pipe-like structure was deemed impractical due to the need for extra cost and structure to control air flow rate. The final solution utilizes centripetal force and involves a tire designed to make iron marbles fall and generate sound. Decibel tests using a sound level meter and video analysis program were conducted, indicating that the resulting structure is effective in producing audible sound at speeds less than 50 km/h. The structure was thus found applicable because the sound was only produced at a low-speed environment and sound produced was sufficient to be audible in the target setting. However, further mechanical analysis and testing is required to manipulate the volume of sound produced and the speed at which the device stops sound production. This study successfully achieves the primary objective of promoting pedestrian safety with a simple structure, and future studies can improve upon its design and quality while maintaining its advantages.

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

EE 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

276

Fair Category

PS

Project Number

6016

Title: Synthesis and Investigation of Metal Organic Frameworks for the Purpose of Atmospheric Water Harvesting

Student Name(s): C. Tice

Abstract:

With over ~771 million people worldwide who don't have access to clean drinking water, the need for alternate clean-water resources is imperative. Metal Organic Frameworks (MOFs) are highly porous materials with chemical and structural properties that enable them to soak up molecules - including water - from the atmosphere to its surface and release it under mild heating. This research successfully synthesized MOFs from $AlCl_3$ and 3,5-pyrazoledicarboxylic acid monohydrate, which when completed, formed water-absorbent, crystallite structures. The amount of water the MOF was able to absorb was found to be dependent on % Relative Humidity of air, absorbing a Water Mass Fraction (g-H₂O/g-MOF) of 0.172 at 88%RH (highest RH tested), and 0.088 at 65%RH (lowest RH tested). 18-minute MOF water absorption and 17-minute desorption (45°C) cycles, respectively, were found to be highly-repetitive and could be completed numerous times without degradation of the MOF, which highlights its usefulness in a Water Harvesting System (WHS). By scaling-up of water absorption and desorption mass changes in a WHS it was estimated that the newly-synthesized MOF can produce 7.04L-water/kg-MOF at 88%RH, and 1.79L-water/kg-MOF at 30%RH in 24 hours, which is a ~38% improvement over most-recent MOF literature. Furthermore, MOF arrangement affected its harvesting capabilities, such that when arranged in a thinly-spread circular pattern (compared to a standard-mound) the water-absorption levels improved by 5.98%, due to increased surface area. To apply the improved MOF, a low-cost atmospheric water-harvester was designed (via 3d-modeling), and constructed with readily available parts so that it can be easily assembled.

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

EM EN 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

264

Fair Category

PS

Project Number

6017

Title: Optimizing Reinforcement Learning Using Dynamic Environment Manipulation to More Efficiently Train Autonomous Navigation AI

Student Name(s): A. Patel

Abstract:

Autonomous navigation, which involves independently navigating an agent/robot through a series of obstacles, can fuel many innovations in society. This is commonly approached through Reinforcement Learning (RL), a deep-learning technique that trains an AI agent through trial-and-error in a virtual environment. However, RL is notoriously difficult to train, sometimes taking days/weeks for simple tasks. Dynamic environment manipulation (DEM) is a largely unexplored approach to optimizing RL. DEM involves adapting a training environment as an agent becomes more intelligent, leading to greater training efficiency. The purpose of this project was to explore the capabilities of dynamic environment manipulation in reducing RL training times for autonomous navigation. To do this, a 2D simulation was created in Python, guided by kinematic equations and existing literature. Using this, a car agent was trained through Proximal Policy Optimization (PPO) to navigate a series of obstacles, where LiDAR sensors served as input and steering/acceleration as output. Two DEM approaches, a raw scaling approach (which gradually added obstacles as the agent improved) and an over-training approach (which directly trained the agent in a harder environment than testing), were then benchmarked against a vanilla (control) RL algorithm. After measuring performance for different DEM amounts and environment difficulties, the over-training approach performed best with 9.05% more reward over time than the baseline. This research provides an easy-to-use and time-efficient approach for optimizing RL, allowing for greater incorporation into complex tasks. Furthermore, it can enhance autonomous navigation algorithms, enabling innovations in fields such as self-driving, indoor navigation, and search-and-rescue robotics.

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

CS AT 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

248

Fair Category

PS

Project Number

6018

Title: The effect of using indophenol to find out how much vitamin C different kinds of fruit contains

Student Name(s): P. Santiago

Abstract:

The purpose of the project was focused on my curiosity about my favorite fruit, the strawberry. I wanted to learn nutritional information about this fruit and I found it would be interesting to compare it with other fruits. I researched various projects and came across a project and kit I could use to compare my strawberry to other fruits (homesciencetools.com). It was common belief that oranges contained the most vitamin c so I wanted to test that nutrient fact by seeing if my favorite fruit, the strawberry and other fruits contained more vitamin c than it.

First, I squeezed the juices out of each individual fruit and placed each one into a cup. Next, I set up 4 test tubes in the rack. I made an Indophenol solution, put 15 drops of indophenol into each test tube. I then tested orange, strawberry, lime, lemon, and ascorbic acid solution by adding drop by drop as much solution as needed to make the blue color of the indophenol turn colorless (the fewer drops needed the higher the content of vitamin C).

In conclusion, my hypothesis was correct which helped support previous nutritional findings from the scientific community: the orange overall had the most vitamin C because it took the least amount of orange juice drops for the indophenol to turn colorless, which meant it had the most vitamin C. The data shows that the orange averaged 6 drops, the lemon averaged 6.3, the lime 9 drops and the strawberry 9.6.

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

CH BI

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

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

Fair Category

PS

Project Number

6020

Title: Sustainable Lithium Ion Battery Recycling using Fungal driven Metal Dissolution

Student Name(s): A. Lewis

Abstract:

Due to an increasing demand in Lithium Ion batteries, a more efficient process of the recycling and reclaiming of metals used in these batteries must be found. Fungi, particularly that of the genus *Aspergillus*, has been found to be effective at the sequestration of metals from a controlled additive to growth medium. This added material can be up-taken and separated out for future use. *A. Niger*, *A. Flavus*, and *Penicillium Chrysogenum* in specific have demonstrated these properties, though the dissolution effectiveness of each is debated. Cobalt (II) Hexahydrate, Lithium Chloride and Lithium Cobalt(III) Oxide are added in concentrations of .13g and .065g per 250ml of either potato dextrose agar for *A.niger* and *P. Chrysogenum*, or sabouraud dextrose for *A.Flavus*. After the fungi is inoculated onto the growth medium, it is left to culture for at least 72 hours. The growth is then removed and transferred to an XRF to have the concentrations of trace metals determined. Based on the data collected in triplicate, the most efficient candidate for the bio separation of Cobalt is *A.Flavus*, having an uptake efficiency of ~99%. *A.niger* was measured to have an efficiency of ~67%, though a substantially larger amount of biological material was separated. The future application of this technique can be scaled to meet larger quantities of material leaving viable metals to be recycled.

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

EN EM

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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

Fair Category

PS

Project Number

6021

Title: The use of NMR to identify the LOD in mixtures of organic compounds to efficiently produce environmentally friendly biomass polymers & reduce energy loss from wasted plastic

Student Name(s): G. Krishnan

Abstract:

As greenhouse gas emissions from wasted energy continue to increase the effects of global warming and climate change, the issue of wasted energy has come to the forefront of research. Not only are buildings spending quadrillions of BTUs of energy only to use a small percentage of that energy, but also over 44 million tons of plastic end up in US landfills every year, causing extreme environmental damage and sequestering large amounts of unusable energy in plastic bonds. Attempts to mitigate this problem through the creation of environmentally friendly plastics from biomass are often slow and inefficient. We aimed to streamline this process via nuclear magnetic resonance (NMR) spectroscopy, testing a model system of organic compounds that could possibly be used as sustainable plastic polymer precursors. NMR was performed on combinations of acetophenone and 1-phenylethanol at different concentrations to identify the detection limit in these mixtures. This information will allow for successful quantification of products formed and determination of conversion rates. We identified a detection limit between 1-10 mM of acetophenone, significantly lower than the initial detection range of 1-100 mM. With further experimentation, we hope to narrow this detection limit further, obtaining an accuracy within 1 mM. As conversion rates are directly proportional to the success of sustainable polymer precursor formation, this approach aims to minimize time, cost, and energy wastage through indirectly increasing the efficiency of sustainable polymer production that, when scaled up, could potentially replace fossil fuels entirely.

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

EM ET 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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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

271

Fair Category

PS

Project Number

6022

Title: Use of Cryptomelane-Type Manganese Oxide Free Standing Membranes for Removal of Oil Contaminants in Water

Student Name(s): R. Wadhwa

Abstract:

The necessity for a material that can absorb oil from the ocean is continuously growing in many areas of the world. Significant oil is spilled into the ocean by careless human activity, such as tanker, barge, pipeline, refinery, and drilling rig accidents. Currently, oil-spill containment booms are used to gather the excess, insoluble oil that floats at the ocean's surface. There remains, however, a need for an effective methodology to remove the unseen, soluble oil that is left behind. This research investigates the synthesis of a free-standing membrane (FSM), that can absorb these soluble hydrocarbons. Specifically, a cryptomelane-type manganese oxide FSM was fabricated, as per methods described by Yuan, et al., with modifications. Scanning electron microscopy, along with ATR-FTIR and EDS spectroscopies, were used to provide evidence for its successful synthesis into a black, absorbent powder. To measure the effectiveness of FMS to remediate soluble oil, gasoline was mixed with water, to create 1.7g/L-benzene in water. The fluorescence of benzene-in-water at 250nm/310nm excitation/emission wavelengths was established, and a calibration curve generated based on serial dilutions of 1.7g/L-benzene-in-water. Air-tight measure of FSM's ability to remediate benzene in water was performed. 0.5g of FSM was inserted into 12ml of 1.7g/L-benzene in water, and its 310nm fluorescence measured over 12 hours. Results indicate that 82.3% of benzene was removed, for a 40.8mg-oil/g-FSM absorption rate. Used FSM was inserted into 10ml Ethanol at 30oC, for recovery of absorbed-oil, and reuse of FSM. 72% recovered was achieved, and the FSM was again ready for use.

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

EM EN 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

248

Fair Category

PS

Project Number

6023

Title: Racial and Ethnic Representations of Crime in True Crime Documentaries

Student Name(s): R. Manzo

Abstract:

In television news about crime, Black and Hispanic offenders are overreported, while White offenders are underreported compared to crime statistics. Similarly, television news about crime is less likely to depict a Black person as a victim of a crime compared to a White person. While crime news is thoroughly studied, there is relatively less research on racial/ethnic representations of crime in true crime media. In this study, I am watching 16 true crime documentaries and track the race/ethnicity of the perpetrator and victim of the crime and the type of crime featured in the documentary. I am also analyzing the way that true crime documentaries portray victims and perpetrators of crime and observe how this portrayal differs across various racial/ethnic identities.

I believe that true crime documentaries will follow a similar pattern as television news about crime and disproportionately represent people of color as perpetrators of crime and White people as victims. If this prediction holds, biases in true crime media should match those in television news media, with large discrepancies in race representations of crime and the actuality of crime statistics. Finally, I believe that a Black or Hispanic perpetrator of a crime is more likely to be characterized as “suspicious,” and a White victim is more likely to be characterized in a way that garners sympathy. Ultimately, the results of this study will contribute to our understanding of racial bias in media and its effect on representations of crime in true crime documentaries.

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

BE

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

125

Fair Category

PS

Project
Number

6024

Title: Caterpillar Robot

Student Name(s): X. Feng

Abstract:

Concrete and rebars are the basis of modern society. It is undeniable that the general contemporary cityscape shifts towards ever taller skyscrapers. What often is neglected about this increase in height, is the equal increase in difficulty for search and rescue missions in the face of disasters; with terrible events such as the SiChuan earthquake and 9/11 in mind, this project initially aimed to produce a search and rescue robot. Important parameters during the design process were low cost, low complexity, modular, and capable of navigating multiple kinds of surface and terrain. The result was a segmented rover design, which makes use of tension and compliant mechanisms, and may be applicable even outside search and rescue, in archeology or even deployment on future extraterrestrial missions.

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

EE 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

252

Fair Category

PS

Project Number

6025

Title: Modeling Subcortical-Cortical Interactions During Reward-Based Decision Making Using a Hierarchical Temporal Memory Artificial Neural Network

Student Name(s): A. Yun

Abstract:

Reward-based decision making is a learning process by which high-rewards are associated with the release of dopamine in subcortical brain structures, which helps train the cortex to make better decisions. To date, it is unclear how projections from the subcortex influence learning at the cortical level. With the resolution limitations of current brain imaging tools, artificial neural networks offer a promising solution to modeling this activity more precisely. The purpose of this project is to develop a biologically plausible neural network model for studying subcortical influences on cortical activity during reward-based decision making. Hierarchical Temporal Memory (HTM) was chosen as a suitable neural network framework due to its modeling of cortical columns, dendritic spinal activity, and neurological feedforward learning. Reinforcement learning (RL) was implemented into HTM to represent subcortical inputs. The network was trained to conduct a reward-based decision making task that has been studied clinically in humans, and the network data was compared to the human clinical data. In this dual-option task, the network performed with greater accuracy on easier decisions ($p < 0.0001$), similar to what was seen in the human clinical data. Additionally, network activity was more evenly distributed between the two options during difficult decisions ($p < 0.0001$), suggesting that this distribution pattern may be related to clinical correlates of decision conflict, such as theta oscillation activity. Overall, the implementation of RL into HTM in a reward-based decision making environment may be a useful tool for studying subcortical-cortical interactions in the human brain.

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

CBIO AT 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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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

Fair Category

PS

Project Number

6026

Title: Using Graphene and Psyllium Husk to Create a Strong 3D Printed Starch-Based Bioplastic that is Thermally and Electrically Conductive

Student Name(s): O. Ritossa

Abstract:

Nearly 400 million tons of plastic waste are produced every year globally, and the United States is responsible for 40 million tons. Plastic waste is growing at an annual rate of 9%, however, the recycling rate is declining. Bioplastics that are also compostable can create a desirable circular waste system. The basic bioplastic protocol (control) for this study included banana peels, water, honey, thyme, and cinnamon. The variables were created by adding graphene, psyllium husk, and both graphene and psyllium husk. Conductivity, strength, and biodegradability for each bioplastic were tested. It was hypothesized that the bioplastic with both psyllium husk and graphene would be strong, compostable, and conduct both heat and electricity. It was found that the variable with psyllium husk was approximately 3.3 times stronger than the control and the graphene added additional strength in that the graphene plus psyllium variable was 4.5 times stronger than the control. The graphene variable did not demonstrate significant conductivity so additional trials with greater amounts and better dispersion of the graphene will be attempted. In terms of compostability, the control decomposed the most within a specific timeframe and psyllium variable decomposed the least. Due to the bioplastic's lack of flexibility, glycerin will be used in addition to honey as a plasticizer for future trials. Future work will also include testing the 3D printing capability for each group. The optimum bioplastic produced can be used in the development of batteries, diodes, electrochemical capacitors, sensors, electrochromic devices, and fuel cells.

**Technical Disciplines Selected by the Student
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EE AT 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

250

Fair Category

PS

Project Number

6027

Title: Prosthetic ASL Hand

Student Name(s): N. Guido

Abstract:

American Sign Language (ASL) Resin Printed Prosthetic Hand Completed Project, Engineering, Physical Science

My goal is to create a working finger and then progress to all five fingers and begin to build a hand, with Arduino coding Servos, screws, and fishing line wire. I intend to make a fully functioning, realistic prosthetic hand prototype that can perform human-like tasks such as bending a finger, signing words using American Sign Language (ASL) such as the word “wow” or picking up a tissue. Eventually, I want the prosthetic hand to control all five fingers and incorporate wrist movements. Once I have those tasks accomplished and have a fully functioning hand, I would like to discover advantages and disadvantages of a prosthetic hand and find places for improvements and make those changes. Then, I can utilize its capabilities to improve sensitivity and perform more fluid movements. My proposed experiment will include the ability for the prosthetic hand to: 1. Perform human-like tasks such as bending a finger 2. Sign simple words such as “wow” using American Sign Language Fingerspelling 3. Pull a tissue from a tissue box 4. Control all five fingers to hold a paper cup 5. Incorporating wrist movements In starting to build the experiment, I will first assess if I can make a functioning finger. Once I have a full functioning finger, I can build upon that progress and use the same system to make the remaining fingers for a complete full functioning hand to perform sign language.

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

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

275

Fair Category

PS

Project Number

6028

Title: Development of an Efficient and Easily Applicable Low-Energy Process for the Degradation of PFAS

Student Name(s): Z. Haque

Abstract:

PFAS, known as “forever chemicals” for the difficulties associated with degrading them, are suspected carcinogens, adversely affect reproduction, and may have negative impacts on antibody production. Given the prevalence of PFAS in drinking water and the environment, the development of a mechanism in which PFAS are degraded into compounds which can be easily repurposed is critical. This research expands upon recent work by Trang, to decarboxylate, and now fully-disassemble perfluorinated octanoic acid (PFOA) into useful, reusable light-fluorinated products. 207mg-PFOA was added to 600mg-NaOH, 5ml-DMSO and 625ul-H₂O, and heated at 120oC in a Teflon reactor. During initial stages of PFOA-degradation, decarboxylation occurs, leading to formation of Na₂CO₃, and C₇H₁₅F₁₅ (hexafluoroheptane, with hydrogen at the cleavage carbon). These results are supported by SEM, ATR-FTIR, and EDS spectroscopies. The fluorinated 7-carbon chain is subsequently broken into fragments via thermolysis, which are easily captured as reaction headspace gases, for eventual repurposing as refrigerants. Gas-phase FTIR of the headspace products highlight the presence of highly-fluorinated C₂-C₅ (chain-length) compounds, with C-H bonds that are consistent with carbon-carbon bond-breaking mechanisms. GC-FID analyses of the thermolysis reaction headspace at hourly intervals, over the 12-hour reaction time, further confirm the presence of C₂, C₃, C₄, and C₅ fluorinated compounds, that elute in order of their molar masses. Analysis of GC-FID timepoint peak areas reveal relative production of 57.9%-C₄H₂F₆, 6.55%-C₃H₂F₆, 35.3%-C₂H₂F₄, 0.2%-C₅H₂F₁₀ fragments, occurring within 2-4 hours of PFOA-degradation. Finally, EDS measure and analysis of the remaining solid/liquid reaction mixture highlights a 4hour reaction time, after which minimal fluorine remains.

**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

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

Fair Category

PS

Project Number

6030

Title: Effect of atmospheric conditions on the voltage output of a solar panel.

Student Name(s): S. Chin

Abstract:

This study aims to analyze the effect of different atmospheric conditions on the voltage output of a solar panel. The temperature, humidity, amount of dust, and light intensity were varied using a heat fan, hair drier, humidifier, flour(for dust), and incense(for smoke) and by changing the height of the light bulb. Statistical analysis using linear regression and Pearson's R correlation test was done using SPSS(Statistical Package for the Social Sciences). Pearson's R coefficient test showed that the light intensity was the most important factor in determining the voltage output, humidity, dust, and temperature in descending order. The linear regression produced an equation of the voltage output as a function of the amount of dust, humidity, temperature, and light intensity:

Voltage=2.801-0.105*Dust+0.746*Light-0.207*Humidity +0.335*Temperature (R2 =0.78, P < 0.001). The low P value shows the statistical significance of this equation, yet the relatively low R2 value led to further analysis. Machine learning using several methods was conducted using python for higher accuracy. Random Forest Algorithm outputted the lowest RMSE (0.02196) and MAE score (0.0240), proving it is the best predictive model. It also showed the light intensity was the most important factor in determining the voltage output and temperature, humidity, and dust in descending order. This study can be used for other analyses of solar panels. These results should be verified in outdoor conditions with a wider range of data.

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

PH ET EV

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

246

Fair Category

PS

Project Number

6031

Title: 3D printed, Smart Pipette for pH Sensing by Smartphone

Student Name(s): J. Liu

Abstract:

Soil is our life-support system on Earth, it is an essential supplier of nutrients to forests and crops we interact with in our daily lives. Soil pH monitoring is critical as it provides valuable insight into the quality of the soil, if the soil were to be too acidic or alkaline it would produce an excess or a deficiency in nutrients (ex. Calcium, magnesium). Currently, soil pH measurements require expensive and fragile pH meters that are not suited for in-field applications. For instance, the ideal pH range for grass growth is between 6.0 and 7.0, while moss prefers a soil pH range of 5.0 to 5.5., so I fabricated and tested a smart pipette to detect pH value in soils with quantifications from a smartphone. The smart pipette consists of a 3D-printed cylinder, filter paper, pH paper, and a disposable pipette. The filter's purpose is to remove debris, enabling more accurate pH measurements. I used the smartphone to take pictures of the pH paper for color value analysis. To optimize the quantitative pH detection, I tested and compared two different color models, including RGB (Red, Green, Blue) and HSB (Hue, Saturation, and Brightness). I selected the Hue value of the HSB model to quantify pH value because it shows a defined linear relationship between pH value and Hue value with a slope of 0.296 pH per Hue degree and an R^2 of 0.915. Furthermore, I applied these findings through a field testing.

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

AT 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

238

Fair Category

PS

Project Number

6032

Title: Can Heat Beat Your Speed?

Student Name(s): C. Ferro

Abstract:

Accentuating the significance and various components of running is vital, as our country evolves as a healthier society. This experiment examines how temperature affects running surfaces and reflects which surface is most suitable to run on, based on its measure of heat and heat absorption. In this experiment, the temperature increase and decrease were measured for three running surfaces. This included synthetic rubber (track), synthetic grass (turf), and cement. Each running surface was positioned under a heat lamp (60-WATT light bulb), for thirty minutes. The temperature of the surface was calculated with an infrared thermometer in 5-minute increments. Once the timer reached 30 minutes, the surface was removed from under the heat lamp and observed as the surface cooled down. The temperature was measured with an infrared thermometer in 1-minute increments. Each surface contrasted with cool-down times, temperature increase, and maximum temperature reached. It was observed that throughout all three trials, the synthetic rubber (track) reached the lowest maximum temperature of 49.7° C. It was also documented that the synthetic grass (turf) cooled down quickly, taking an average of 3.6 minutes to cool down. Whereas the track and cement trials took significantly longer to cool down (track, 20.3 minutes, and the cement, 23 minutes to cool down). This experiment is substantial to the future of running, discussing the significance of running on a surface with a temperature absorption suitable for endurance, strength, and speed.

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

ET

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

172

Fair Category

PS

Project Number

6033

Title: Potential Role of High Rainfall Events on Localized River Flow

Student Name(s): T. Maines

Abstract:

Increased rate of flow in rivers can increase rate of erosion, and cause stress to nearby infrastructure and wildlife. Flow rate was measured at three different sites within the coastal river system in Old Saybrook: the mouth of the Back River, the mouth of the Oyster River and a bend upriver of the Oyster River with the expected findings that increased rain would cause an increased rate of flow. Each site was sampled in a replicated design to evaluate the potential impact of weather variables (tide, wind, rain, etc.). Correlations between rainfall (24 hour) and flow rates showed a progressively stronger relationship as the sites became narrower (Oyster River Mouth, $R^2 = 0.087$; Oyster River Upriver, $R^2 = 0.404$; and Back River, $R^2 = 0.498$). This led to the conclusion that narrower coastal rivers may face increasing threats, especially coastal development continues to increase. Erosional damage may drive irreversible changes in ecologically sensitive coastal salt marshes, meaning that coastal zone managers need to be more cognizant of this as they make decisions about these systems.

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

EM EV 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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 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

246

Fair Category

PS

Project Number

6034

Title: Designing and Optimizing a More Efficient and Inexpensive Optical Component for Thermal Cameras

Student Name(s): A. Sharonov

Abstract:

Thermal cameras are devices which display the image of heat locations. Although they have been around for a long time, their light sensing component (known as microbolometers) causes them to become very expensive. The purpose of this project is to design an inexpensive optical component using cheaper materials than current microbolometers and to efficiently absorb infrared light. The use of periodical structures such as infrared antennas can boost the strength of infrared absorption. To design the optical component, an optical simulator can be used, which simulates a light source passing through a medium. The simulation is set up so the wavelength of the light source remains constant, meanwhile the dimensions of the structure, the materials, and the antennas will be varied. In last year's work, molybdenum trioxide was used as the main material for the design, which the infrared antennas will be laid on top of. All of the mentioned methods are done by the student, meanwhile, the mentor guides and explains the meaning of values, objects, and data analysis techniques. In order to determine that the results are efficient and cost-effective, they will be compared with results obtained from literature and market prices for materials. A cheaper, more efficient, and smaller optical component for a thermal imager brings down the cost and increases the efficiency of the thermal imager. If the thermal imager becomes inexpensive and more efficient, then it can be used in many professional applications such as space, military, or emergency situations.

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

EN ET 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

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- Yes No

CSEF Official Abstract and Certification

Word Count

171

Fair Category

PS

Project
Number

6035

Title: Rolling Tie Storage

Student Name(s): J. McKinney

Abstract:

The purpose of this item is to help make the storage of ties more convenient for their users, particularly those who have several of them. Ties are stored in a manner of ways, yet there are few tools used for their storage specifically. Attending a preparatory school in Connecticut, I used a survey of fellow students to collect opinions on tie storage and its issues. I asked how and where students stored their ties, and what improvements they would like to see to tie storage. Most stored them hanging, and when questioned about potential improvements, common themes were organization, a rotating selection, and additionally for the ties to avoid falling off their hangers. With this information I have resolved to create a hanger designed specifically for ties, with means to securely and neatly store ties for their users. It will feature a triangular shape, with multiple layers. Bars on each side connected to springs will be able to roll up ties fastened to them, to store ties more efficiently and securely.

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

EE

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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

262

Fair Category

PS

Project Number

6036

Title: Environmental Remediation via Photocatalysis for Partial Methane Oxidation and Oil Photodegradation

Student Name(s): A. Kolb

Abstract:

Methane (CH₄) is the most potent greenhouse gas in terms of global warming, and its ever-growing presence in the atmosphere from anthropogenic emissions is a leading contributor to climate change. This project aims to demonstrate the viability of photocatalysis as an efficient method for oxidizing CH₄ to carbon dioxide (CO₂), which has only ~1.25% of methane's heating potential. Existing applications of photocatalytic methane oxidation are notoriously energy-intensive and mostly nonviable to operate at industrial scale. A novel reactor design intended for real-world implementation is described that activates the reaction with blue LEDs at substantially lower energy through a scale-optimized catalyst system, consisting of photo-absorber gallium phosphide and cadmium sulfide, protective coating (Ti,Mn)₄:1OX, and co-catalysts palladium silver, achieving a ~2% conversion of methane to CO₂. This represents significant progress in removing a dangerous environmental pollutant and may potentially aid in reversing human-induced causes of the greenhouse effect. Similarly, the presented, feasible approach to photocatalytic hydrocarbon oxidation for curbing methane emissions can be extended to an original, nanotechnology-based application for oil spill removal. Using non-toxic copper oxide (CuO) nanosheet-catalysts for the photochemical degradation of petroleum hydrocarbon, co-functionalized with paramagnetic magnetite (Fe₃O₄) nanoparticles to allow for facile particle collection with a magnet post-reaction, this system is designed to be both economically and ecologically sound. Developed as a scalable alternative to current mitigation techniques, which have proven cost-prohibitive for removal at catastrophic levels of liquid petroleum release into open water, this photocatalytic nanoreactor is shown to have superior, real-world effectiveness.

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

240

2023

Fair Category

PS

Project Number

6037

Title: Removing the Ocean's Noose: Designing a Ropeless Solution to the Lobster Trap

Student Name(s): M. Neiss

Abstract:

The lobster trap design has remained consistent over a century despite its obvious limitations and environmental consequences. The classic small trap buoy system negatively impacts marine life and the environment. This project aims to improve the classic lobster trap by addressing the adverse effects of bycatching and ghost traps on the environment. In addition, the buoyed long rope lines connecting the traps also cause a significant decrease in marine mammal populations.

Although a single lost trap might appear insignificant compared to the vast size of the ocean, the magnitude of the one-million traps lost each year in North America alone continues to catch and kill marine life for up to ten years. Similarly, trap rigging leads to the entanglement and death of an estimated eighty-two whales annually in North America.

The ease of transportation, size, price, and durability of current wire mesh traps contribute to their long-standing popularity. In order to determine components of an improved system, research was conducted on the current traps flaws of bycatch, ghost trapping, and the entanglement of whales.

The first improvement includes an inexpensive, replaceable, dissolving door, which fully biodegrades within twenty days to address bycatch and ghost trapping. The second addresses the impact of the rope by adding an inflatable lift bag to float the rope to the surface when needed. As a result, the improved design builds off the current lobster trap to provide a realistic and economical solution.

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

AT EE EM

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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

248

Fair Category

PS

Project Number

6038

Title: Which Type of Rocket Oxidizer Can Combine with a Solid-Propellant Rocket Fuel in Order to Produce a High Output, Height, Distance, and Time?

Student Name(s): P. Gokhale, N. N/A, N. N/A

Abstract:

Rockets have been utilized for various purposes, evolving into current weapons and spacecraft. Determining the greatest single-propellant engine type became the objective after determining the optimal rocket fin type for model rockets. The purpose of this analysis is to investigate the utility of composite propellant model rocket engines compared to black powder propellant engines, regarding their capability to achieve a great height, distance, and time. It was hypothesized that the composite propellant would yield better results as opposed to the black powder propellant engine, as it contained a mixture of ammonium perchlorate and powdered aluminum, bound by polybutadiene acrylonitrile, rather than the potassium nitrate, charcoal, and sulfur mixture. After much research, it was determined that no other oxidizer should be mixed or used, due to safety concerns. As this was determined, alternatives were found and ordered, although they have yet to be delivered. 3 trials for each type were to be conducted, for a total of 6 rocket preparations. Every other rocket component was kept constant. In the end, the black powder engines did not arrive. Experimentation and result compilation for the 3 composite engine rockets was conducted. A mean distance of 107 meters, an average height of 121 meters, and an average time of 7.67 seconds were found under a wind speed of approximately 6 mph. Due to a lack of objective results, this experiment was inconclusive. Given the absence of a testing group, the results were disappointing and may inspire a continuation in the future.

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

ET 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

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- Yes No

CSEF Official Abstract and Certification

Word Count

244

Fair Category

PS

Project Number

6040

Title: Multitemporal Analysis of Beaver Activity in Connecticut Forests Using Aerial Imagery

Student Name(s): H. Witharana

Abstract:

Beavers play an instrumental role in shaping Connecticut riparian landscapes. It is important to monitor beaver activity for conservation and management efforts. The goal of this study was to investigate the utility of time series aerial imagery to map beaver activity over time. Approximately 85-years long time series aerial imagery (1934-2019) for study sites in Fenton River watershed and Carse Brook watershed were downloaded from online data repositories. Target characteristics of beaver activity, such as beaver dam, pond, and forest disturbance were identified and digitized using GIS analysis software. Study results demonstrated the capability of detecting beaver dam, lodge, and other key features from aerial image data. Image analysis revealed when the beavers had started building dams and how they transformed the landscape. For instance, during 1995 in the Fenton River site there were 4 beaver dams detected and the beaver impact area was approximately 5.55 acres. By 2019, the number of beaver dams detected increased to 14 while the beaver impact area had become 6.61 acres. During 1970, in the Carse Brook site there were 6 beaver dams detected and the beaver impact area was approximately 7 acres. In 2019, the number of beaver dams detected was 19 and the beaver impact area had similarly increased to 12 acres. Since publicly-available aerial imagery provides a state-wide coverage, this analysis can be extended to map beaver activity in Connecticut's riparian landscapes to increase our understanding on the ecological role of beavers.

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

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

177

Fair Category

PS

Project
Number

6042

Title: The effect of cooling on the crystallinity of amorphous solids.

Student Name(s): A. Yang

Abstract:

The present study investigated the difference in properties of amorphous solids in different cooling conditions in an effort to find out if temperature has an effect on the formation of crystalline structures. Amorphous solids are classified as a state of matter between solid and liquid. Also known as supercooled liquids, amorphous solids possess similar properties to regular crystalline solids, but lack a uniform crystalline structure and tend to be weaker than them¹. Some examples of these are glass, plastic, and rubber. In the present study, melted sugar, which would form amorphous solids, was cooled at different rates. The hardness (Mohs scale) and density (g/ml) were then measured. The sugar cooled at the slowest rate was the hardest and most dense, while the sugar that cooled fastest was softer and less dense. As crystallized solids are stronger than amorphous solids, it was concluded that the rate of cooling has an effect on the crystallinity of amorphous solids. However, more thorough research in a lab is needed to get more detailed and accurate measurements, and consistent cooling rates.

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

CH 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

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- Yes No

CSEF Official Abstract and Certification

Word Count

268

Fair Category

PS

Project Number

6043

Title: Reversible, Tunable Metal Electrodeposition on Pt-Functionalized, Indium Tin Oxide, Transparent Electrodes for Thermal Regulating and Dynamic Optical Properties of Smart Windows

Student Name(s): M. Minichetti

Abstract:

Energy conservation within the home has become increasingly important, in an effort to reduce our reliance on heating/cooling energy. Building materials that can save energy have gained focus. Smart windows, for example, can tailor our use of natural sunlight for heating in the day, through the use of electrochromic materials, that provide tunable light-transmittance properties via changes in input voltage. In this research, an improved dynamic window (I-DW) was fabricated that achieves constant thermal regulation, rapid-optical switching ability, cost-efficiency, and aesthetics. This dynamic window was designed with a unique Pt-functionalized indium tin oxide (ITO) coated glass, to provide uniform and rapid nucleation of Cu and Bi particles across the ITO electrode, for tunable transmittance, longevity, and dynamic optical properties. The combination of Bi and Cu ions in the fabricated gel solution ensures tunability, maximum opacity, and addresses leakage challenges of current smart windows. This new I-DW changes from clear 99%T to full-block, 2%T in only 12 seconds, and is fully reversible at the same speed. The I-DW is stable, and controlled voltage input allows for tunable transmittance from 2-100%T, in 1% increments, for improved longevity and functionality, relative to current designs, which are costly, slow-tuning, and unable to block below 10%T throughout the 450-700nm visible region. The reflectance evaluation of this new dynamic window also highlights its heat-reflective property, for efficient temperature-boundary separation. The novel ITO-coating on the I-DW glass reflects infrared wavelengths while allowing visible-light transmittance, to save on heating and cooling costs for homes, offices, and more.

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

EE EN ET

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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

Fair Category

PS

Project Number

6045

Title: Ping Pong Robot

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 designing and 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 will see 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 and 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. After all of the functions are incorporated improvements will be made to increase speed and efficiency for a better outcome. I expect that the robot will be incapable of the goal at first but I will keep making improvements until it does work. When the robot is successful I think that it will be capable of replacing a human player on a low level and will be able to return a ball back across the table.

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

233

Fair Category

PS

Project Number

6046

Title: Utilizing Professional Human Experience and Synthetic Data for Machine Learning

Student Name(s): M. Chowdhury

Abstract:

Machine learning typically requires a large amount of testing in dynamic environments. However AI can be time consuming in scenarios where complex variables make simulating these environments costly. Therefore if machine learning can be utilized to reach at least professional human level in these environments quickly, without the need to simulate these environments, time can be saved and human experience can be reused to teach these programs. The experiment utilizes the environment of the game "Super Mario Bros.", where various variables such as enemies, obstacles, and the environment, can all be difficult to simulate and test in. To efficiently do machine learning, the machine learning program in this experiment first utilized synthetic data to easily identify objects in game. Next, it utilized data from professional speedrunners, human players who have already learned much of the optimal pathing for the game, and have demonstrated it to achieve record game completion times. It analyzed the videos through the custom object detection algorithm, gathering data on where various objects are, and correlating that with the controls pressed to replicate what the speedrunner would do in any given situation. It was able to identify most objects, indicating that synthetic data is effective for object detection algorithms. However, it was unable to play accurately based on player data, suggesting that because of the inconsistencies in human behavior, utilizing it to train AIs is not a very effective method.

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

249

Fair Category

PS

Project Number

6047

Title: Linear Particle Accelerator

Student Name(s): E. Adorno

Abstract:

The purpose of this project is to design and construct a functioning linear particle accelerator in order to bombard various subjects such as plastics, sensors, and semiconductors. The accelerator consists of four main systems: an accelerator tower assembly, a home-made Van de Graaff generator, a high vacuum system, and electronic circuits and sensors. A 30 gauge nichrome wire cathode connected to a 12V 1A transformer and rheostat boils off electrons at the bottom of the tower assembly. The vacuum system rids the chamber of air molecules, creating a clear path for the electrons to accelerate towards the top of the tower which is connected to the +350kV Van de Graaff generator. Although the generator produces 350kV, due to the smaller surface area of the top of the tower assembly, the accelerator only runs at 175kV. Near the top of the tower, the target or sensor collects data. With a pressure of 1×10^{-4} torr and 0.62A at 12V running through the cathode, a beam current of 1.5-8uA was measured – depending on the time frame chosen. After bombarding a transistor and plastics for 30 minutes, the hFe decreased four points, while the plastic yielded no obvious result. Overall, this accelerator functioned at an impressive rate considering it is only version one. Although more testing is needed to quantify the changes in the plastics, I gained data that will allow me to make future improvements in the machine's consistency and efficacy in order to conduct more complex, thorough, and promising research.

Technical Disciplines Selected by the Student
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PH EE 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

256

Fair Category

PS

Project Number

6049

Title: Assisting Carbon Neutralization: Automated Energy-saving Controller for Household Appliances

Student Name(s): D. Zheng Zhou

Abstract:

As the effects of climate change continue to worsen, researchers are scrambling to achieve carbon neutrality, which refers to a relatively "zero-emission" state in which human-generated greenhouse gasses are offset by afforestation, energy conservation, and emission reduction. Using energy conservation as the central strategy, this project investigates whether an automated energy-saving controller can be developed for household appliances to reduce energy waste. Specifically, air conditioners are often left running for hours, even in uninhabited spaces; this adaptive automated controller, after failing to detect human activity for thirty minutes, intelligently adjusts temperature and toggles nearby air conditioners by mimicking the original remotes. Fulfilling the initial design's efficiency and compactness requirements, Arduino was selected as the control component for the prototype. Then, infrared remote control code learning, human body infrared induction, and indoor temperature detection modules were wired, coded, and integrated into a 3D-printed shell. The prototype was tested over several weeks on an air conditioner placed in various environments, such as classrooms, hallways, and dorm rooms. The results showed up to a 20% decrease in energy consumption compared to the unregulated air conditioner unit, proving its effectiveness in conserving energy even in non-ideal winter conditions. The experiment will be conducted again over warmer months to more accurately display the full extent of the automated controller's capability in a realistic scenario. As a highly affordable product that decreases homeowners' electricity bills, this patent-pending device has bright market potential for widespread implementation and future compatibility expansions into other household appliances with further development.

Technical Disciplines Selected by the Student
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EE AT 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

250

2023

Fair Category

PS

Project Number

6051

Title: Testing Model Rocket Propulsion Methods

Student Name(s): A. Neal

Abstract:

As fascination in colonizing Mars increases, the need for stronger rockets to transport us there becomes more evident. Rocket launches have many components to consider for a successful flight, such as distance from the target, strength of the engine, amount of fuel consumed, duration of thrust, and weight of the rocket.

This project was designed to explore these variables with different rocket designs and methods of propulsion. Five different propulsion methods were determined: pressurized air, pressurized air/water, Estes' A3-4T engine, Estes' 1/2A3-2T Engine, and Estes' A10-3T engine. Each method of propulsion has varying thrust strength and duration, along with overall weight. In order to launch these rockets, three different types of rocket launchers were constructed. Different rockets were fabricated for each launcher/propulsion method. Estes' "3 Bandits" rockets were used to test the Estes' engines, while a slightly larger, 3D-printed rocket was fabricated for the water and air rocket launchers. A wooden frame with a 5.4 mil barrier of Kirkland Signature "Flex-Tech" Plastic was constructed to constrain the launch of the rockets. To evaluate each rocket's relative strength and thrust duration, a camera was set up to record the rocket's flight as they were fired into the flexible plastic sheets. The stretch/tear of the plastic sheet was measured along with the thrust duration of the engines.

Surprisingly, the compressed air rocket out-performed the Estes fuel rockets and had the greatest thrust strength as evidenced by the largest "stretch" of the plastic sheet seconds after launch.

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

PH EE

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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

Fair Category

PS

Project Number

6052

Title: Using Magnetic Fields to Direct Crystallization of Calcium Carbonate to Emulate the Growth of Trabeculae Post Bone Fracture

Student Name(s): J. Rosenbaum

Abstract:

The process of realigning the trabeculae (internal bone structure) after a fracture can take up to 5 years. Extended periods with a weaker bone leaves patients more susceptible to repeat fractures and other dangerous side effects. Facilitating the growth of trabeculae could reduce the time it takes for a fracture to heal and may reduce the risk of complications. By dissolving calcium carbonate using a hydrochloric acid solution and supersaturating it with distilled water, the resulting solution when crystallized emulates the growth of trabeculae post-bone fracture. It was crystallized in the presence of magnetic fields and without fields. Given calcium carbonate is diamagnetic, it is predicted crystals will form along the magnetic field lines. Test results showed crystals forming patterns of many “swirls”. The number of swirls per plate was counted along with the diameter of each swirl. There were significantly more swirls in the test group, with an average of 5.5 swirls per plate, compared to an average of 2.883 swirls per plate in the control. However, there was no noticeable or statistical difference in the diameter of the swirls between test and control groups. When placing a plate of iron filings in the same location as test plates, there are similarities between patterns formed by crystals and those by the iron filings. These preliminary data suggest magnetic fields can have effects on the crystallization pattern of calcium carbonate and may positively influence the growth of trabeculae. Additional experiments with real bones may be needed.

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

EE 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

247

Fair Category

PS

Project Number

6054

Title:

Development of Soft Robotic Arms Which Mimic Biological Systems and Structures

Student Name(s): M. Daly

Abstract:

The development of new robotics has largely been dominated by rigid robotics from the assembling of machines to surgery to the deactivation of explosive devices. However, within the field of soft robotics, bioinspired robots have abilities that are not only high performing universal and customizable, with features such as the abilities to fit into tight spaces, change color or surface texture, and manipulate objects. Methods to design and fabricate soft robots are much less developed than rigid robotics. By applying nature's solutions to problems that we are still struggling to solve using existing engineering methods. Features of natural organisms, especially soft organisms are often not present in rigid robotic systems and therefore lack the ability to complete certain tasks or skills. There are several issues in bio-inspired robotic systems that can be addressed by using soft materials: design considerations, impact resistance, and ability to move in confined spaces. The objective of creating arms is to provide a range of behaviors such as handling fragile objects, moving across irregular, shifting, and unknown terrain. The objective of the soft robotic arms is to create multiple arms that are interchangeable that can accomplish three critical issues that can only be addressed using soft materials: mobility in confined spaces, impact resistance, and design complexity. Soft materials such as silicone, fabrics, and elastomers will be used because they are suitable for manipulating objects. The stiffness and dimensions of a material will determine its load capacity, deformation, and how stress is distributed.

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

AT 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

240

Fair Category

PS

Project
Number

6055

Title: Multitask Learning Model for Arrhythmia Detection using the ECG Fractal Character

Student Name(s): D. Yoon

Abstract:

Cardiovascular disease is one of the leading causes of death worldwide. In addition to heart attack and stroke, arrhythmia, a disorder in regular heart rate, continues to be a difficult disease to manage owing to its complicated detection system. This study highlights a deep neural network that utilizes multitask learning and electrocardiogram (ECG) fractality to assign individual heartbeats to five different beat categories provided by the Association for the Advancement of Medical Instrumentation. A total of three models were trained and tested, using the MIT-BIH Arrhythmia dataset. Model 0 functioned as the baseline model, which was a four-layer 1D convolutional neural network. For Model 1, two more dense layers were added to the end, where we fed the five different fractal features of ECG to the first dense layer, combined with the features extracted by the 1D CNN in the previous layers. For Model 2, we also added two more dense layers, where this time, we made the second layer output both the heartbeat type and the five fractal characters. The overall accuracy and F1 score of Model 2 were 98.6% and 0.921, respectively. Compared with the two baseline models, the multitask learning Model 2 achieved higher accuracy and a significantly higher recall rate for abnormal heartbeats. Model 2 not only showed a steeper and smoother learning curve compared to other models but also showed a shorter computing time than Model 1 during testing, proving its computational efficiency.

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

CS CBIO 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

267

Fair Category

PS

Project Number

6056

Title: Photocatalytic Degradation of Microplastics Found in Southwestern CT Drinking Water

Student Name(s): A. Jackson

Abstract:

The production of microplastics (MPs) and plastic waste are serious environmental issues in today's world and pose human health risks. The MPs that degrade are ubiquitous, persistent, and find their way into local water supplies. The need to assess MPs local impact and efficiently remove them from all water resources is clear. In this research, drinking water samples from 5 areas of Greenwich were evaluated for MP content. Using SEM/EDS analyses, 20-50MPs per 600ml of water were found throughout the region. To remove these, ZnO nanorods were synthesized on glass nanofibers, and used as the photocatalyst in a reactor that degrades polyethylene microplastics into fragments, which are in turn absorbed by the glass-ZnO-nanorod structures. Contained in a glass tube, with 15W halogen illumination, MP-photocatalytic degradation was measured via ATR-FTIR spectroscopy, looking at OH, C-H and C=O functional fragments. 5ml of 5mg-MPs/ml solution (high-content of Greenwich findings) was loaded with 87mg ZnO-NRs, and illuminated with 15W-300lumen visible light for 48 hours. Time-dependent, functional group index-modeling of photocatalytic MP degradation highlights ~80% decomposition in 35hours (or 100% in 48hours). SEM analysis of MP-degradation fragments suggests that 80% of MPs are reduced to 50 μ m in size in 20hours, with 90% reduced in 35hours. Capture (from water) of the MP photocatalytic fragments occurred in the same timeframe. SEM analysis of used ZnO nanorods depict as many as 13-15 MP-fragments per ZnO-NR reactor fiber, which acts to concurrently clear the water resource of its fragments, as the MPs are degraded from their original chemical composition.

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

EN EM AT

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

182

Fair Category

PS

Project Number

6057

Title: The Perpetually Flying Plane

Student Name(s): H. Alsaleh

Abstract:

In aviation, airplane manufacturers aim for making the most efficient, safest, and most profitable aircraft. The way that airplane manufacturers have been doing this is by increasing the bypass ratio and using more composites, like carbon fiber, in their plane's frame. Another way to increase the efficiency, safety, and profitability of an aircraft is by making it electric.

For my project, I will construct a self-charging electric plane that will be able to fly perpetually. To do this, I will use the air around the aircraft to charge the aircraft's batteries. By doing this, planes will become more efficient and environmentally friendly. Airlines will also benefit from this since the operational cost of the plane will be much cheaper and affordable, increasing the profit.

For my prototype, which is a model of the 737 max 9, I'm going to use two carbon fiber wind turbines, each one placed in each engine cell. Then, using copper wire, I'm going to connect the dynamos to the batteries. The set-up will differ when used on an actual plane than on an RC plane.

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

EE 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

209

Fair Category

PS

Project Number

6058

Title: Generating Alternative Energy Using Water

Student Name(s): D. Walker

Abstract:

The purpose of my project was to generate energy using water. I first took an existing water turbine, the Wonofa Water Flow Generator Turbine, placed it in line with my shower head, and measured its voltage output. It produced 11.83 volts, which was close to the advertised 12 volts. After this, I sought to improve the design of the water turbine to produce more electricity. I 3D printed my own wheel that spins as the water passes through the casing of the turbine, to improve the effectiveness of the rate at which it turns the electromagnet. I also replaced the electromagnet with a more powerful one from the Keenso DC Water Hydroelectric generator, which was able to produce up to 185 volts. However, after constructing my own turbine, I was only able to measure a voltage of 1.7 mV. Although I did not achieve the results I'd hoped for, I will continue researching and developing my turbine design for next year's fair. I will eventually place my turbine in line with the water line that supplies water to my house from the water tank in my basement. By doing so, I will be able to charge a battery whenever water is used at my house to produce clean energy.

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

ET

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

163

Fair Category

PS

Project Number

6059

Title: An Analysis of the Longevity of Biochar Filters in Removing Agricultural Pollutants from Water

Student Name(s): L. Dougherty

Abstract:

The objective of this study was to evaluate the longevity of biochar filters as a potential substitute for activated carbon filters in removing agricultural pollutants from water. Two biochar filters were created, one using laboratory-produced biochar and the other using biochar produced from a cone-shaped kiln in a home setting. An activated carbon filter was also included as a control. The efficacy of each filter was initially tested against three common agricultural pollutants: nitrate, phosphate, and ammonium. Subsequently, a 6 L sample of highly contaminated water was fabricated and passed through each filter. The filters were periodically examined for their performance against the same pollutants during this period. It was concluded that the biochar filters, particularly the laboratory-produced biochar, were equally effective or even more effective than the activated carbon filter. However, the activated carbon filter displayed superior longevity, indicating that the biochar filters would need to be replaced quite frequently to be an effective substitute in the long term.

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

AT EM 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

250

Fair Category

PS

Project Number

6061

Title: Creating and Testing a Novel Drone Swarm Mapping Surveillance Algorithm

Student Name(s): F. Cavallaro

Abstract:

Closed-Circuit Television (CCTV) camera technology currently used is only beneficial in 29% of criminal investigations. A new approach to CCTV cameras is necessary. A group of autonomous drones with cameras would serve as a good solution, and the purpose of this project is to write algorithms to simulate how a system of drones would behave in order to obtain the most film in a certain area. In Unity3D, a C# game engine, a swarm of simulated drone objects with cameras were created and set to patrol a virtual area. Two algorithms were created: a “dependent” algorithm where drones communicated their vision and location with a central computer hub that calculates their routes and directs their behavior, and an “independent” algorithm, drones will traverse the environment while calculating their own routes. Drones will contain object detection using raycasting in order to simulate infrared object detection. Dependent drones were sensitive to their battery levels and could self charge. Both algorithms were effective at detecting issues and at covering ground, and the dependent is more sophisticated and thus more likely to be utilized in a real-world setting. A mentor served as a resource for drone function questions and a guide for creating a drone and implementing the best performing algorithm into it. Drone swarms have the capability to transform surveillance techniques and policing as they continue to become more sophisticated. This study could reveal the wide developmental opportunities for students and researchers seeking to get involved as well through simulation software.

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

AT EE 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

55

Fair Category

PS

Project Number

6062

Title: QUANTITATIVE INEQUALITIES FOR THE
MAXIMUM CURVATURE OF PLANAR CURVE

Student Name(s): M. Ren

Abstract:

On this report, we prove some quantitative versions for an inequality involving the maximum curvature of planar curves that was first obtained by Konstantin Pankrashin. We draw on various previous results in differential geometry such as the Pestov-Ionin theorem. For convex and non-convex curves, we prove a improved version of the inequality respectively.

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

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

101

Fair Category

PS

Project
Number

6063

Title: Investigating the effect of dimpled and tubercled geometries in conjunction on the drag and lift of airfoils.

Student Name(s): T. Zoghol

Abstract:

Superior airfoil performance often relies on clever geometric design derived from natural inspirations, as with leading edge tubercle geometries inspired by the Humpback Whale (proven to decrease drag). This work seeks to determine whether tubercled and dimpled airfoil geometries working in conjunction with each other improve the drag/lift ratio. Six airfoils of identical dimensions (tubercled leading edge, dimpled leading edge, dimpled trailing edge, completely dimpled, smooth, tubercled trailing edge), were fabricated then tested qualitatively via Wind Tunnel. Results showed that dimpled and tubercled surfaces changed the flow pattern and aerodynamic characteristics, resulting in improved lift/drag ratio, and aerodynamic performance.

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

EE ET 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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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

229

Fair Category

PS

Project Number

6064

Title: Self-Stabilizing Haptic Accessibility Mouse for Parkinson's Disease Patients

Student Name(s): J. Zhang

Abstract:

Haptic technology, which delivers a sense of touch, has gained significant popularity in the electronics and entertainment industries for providing immersive virtual experiences. However, its potential as an accessibility accommodation for medical disabilities remains largely untapped. This project proposes a novel application of haptic technology for Parkinson's Disease patients by developing a low-cost accessibility mouse that provides guiding forces for users to navigate electronic devices.

The gadget addresses the limitations of current accommodations by providing direct friction and applied forces, overcoming tremors, stiffness, and coordination issues that make it challenging to control electronic devices. The design incorporates optical flow movement testing, Hall effect sensors, and route planning algorithms to improve accuracy and efficiency.

A framework was developed to compare the stability of the gadget under spasms, leading to the development of the final product. The final gadget significantly improved cursor navigation accuracy and efficiency by up to 81%, compared to current accommodations. This research demonstrates the potential of haptic technology as an innovative accommodation for individuals with Parkinson's Disease, offering a new avenue for individuals with movement disorders to access electronic devices and improve their quality of life.

Overall, this project highlights the promise of haptic technology as a practical, cost-effective, and accessible solution for medical disability accommodations. Further research is warranted to explore the full range of applications of haptic technology in healthcare and other fields.

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

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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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

256

Fair Category

PS

Project Number

6065

Title: Is the Initial Therapy Session Better Online or In-person

Student Name(s): M. Chauhan

Abstract:

This project is important because it helps better mixed therapy, which is a therapy treatment including a combination of online and in-person sessions. The way the treatment starts is a big factor in how the rest goes.

This project will include surveying professional therapists whether they think the initial meeting is better to be in-person or online. It is important to have the patient to therapist connection, which might be better obtained if they meet in-person for the first session. There was a survey sent out with questions including subjects like the environment the therapist provides. It asks whether it is easier to deal with a patient who is uncomfortable sharing certain things, in-person or online. The therapists are asked if the bond between them and their patients are weakened by online therapy.

The responses have supported the hypothesis of mixed therapy treatment being better when the initial session is face-to-face. One of the therapists said the first session is the most important one because it is where they get to know their patients. So, they tend to have relaxing music playing to provide a comforting environment. Therapists have also said that they make sure to provide a clean environment with no distractions. One therapist said that it is easier to deal with people online when they are hesitant.

It is apparent that having the initial therapy session is easier if done in-person. This information can really help therapists better warm their patients up to the world of therapy.

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

EV

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

254

Fair Category

PS

Project Number

6066

Title: A novel semi-automation approach to enhance the implementation of NIST 800-53 cybersecurity framework in corporate environment using numerical statistic word analysis

Student Name(s): R. Sahu

Abstract:

Cybersecurity frameworks, like NIST, CIS, and ISO, are made up of a collection of families and controls which recommend security policies to organizations. These frameworks play a critical role in mitigating the risks of cyber attacks and breaches in organizations. The implementation of these frameworks is resource-intensive and time-consuming due to the manual process of selecting families and controls. This project addresses this challenge by investigating the feasibility of automating or semi-automating the process of selecting families. In this study, I developed a program in Java to apply statistical techniques such as TF-IDF and Cosine similarity to the families of the NIST cybersecurity framework. As a result, the framework is split into distinctive corpora of tokens representing each family. A corpus comprises all the controls for a given family, and is simplified into the tokens that are most representative of that family. We evaluated how accurately the corpora represented the framework by using both a qualitative and a quantitative approach, using data from interviews and documents from an organization undergoing its implementation process of the NIST framework. Considering the positive results of our tests, we believe that this approach has a great impact in automating the process of selecting controls within a family. This will dramatically reduce the resources and the cost needed for implementing cybersecurity frameworks and increase the accuracy and consistency of the selection process. This study contributes to the advancement of cybersecurity framework implementation and paves the way for future research on the automation of cybersecurity processes.

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

54

2023

Fair Category

PS

Project Number

6068

Title: Research on the Equation of the Magnetic Field Caused by Magnets

Student Name(s): J. Su

Abstract:

In this paper, we use the variatioanl formulation to analyze the existence and uniqueness of the corresponding partial differential equations. We also study the equation of the magnetic field caused by magnets. By constructing the corresponding Hilbert space and variational formulation, we can deduce that the equation admits a unique solution with some assumptions.

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

MA 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

260

Fair Category

PS

Project Number

6069

Title: Object Attribute Dataset (OAD): Probing Large-Scale Neural Networks for Visio-Linguistic Compositionality with High-Focus Diagnostic Benchmark

Student Name(s): M. Zhang

Abstract:

The binding problem of neural networks has long been a bottleneck preventing machines from achieving human-level performance. While large-scale vision and language models (VLM) have demonstrated remarkable zero-shot image classification, their ability in compositional reasoning is not fully understood. CLIP is one such model with rising prevalence in natural language processing and computer vision, but it fails to bind object representations to their corresponding attribute when multiple concepts are in the input image. Concept Association Bias (CAB), which describes CLIP's preference toward the concept missing from the text, has been proven for color. To investigate whether CAB generalizes to other attributes (material, shape, texture), we construct the diagnostic Object Attribute Dataset (OAD) consisting of synthesized two-object images with matching prompts that requires CLIP to retrieve the attribute for one of the objects in view. Our tests show that CAB persists across multiple modalities, revealing the fundamental bag-of-concepts behavior of model embeddings where the visual and linguistic features are extracted separately. Furthermore, we find that fine-tuning CLIP mitigates CAB, indicating that increased modality interaction improves object-attribute binding on OAD. Lastly, we discover differences in the binding difficulty of different attributes. We find that separation is particularly difficult for color but less so for material, shape, and texture, revealing variability in concept association strength. In short, we present a high-quality, comprehensive benchmark that precisely probes visio-linguistic compositionality and can be applied across VLMs. We suggest a new angle of understanding the binding problem through different modalities, which could solve the longstanding bottleneck.

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

256

Fair Category

PS

Project Number

6070

Title: Development of an Autonomous Device that uses Heart Rate and Vibrational Pulses to Reduce Stress

Student Name(s): S. Munim

Abstract:

Stress is a natural response that can have detrimental effects on individuals and has a strong correlation to heart rate (HR) and heart rate variability (HRV), a measure of the variation in time between each heartbeat. Research demonstrates that heartbeat-like vibrational pulses can reduce stress and increase HRV. Similar solutions utilizing haptic technology to reduce stress already exist, but are not cost-efficient, ranging from \$200+, and do not calibrate the pulses to fit the user's best needs. For this study, a device was coded in the Arduino IDE and designed in Autodesk Tinkercad that autonomously emits vibrational pulses at a frequency based on the user's current HR interpolated from their HRV. To test the device, participants were split into 2 groups: one group would receive the pulses while the other group would not. In the study, participants completed a 50-question Algebra 1 math test in a 10-minute time period and took a questionnaire reflecting their stress levels before and after the task. Results found that the pulse group reported lower stress levels than the no-pulse group. The no-pulse group did score higher on the task, though their baseline scores before the test were also higher, indicating greater proficiency in the subject matter than the pulse group. Preliminary results also suggest that the pulse group had a lower HR trend and a higher HRV trend in comparison to the no-pulse group. The further widespread accessibility of this technology will help people focus and reduce their symptoms of stress and anxiety.

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

EE BE AT

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

124

Fair Category

PS

Project Number

6071

Title: Motion Sensor Robot!

Student Name(s): I. Campbell

Abstract:

Considering the history of guarded valuables like money at a bank or security for homes, we should trust in the protection of motion sensors to alert us of any possible danger. This project, when concluded, will give security developers an added knowledge of how to redesign the radar detectors to serve their purpose. According to (Sanchari, 2022) a motion sensor is a type of electrical instrument that uses a detector or a sensor for detecting proximal motion. Such types of sensors are incorporated in automatic lighting control devices, security systems, video cameras, gaming devices, and numerous other automated devices.; however, motion sensors suffer from short but suffering problems such as not going off when directed to, bad lighting, insecure patches, and poor application making.

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):

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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

Fair Category

PS

Project Number

6072

Title: Robotics Collision Course Prevention

Student Name(s): B. Spies

Abstract:

As an upcoming engineering student, the goal with this project was to create a functional robot that had the capabilities of detecting an obstruction within its path. For this project, the system needed an optical and motor system. Within the optical system, the Arduino board could handle a 9600 baud rate, which is the one used in the system. Research was also done on serial bus systems like SoftwareSerial and I2C because these would enable the proper connection between the board and the optical sensor. This system uses I2C, as it allows for the optical sensor to properly return the data. Within the motor system, several different parts were tried in order to regulate the current flow and allow for the motors to drive. There were many challenges such as putting together the optical and motor systems as well as making sure that the optical system would work within the limiting power supply. The motor system needed to have the proper amount of current to function. The motor drive board was used because of the Arduino's current. The sensor scans for an obstruction 65cm in front and once detects the obstruction, orders the digital output pin on the Arduino board to stop outputting power. These output pins connect to the motor drive system which therefore stopped the robot. These steps allowed for the robot to successfully operate, detecting an obstruction and stopping the robot. This system can be utilized in automatic braking systems within vehicles, making a safer environment.

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

EE CS AT

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

242

Fair Category

PS

Project Number

6075

Title: AI Based Skin Cancer Detection System

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 code written by Sasank Chilamkurthy, in which Python 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 88.1%, tested on a set of 2,000 images.

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

CS AT ME

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

250

Fair Category

PS

Project Number

6076

Title: A Density Functional Theory Investigation of Sodium Ion Adsorption on Nitrogen-rich Graphene as a High-Rate Anode for Sodium-Ion Batteries

Student Name(s): H. Ding

Abstract:

Sodium-ion batteries (Na-IBs) have recently garnered attention as a sustainable alternative to high energy-density lithium-ion batteries for renewable energy storage and electric vehicle batteries. Nitrogen-doped graphenes (NGs) are promising anode materials for Na-IBs with high capacities and excellent rate capabilities. NGs enhance sodium (Na) storage by adsorption and intercalation; however, limited theoretical models exist for Na-ion adsorption on different types of NG defects, and the effects of these defects on inter-sodium (Na-Na) interactions are unknown. This study uses density functional theory (DFT) calculations to model Na-ion adsorption and Na-Na interactions on NGs. By providing a charge vacancy region for favorable Na ionization, the pyridinic and pyrrolic nitrogen defects were found to enhance adsorption, preventing sodiation and increasing anode capacity. Ionic interactions between nitrogen defects with adsorbed Na-ions and disruptions of the graphene pi-electron system also enhanced adsorption near pyridinic and pyrrolic defects. However, graphitic nitrogen defects inhibited adsorption. The pyrrolic defect was also observed to reconstruct into a pyridinic defect for certain Na adsorption conditions, suggesting reduced cycling stability in NGs anodes. In the presence of multiple Na-ions, pyridinic graphene prevented Na-Na bonding, enhancing Na adsorption onto NGs. This suggests that NGs enhance Na adsorption even at higher Na concentrations. These theoretical results motivate NG defect engineering to maximize Na storage for high-rate and high-capacity battery anodes, paving the way for the development of optimal anode materials in a growing Na-IB market.

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

PH EN ET

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CSEF Official Abstract and Certification

Word Count

245

Fair Category

PS

Project Number

6077

Title: Developing a Machine Learning-Based Model to Identify and Predict the Presence of Alzheimer's Disease from Clinical Notes

Student Name(s): H. Chaudhry

Abstract:

Alzheimer's Disease (AD) is a progressive neurodegenerative disorder that can completely destroy important cognitive functions. The disease affects millions of individuals worldwide and can have fatal consequences. Early detection and diagnosis of AD are crucial to improving patient outcomes and quality of life. In this study, a Natural Language Processing (NLP)-based machine learning model was developed to identify and predict the presence of AD from clinical notes. First, the data was collected consisting of the clinical notes of AD patients, and a preliminary NLP model was created to extract the most common terms/phrases from those notes that may indicate the presence of AD. Then, a word embedding model was applied to find semantic relationships between the common terms/phrases and grouped them into concepts based on their similarity. These concepts were trained into a final NLP model which was used to identify the prevalence of the concepts in patients' clinical notes and provided insight into the patients' likelihood of developing AD. The model's performance was evaluated using a logistic regression algorithm and a ROC curve, and it was found that the model had a very strong performance with an AUC value of 0.89, precision value of 0.86, recall value of 0.95, and F1 score of 0.91. These strong results suggest that this model can be a valuable and effective tool for identifying and predicting the presence of AD, and has the potential to greatly improve the diagnosis and management of this devastating condition.

**Technical Disciplines Selected by the Student
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CBIO ME CS

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

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- Yes No

CSEF Official Abstract and Certification

Word Count

252

Fair Category

PS

Project Number

6078

Title: Comparing the Efficacy of Various Delivery Methods to Target Hepatic Oncogenes using CRISPR-Cas9: A Meta-Analysis

Student Name(s): C. Fitzgerald

Abstract:

CRISPR-Cas9 is a new tool to treat incurable diseases. But, its application in cancer treatment has been hindered by low editing efficiency in tumors, and the potential toxicity of delivery systems. The PLK1 gene is a hepatic oncogene with a vital role in the G2 phase of the cell cycle. The ability to use non-homologous end joining with Crispr-Cas9 could induce apoptosis in tumors. Electroporation is a delivery method that uses an electrical pulse to pass nucleic acids into cells, and is the most common delivery system for CRISPR, but has shown low editing efficiency in the liver. The newer delivery system Lipid nanoparticles have shown higher encapsulation and lower toxicity. This study proposes an analysis of the delivery systems Electroporation vs LNPs to the PLK1 gene to compare the impact on tumor growth. Data collection began by searching available data on LNP and Electroporation delivery for CRISPR. Articles were confined to CRISPR delivery to oncogenes and hemophilia genes in mice livers. Data were collected on 10 LNP and 10 Electroporation articles. Data were interpreted and synthesized. The LNPs are showing higher editing efficiencies by ~20%, and the editing efficiencies within SERPINC1, a hepatic oncogene used to test variability, showed little change within editing efficiencies between delivery methods. The ability to disrupt gene expression in liver tumors opens new avenues for cancer research. If the LNPs prove to be highly effective in CRISPR delivery, it would help not only tumor growth, but cystic fibrosis, crop growth, and antibiotic resistance.

**Technical Disciplines Selected by the Student
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ME CB

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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

250

Fair Category

PS

Project
Number

6079

Title: An Analysis of the Efficient Blockage of RFID Readers Based on the Thickness, Distance, and Density of Each RFID Reader Obstruction Material

Student Name(s): N. Ananth Iyer

Abstract:

Ever since the innovation of Radio-Frequency IDentification readers, they have been exploited for negative intents, mainly the confidential reading of informative cards using powerful radio waves. This analysis investigates the vulnerabilities that lie in RFID readers and dictates which materials can be used to prevent them in terms of the thickness and density of each material. It was hypothesized that aluminum metal with higher thickness and density would yield the closest distance achievable between it and the detection of an RFID reader due to its ability to deflect radio waves efficiently. After the desired testing materials were obtained, a distinctive driver for the sampled computer was downloaded to guarantee the encryption of the card via the RFID reader. Furthermore, an RFID reader, sensitive scale, and ruler were operated to measure the density, thickness, and distance for each material. The experiment suggested that the aluminum sheet with the closest detection of 0 cm was the most promising material against RFID readers, that a thickness of 0.8 cm compared to the lower degrees of thickness had the closest detection rate of 5 cm, and that a density of 3.7 cm compared to the lower tested densities possessed the closest detection rate of 4.7 cm. These results propose that modern-day wallets with leather materials should be substituted with metal-like materials to decrease crime rates and that the research of potential wallet designs with multiple layers of thickness and increased density should be considered with the implementation of metal-like materials.

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

CS AT 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

243

Fair Category

PS

Project
Number

6081

Title: Car oil drain plug

Student Name(s): E. Cramer

Abstract:

I initially got my idea for my project after scrolling through Tiktok videos and watching mechanics and your everyday person try to change their oil without it leaking on their hands. So, I figured I could solve this problem by formulating a product where there is no need to unscrew a component to drain the oil from the tank. Knowing that I am no expert in the field where my product would most likely be used, I needed to do some interviewing to understand what I needed to add to my product and what I should stay away from. After taking advice from my research participants, I had what information I needed to design and build a prototype. I decided to make my prototype out of simple materials considering they were the easiest to manipulate and demonstrate how my product works. For my design, there was a tube-like foundation and then ridges where the hose attachment could be connected and ridges on the inside where it could be connected to the oil tank valve. The real product would be constructed out of steel, with a ball valve that includes a folding rubber handle to control when the oil is drained or not. On the inside of the tube about halfway through, I used a piece of cardboard to represent the ball valve when it is closed. I am very pleased with my research and the prototype that I was able to create.

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

EN ET 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

182

Fair Category

PS

Project Number

6083

Title: Engineering a Methodology to Efficiently and Effectively Discover and Classify Micrometeorites

Student Name(s): H. Wallace

Abstract:

Micrometeorites (MMs) are minuscule (150-400 μ m) geologic forms originating from asteroids in our solar system. 40,000 tons of MMs reach Earth's surface after traveling through interplanetary space annually. MMs provide insights into the story of our solar system, our planet, and ourselves. Most MMs are found in remote parts of the globe, such as Antarctica, yet previous research has proved that they can be found in urban areas. Multiple independent collection methods have arisen due to this discovery, but there has not yet been research comparing those methods. This study compares the ratio of MMs to debris (material other than MMs) in samples collected in different conditions (dry vs. wet) from rain gutters on residential homes in Southwest Connecticut. Samples were collected using a ladder and proper safety equipment, taken back to a laboratory for processing, and observed under a stereomicroscope for analysis. All potential MMs were matched with a photo guide/MM encyclopedia and verified with an expert. With a tested collection method, professional researchers and citizens can find their own material to provide new insight into our place in the universe.

**Technical Disciplines Selected by the Student
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EA PH 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

251

Fair Category

PS

Project Number

6084

Title: Feasibility of a Water Quality Sampling and Monitoring Catamaran

Student Name(s): C. Zhang

Abstract:

Water quality problems have increased over time and now, the severity is even more urgent. It is increasingly critical for people to save and protect water sources. Even though there are catamarans produced aiming at solving oil spill, litter, malnutrition of aquatic plants and other water related problems, the call of action on ordinary inhabitants is still essential. In this project, the catamaran is designed to advertise and educate civilians about the scarcity and importance of water resources. The catamaran can systematically analyze the impact of water pollution being ubiquitous. By operating a programmed ps2 remote control, people can steer the boat and abstract water from different water levels, observe the change of pH and turbidity value through the Internet of Things on a computer, which are data transmitted from the sensors on the boat. Most importantly, when the boat encounters big waves, its body can be extended to stabilize and avoid turning over. To improve the performance and capability of the boat, a second version is designed without much change in the programming section, but mainly in its shape and structure. Instead of a combination of a small main warehouse and two large side compartments, this second version switched into a large main warehouse containing all the electronic components plus two small but flexible side compartments served only for stability. The ps2 controller is replaced by bluetooth control on mobile phones to make it more convenient to be operated. This experimental catamaran proves the practical usefulness for real-world applications.

Technical Disciplines Selected by the Student
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CS EE 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

252

Fair Category

PS

Project Number

6085

Title: Refining a Novel Pediatric Bionic Ankle Through Empirical Testing and Integration of an Intelligent Fluidic Joint Control Architecture

Student Name(s): A. Bhattamishra

Abstract:

Dependability is a key factor for the widespread adoption of bionics, and only achievable through longer battery life, lighter weight, and increased affordability. Because of stagnation in electro-mechanical designs (the current state-of-art), modern bionic limbs cannot be effectively enhanced to combat inherent drawbacks without altering already-high cost components. Children suffer the most; pediatric prosthetics are made by adapting adult components, lacking scalability and causing discrepancies in form/fit that make them more expensive without improving performance and quality of use. To address this, research has been done on a novel smart electro-hydraulic actuator for application in bionics that is scalable, configurable, and adaptable for children. The purpose of this project is to refine a novel bionic ankle utilizing this actuator's performance through empirical testing and custom control architecture. The prototype has a set of targeted kinematic/dynamic specifications derived from theoretical calculations to analyze success. The prototype build and closed-loop control system were developed simultaneously. A final set of empirical tests using specially designed test setups yielded output force, speed, and power consumption data to validate the prototype performance. The mentor takes the role of an advisor, advising on controller development, test setup design, data collections and helping analyze data from the prototype. The prototypes are capable of matching expected force outputs at considerably low power expenditures, but the max speed is slightly lower than needed. The completion of this project has established the efficacy of a novel bionic ankle with the potential of commercial implementation.

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

AT EE 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

243

Fair Category

PS

Project Number

6086

Title: Biodegradable Bamboo Cup with Thermos Technology

Student Name(s): A. Jenkins

Abstract:

60 million plastic water bottles end up in landfills every day. 1,500 plastic water bottles are disposed of every second, and 35 billion are discarded a year. Only 12% of this is recycled. 2/3 of people have their own disposable cups in the United States. Based on these statistics it is critical for people to start looking into eco-friendly alternatives to this menace of plastic filth. Their alternative became metal/reusable cups/bottles. But most reusable cups/bottles that are mostly stainless steel, are also not biodegradable though they are reusable. Also, given that all these reusable bottles have portions made from plastic and cannot be recycled by the average garbage disposal company, the issue of harm to the environment persists. People who use this type of mugs. They would have to take them to special facilities that accept them for recycling. Rarely do people even know where these special recycling facilities are located, hence they just throw their leaking bottles out anywhere. This adds to landfills when no longer useful by their owner. If a cup is made from pure biodegradable materials, it would be sustainable and eco-friendly. The best materials for this would be a natural alternative and a consideration for bamboo cup which this project is looking into. Bamboo, unlike other plants, is durable for this use and biodegradable. The problem of microplastics or broken-down particles of metal from choking animals and eventually dying can be minimized.

Technical Disciplines Selected by the Student
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EM EA PS

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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

253

2023

Fair Category

PS

Project Number

6087

Title: Designing a Simulation for Aerothermodynamic Performance of Transatmospheric Vehicles and Ablative Heat Shield Designs for Space Exploration

Student Name(s): R. Wempen

Abstract:

Since the advent of the Mercury, Gemini, and Apollo missions, NASA and its contractors have used computer simulations to design next generation space and reentry vehicles. The complexity of designing spacecraft to travel to distant planetary bodies and reenter earth's atmosphere at hypersonic speeds is a complex undertaking, and simulations permit engineers to test novel designs and new materials. Since no unclassified simulations are available with the capacity to assess all relevant spacecraft specifications and flight parameters, one was developed to fulfill this need. Utilizing hypersonic computational fluid dynamics and simulation (MATLAB Simulink) software, this project integrated primary vehicle parameters with a complete atmospheric reentry profile that included aerothermodynamic heating, hypersonic shock waves, and reentry aerodynamics to determine optimal vehicle design and reentry trajectory. The simulation uncovered the novel idea of using an ablative reentry heat shield that ejects to reveal a slender body. This design was tested in the simulation against two real-world missions: 1) a SpaceX International Space Station return mission and 2) a Missile Defense silo attack mission, and the results showed that an ablative, ejectable heat shield can fill two current gaps. For commercial and space exploration missions, it can fill the gap between using a thermodynamically-efficient blunt vehicle to minimize heating effects and a slender aerodynamic vehicle for precision landings and vehicle reuse. For missile defense missions, the reduction of a missile's infrared signature after heat shield ejection provides a window of non-detection by enemy satellite-based sensor platforms thereby exhibiting potential national security applications.

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

PH PH 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

252

Fair Category

PS

Project
Number

6088

Title: An Attention-Based Multi-Modal Deep Learning Approach for Solar Flare Prediction

Student Name(s): P. Yadav

Abstract:

Solar flares are a sudden explosion of radiation generated when the magnetic field lines in the sun's atmosphere become twisted and tangled, resulting in a sudden release of energy. Strong solar flares have the potential to damage satellite operations, telecommunications, navigational networks, and electric power grids on Earth by causing radio communication black-outs, and increase in satellite drag. Predicting these events before they occur would allow us to minimize damages. Today, solar flare forecasting is done through physics-based models, but these models have poor forecasting capabilities and enormous computational costs.

In this project, a novel probabilistic tool is developed that predicts the X-ray brightness caused by a solar flare 24 hours prior using deep learning and multi-wavelength imaging. Magnetograms and EUV images with wavelengths 171, 304 and 193 Å taken from the SDO satellite were chosen as inputs for deep learning. The active regions from these images were extracted using image thresholding and were individually trained on a Vision Transformer to predict the peak solar X-ray brightness 24 hours in the future.

Then the different active region's predictions are given to a SVM along with some magnetic features to predict the final X-ray brightness. Evaluation on data from the SDO and GOES satellites from 2019 to 2022 resulted in a mean absolute error of 0.4. When employed for predicting the occurrence of X and M class flares, the model reached a peak True Skill Statistic of 0.82 and 0.85 respectively, more accurate than current physics-based models.

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

PH AT CS

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CSEF Official Abstract and Certification

Word Count

251

Fair Category

PS

Project Number

6089

Title: Password Analyzer

Student Name(s): K. Spodnik

Abstract:

Cybersecurity is a critical factor these days because technology has advanced so much. During the pandemic, schools converted to online work while businesses began working remote. Cybersecurity is to protect organizations and individuals from cyber attacks. Cybersecurity can help prevent data breaches, identity theft, and other cybercrimes. A few ways you can prevent cyber crimes are by having strong passwords, being cautious of phishing scams, using multi-factor authentication, and keeping your software up-to-date. The objective of my project was to test what makes a good password, a long one or a complex one. To conduct my experiment I combined and modified code from several sources, to estimate how long the inputted password would take to crack. For my data, I used two password-cracking estimate sites. With a variety of passwords I created I found a password needs a balance of complexity and length to be considered strong. Having strong passwords does not eliminate your chances of being hacked but it does have an impact on the security of your account. Passwords will always be one of the weakest links protecting your accounts. I encourage you to add another layer of security by using Multi-Factor Authentication. My project demonstrates a brute-force attack but there are a variety of different attacks hackers use to steal passwords and PII (personal identifiable information). Two other common ways passwords are stolen are through phishing and keyloggers, where the user pretty much gives the hacker their password by typing it.

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

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- Yes No

CSEF Official Abstract and Certification

Word Count

199

Fair Category

PST

Project Number

6501

Title: Formulating Lip Balm

Student Name(s): C. Donnelly, V. Castellani

Abstract:

For our project we formulated a tinted lip balm. Our love for makeup and desire to figure out what was in the products we use inspired this project. We wanted to figure out the best method to create a UV Blocking moisturizing lip balm. We did research on the ingredients used to formulate lip balm. We concluded the best ingredients to use were Cocoa Butter, Carnauba Wax, Canola Oil, and Titanium dioxide. The titanium dioxide would provide the blocking of UV Rays, the cocoa butter and canola oil would provide moisture, and the carnauba wax would formulate the lip balm and provide water repellency. After many trials and error, we successfully created a recipe for lip balm that has uniformed properties, provides a tinted color, is moisturizing, UV resistant, vegan, and water-repellant. We discovered that titanium dioxide, canola oil, carnauba wax, and cocoa butter were the substances that performed the best. We also did trials to test the water repellency, first we used water, the lip balm would not remove, soap and water it took a bit to come off, and then it came off with a makeup wipe. We determined that our lip balm was a success.

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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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

105

Fair Category

PST

Project Number

6502

Title: solar power amphibious trash collector

Student Name(s): J. Pabon , B. Gamble

Abstract:

Trash in the ocean is a global problem. Trash in the ocean has been known to harm wildlife and pollute our waterways. It knows that as animals eat plastic that it breaks down and stays in their body. Then humans eat fish that contain plastic within their bodies, which is harmful for humans. Our project is looking to find an affordable mechanism that can collect and pick up trash in the water by using easily accessible things such as a water wheel, amphibious vehicle and conveyor belt. Our goal is to design a prototype to effectively pick up trash and power itself with solar energy.

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

ET AT 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

250

Fair Category

PST

Project Number

6505

Title: Alternative Fuel Sources for Commercial Jetliners to Combat Climate Change

Student Name(s): C. Crozier, L. Matejek

Abstract:

The purpose of the experiment was to analyze and determine if a more sustainable fuel for jetliners is possible. Sustainable Aviation Fuels are a type of aviation fuel that is made from renewable resources, such as plant materials or waste products, and have the potential to reduce carbon emissions from the aviation industry. SAFs can significantly reduce greenhouse gas emissions from aviation. According to the International Air Transport Association (IATA), SAFs have the potential to reduce aviation's carbon emissions by up to 80% compared to traditional fossil fuels. Various feedstocks can be used to produce SAFs. Feedstocks for SAFs include agricultural residues, forestry waste, municipal solid waste, used cooking oil, and algae. There are several challenges to scaling up SAF production. These challenges include feedstock availability, infrastructure for production and distribution, and regulatory barriers. In conclusion, SAFs are an extremely viable option for plane fuel in the future and will be a great way to combat climate change. SAFs can reduce emissions from Airplanes by almost 80% meaning additional research into utilizing SAFs in possibly domestic or personal airline companies should be further investigated. Also SAFs can be made from landfills, crop waste, and food waste meaning that SAFs can help mitigate greenhouse gas emission from fossil fuels used in the airline industry. The downside of SAFs is the cost as there is not much infrastructure right now to use SAFs efficiently but with the correct infrastructure SAFs promise to be a great resource for the Earth and aviation business.

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

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

Fair Category

PST

Project Number

6506

Title: Comparative Analysis of the Most Efficient And Accessible Gasifiable Biomatter

Student Name(s): E. Lorenz, W. Armstrong

Abstract:

The purpose of our project is to discover the most efficient, readily available biomatter to use in the creation of synthesis gas (syngas) via a process called gasification. A gasifier was designed and constructed using a large pot, an empty paint can, and a professional-grade gas connector tube. The large pot was used as a fire containment chamber to be filled with wood or charcoal briquettes to heat the 150g of biomatter (wood, leaves, compost, horse manure) within the paint can. The gas connector was inserted into a hole drilled into the lid of the paint can in order to divert the syngas out of the gasifier and into the testing area. The efficiency of the fuel was tested two ways: the energy of the syngas and the volume of the syngas. The energy was tested by determining the time needed to heat 75 mL of water and employing the specific heat equation to determine the Joules per second being produced by the flame. The volume of the gas produced was measured using water displacement at intervals throughout each test. The gasification of compost and manure did not produce enough syngas to perform purity and volume tests due to a combination of poor energy density and an unattainable pyrolysis temperature while using this system. It was concluded that firewood produced a more pure, higher energy syngas, but at lower volumes than dried leaves, which conversely produced a less pure, lower energy gas in copious volumes.

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

247

Fair Category

PST

Project Number

6507

Title: Using Surveys to Study the Evolution of Art Generated by Artificial Intelligence

Student Name(s): H. Chaine, E. Huang

Abstract:

Recently, artificial intelligence has sparked controversy in the art community, and artists around the world are debating whether or not AI should be considered legitimate art. Which raises the question, how AI has evolved, and what separates it from art drawn by humans. The purpose of this project was to determine if there was a relationship between the improvement of technology and the distinguishability of art generated by Artificial Intelligence. The hypothesis for this experiment was as follows: "If AI technology is advanced, then the artwork generated by machines will be less distinguishable as a product of a machine as opposed to a human artist, because AI machines will be able to collect more data and process that data more effectively to better imitate humans. This will allow the AIs to produce more complete and complex artworks that are harder to differentiate from human artworks." A survey containing artworks by humans and AI from different time periods was sent out to middle and high school students, asking them to identify whether the artwork was human-made or AI-Generated. The data showed that 41% of respondents were not able to differentiate AI-generated artworks from human artworks. A direct correlation could not be drawn between the year each artwork was made and the percent of people who were able to correctly identify the artist of each artwork. However, the data shows that AI is evolving at an alarming rate which may endanger the careers of future artists.

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

AT CS

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

161

Fair Category

PST

Project Number

6508

Title: Oil Presence in Surfactant Solutions

Student Name(s): K. Guamarrigra , A. Rodrigues

Abstract:

In this experiment, we tested if homemade shampoos work as well with oil additives. We tested how well they removed the oil from the "hair," its foaming characteristics, and how long the foam takes to break down. Apart from this we conducted other smaller tests like dirt dispersion and pH testing.

To test its foamability we used an air pump and variac to produce bubbles at a rate of 264 bubbles per minute. Each test was done at least three times to make sure that the results were consistent. At the end of this experiment, we gathered all our data, and we concluded that the oil presence in these homemade shampoos altered some of its properties, like its cleaning power (oil absorption) but what it had mostly affected its foaming characteristics. The other properties like its pH and dirt dispersion were barely affected. For example, the pH change didn't matter since it stayed within the same group in the pH scale.

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

220

Fair Category

PST

Project Number

6509

Title: How Does Acid Rain Affect The Production Of Eggs And The Agricultural Aspects Of Jamaica?

Student Name(s): A. Smith, K. Hamilton

Abstract:

Acid rain may occur in Jamaica because to air pollution, emissions from cars and factories, and other factors. The goal of the experiment was to determine how acid rain might impact Jamaica's agriculture sector and egg production. Any type of precipitation that falls to the earth from the atmosphere and contains acidic elements, such as sulfuric or nitric acid, is referred to as acid rain. The acid-base reactivity of eggshell in vinegar was examined in this experiment using 400 ml of white vinegar (raw and diluted) in a beaker. Several pH values were produced in beakers using vinegar: 2.32pH, 3.0pH, 4.02pH (acid rain), and 5.04pH. Each beaker had four distinct eggs that were entirely submerged. The solid calcium carbonate crystals (base) in Egg D are broken up into their calcium and carbonate components by vinegar (acid), leaving the inner semi-permeable membrane unharmed. According to the findings, there is a direct correlation between vinegar's pH and the egg's reactivity. It took 48 hours for Egg A soaked in "acid rain" to begin reacting. When eggs are exposed to acid rain for a prolonged amount of time, the shell dissolves and the interior is gradually harmed. Egg production and agricultural features would not be immediately impacted by acid rain, but over time, it would worsen and egg output would decline.

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

CH EV

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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

90

Fair Category

PST

Project Number

6510

Title: Self sustaining efficient apartment

Student Name(s): D. Hardy, C. Wright , E. McMahon

Abstract:

In Connecticut, approximately 1.4 million households and 140,000 businesses together account for more than 70 percent of Connecticut's 750 trillion BTU of annual energy consumption. Our project is an apartment building/studio that uses natural energy to power what is needed for a functioning apartment. We hope this will eliminate some of the cost associated with traditional electricity and decrease pollution. Our process is simple: we need to implement reusable energy sources into buildings all across the america. We also want to make it as cheap and affordable as possible.

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

ET AT

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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

225

Fair Category

PST

Project Number

6511

Title: Using Piezoelectric Diodes to Power up a Pair of Heat-Producing Socks

Student Name(s): B. Sanchez, E. Telford, C. Edmondson

Abstract:

Piezoelectric Floor Tiles generate electricity when pedestrians walk over them. The energy produced from it could power up street lights, buildings, traffic lights, and more. For our project, we wanted to use piezoelectric diodes to power up a pair of heat-producing socks for construction workers, hikers, or just anyone who works outside in cold weather. We bought already-made heat-producing socks that are battery-powered and piezoelectric diodes. Initially, we tried using a single diode inserted into the heel of a boot and connected that to the sock. That did not generate a significant amount of energy to heat the sock. Then we soldered multiple diodes in series, taped them on a sole, and “sandwiched” another sole on top of it but that still did not generate enough electricity. We did some more research and found that these were not the best diodes to use, so we ordered a different kind and used the same method to test them. Unfortunately, that still did not generate enough electricity to heat the sock. Now I know with all the research that I have done I need bigger diodes, probably the same diodes used from a single slab of Piezoelectric Floor Tiles to create what I diligently tried to do. This trial taught me: real science work requires failure and perseverance to acquire progress and achievement.

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

ET AT

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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

251

2023

Fair Category

PST

Project Number

6512

Title: Optimizing Wind Turbine Designs through the Incorporation of Piezoelectric Material to Maximize Energy Conversion Efficiency

Student Name(s): R. Ramesh, A. Singh

Abstract:

Modern wind turbines are designed to operate off of sustained high wind speeds to generate energy but are less effective in areas where lower wind speeds are more prevalent. To best utilize lower wind speeds and improve the efficiency of wind turbines, multiple prototypes were designed with varying parameters, such as the orientation of the wind turbine axis, blade angle/pitch, and surface area of blades. Piezoelectric materials, whose unique ability to convert mechanical wind energy into electrical energy, were then incorporated into the turbine/piezoelectric assembly to maximize energy output at reduced wind speeds.

The first phase of this project was to design wind turbines using Fusion360 and fabricate them using a Prusa 3D printer. Data was initially collected by placing each of these turbines without any additional piezoelectric materials in a wind tunnel and the voltage, current, and power levels were recorded. It was found that the vertical axis turbine was close to 100% more efficient than the giromill turbine and roughly 40% more efficient than the horizontal turbine. The incorporation of additional piezoelectric materials into the turbine assemblies increased the efficiency by an additional 18%.

The second phase of this investigation was to simulate the interaction of wind with the turbine/piezoelectric assemblies using computational fluid dynamics software such as Autodesk CFD-Ultimate and ANSYS-Fluent software to support the experimental data. Ongoing simulations are used to identify the most efficient assembly design by calculating rotational speed and torque, both of which are directly related to power generation.

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

ET EE MA

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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

254

Fair Category

PST

Project
Number

6513

Title: ParkBD: A Novel Multimodal Deep Learning Framework for Parkinson's Disease Severity Prediction Using Clinical and Blood-Based Biomarker Data

Student Name(s): S. Jonnalagadda, D. Girish Kumar

Abstract:

Parkinson's Disease (PD) is the second most prevalent progressive neurodegenerative disorder. The development of new therapeutic approaches requires a better understanding of the underlying mechanisms of PD and the identification of new biomarkers that can aid in disease monitoring and the development of targeted therapies. Blood-based biomarkers hold promise for PD prognosis, but their identification and use in disease prediction remain challenging due to its complexity and heterogeneity. To address this challenge, we present ParkBD, a comprehensive deep learning framework that integrates clinical and blood-based biomarker data to provide a reliable and accurate prediction of PD severity over time. The framework includes a biomarker discovery module that identifies ten correlated blood-based biomarkers with PD using differential protein analysis and linear regression with ten-fold cross-validation. It also has a severity prediction module that utilizes a modified XGBoost classification algorithm with clinical and biomarker data to predict MDS-UPDRS values over time. We evaluated the performance of ParkBD on a dataset of PD patients and healthy controls and compared it to existing methods. Our results show that ParkBD outperforms similar methods for PD severity prediction, with an accuracy of 90%. We also identified a set of novel blood-based biomarkers that are highly correlated with PD and utilized existing machine learning models to rank effective drug compounds. ParkBD is a promising tool for the development of therapeutic approaches for PD and the implementation of disease management strategies that can help maintain function, delay disease progression, and improve the quality of life.

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

CBIO CS BI

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

211

Fair Category

PST

Project Number

6514

Title: Assessing the Environmental Impacts of Commonly Used Mosquito Repellents: DEET, Picaridin, IR3535, Permethrin, and Oil of Lemon Eucalyptus.

Student Name(s): S. Roy, V. Bathula, K. Odobashi

Abstract:

As global temperatures rise, the habitat and frequency of mosquito populations also grow. This increases the use of repellent products to protect against mosquito-borne diseases and irritations. This use, however, links to the contamination of major bodies of water, which has detrimental effects on aquatic life. This project researches the effects of insecticides, DEET, Oil of Lemon Eucalyptus, and Picaridin, in water. In our experiment, distilled water and each respective insecticide were mixed at a 20:1 ratio to simulate real-world concentrations. The turbidity, pH, and dissolved oxygen concentration of these solutions were found through a light spectrometer assessing wavelength transmittance, a pH meter to measure acidity or basicity, and a dissolved oxygen meter measuring milligrams of oxygen per liter respectively. The oil of lemon eucalyptus was the most effective mosquito repellent tested, having 88.963% transmittance, 7.164 pH, and 6.814 mg/L dissolved oxygen. This demonstrates considerably effective eco-friendliness by having the lowest turbidity, the closest dissolved oxygen level to distilled water (control), and the second closest pH level to distilled water. The results of this experiment will make repellent businesses consider switching to more natural alternatives. Additionally, the investigation will be further extrapolated to the impacts of insecticides within an environment including real-world aquatic flora and fauna.

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

EV EA 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

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

Fair Category

PST

Project
Number

6516

Title: Oil Absorption- Testing Oil absorptivity & identify the sorbent that is most effective for cleaning oil spills

Student Name(s): B. Ranzha, A. Alvarado, S. Lopez

Abstract:

How can humans help minimize the harmful environmental impacts of oil spills through faster clean-up mechanisms? In this experiment, the focus is on identifying and testing sorbents oil absorptivity in emulsions. Currently, the methods used to clean oil spills tend to be petroleum-based, or have various harmful chemicals, which are often counterproductive. Our experiment entails gathering environmentally friendly sorbents to test for oil absorptivity. One cup of 100% natural vegetable oil was poured into each labeled sorbent; the same oil was used for other trials, thus requiring only a minimal refill. Each sorbent was added to the oil and placed for about a minute. The dependent variable (DV), amount of oil absorbed, was calculated for each independent variable (IV), sorbents. Graphs were plotted using the independent and dependent variables to compare which sorbent had the highest absorptivity and sorbent ratio (tested using a prototype). The first part of the experiment was solely to determine the absorptivity of sorbents in oil alone, and the second part of the experiment was to test the absorptivity in an oil-water mixture (2 cups of water and 1 cup of oil). The highest oil absorptivity was measured as 49.2 ml in animal hair, also came first in the oil water mixture with 75% of oil absorbed. A prototype was created to test the absorptivity of sorbents in a small-scale oil spill. The conclusions on the highest ratio of the most effective sorbent are justified for further environmental analysis on oil spills in land or water.

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

EV 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

125

Fair Category

PST

Project Number

6517

Title: Which insulation performs the best.

Student Name(s): A. Suarez, C. Casner, K. Colbert

Abstract:

There are multiple types of insulations on the market for home owners and builders to consider using when building a new home. Determining which type of insulation is the best may take a lot of time and money for a builder to explore. By doing this experiment, we want to learn which insulation will keep heat in the inside of a house the longest thereby saving money and fuel for the homeowner. The experiment will test out the resistance performance of various types of insulation including Wool, Rigid Foam Board, Pink Panther Fiberglass Batting, and loose fill and dense packed Cellulose. We hope to learn which insulation will perform best and results will show which material will prove to be the best choice for insulation.

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

ET

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

246

Fair Category

PST

Project Number

6518

Title: Cerebral Palsy Accessible Keyboard

Student Name(s): P. Zint, G. Gumbs

Abstract:

Many children around the world suffer from motor limiting disabilities like cerebral palsy where these children are unable to perform everyday hobbies such as playing video games. Large companies such as Microsoft have made adaptive controllers for children with disabilities, but these are very expensive and intricate solutions that can be difficult to use. Our prototype was intended to make a cheaper option for children looking for an adaptive controller for gaming and we tried to make it more adaptable. Since other solutions were made to make a controller for a console more usable, we designed a computer keyboard for gaming. Our design featured fewer buttons to make more room for them to be bigger, but still provides the necessary buttons for gaming, while its simplistic design allows it to be laid over an existing keyboard, so it works with other gaming equipment. We came up with this design by doing initial research of the types of cerebral palsy people can have and how each would impact their daily life. Then we began sketching designs that would allow children with cerebral palsy to game on a keyboard and mouse. After this we constructed a partially functioning model where we could demonstrate how the buttons of our layover keyboard would physically push the buttons below it on a regular keyboard. We found that although our design was functional, we could improve upon it by making mechanical changes to the design and adding other elements such as an adaptive mouse.

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):

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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

248

Fair Category

PST

Project Number

6519

Title: Using organic dyes for a more economical approach to a Dye Sensitized Solar Cell

Student Name(s): P. Kakkar, A. Anand

Abstract:

Many third world countries do not have access to the resources necessary for the production of traditional photovoltaic cells. The individual parts of a traditional silicon photovoltaic cell are either too scarce or too expensive for these countries to import, and a cheaper alternative is a necessity for the production of clean energy. We propose a Dye Sensitized Solar Cell that is much easier to produce. Firstly, we needed to make a titanium dioxide paste, which was done by adding acetic acid to TiO₂. 3 drops of this paste needed to be added to the conductive side of a Fluorine-doped Tin Oxide (FTO) glass square and spread evenly throughout. The glass plate needed to then be annealed at 450 degrees Celsius for 30 minutes in a tabletop scientific convection oven. After this, the conductive side of another FTO glass was covered in graphite, with a No. 2 pencil. Then, the glass with graphite was sandwiched with the other FTO glass, and an aqueous electrolyte was placed between the two. From our testing, we found that chlorophyll was the most effective dye, producing 250 milliVolts on average and up to 9 microamperes. These results prove to be extremely promising as scaling this to an average sized solar cell (about 99cm by 165 cm) can produce about 10 watts, enough to power a smart device as well as a few light bulbs. With industrial dye extraction and production, both efficiency and cost of the DSSC can be improved greatly.

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

EE PH 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

249

Fair Category

PST

Project Number

6520

Title: Food Delivery Drone

Student Name(s): H. Raycraft, H. Shelton, M. Song

Abstract:

As quadcopter drones become increasingly popular in a multitude of industries, from payload delivery and photography to search and rescue, the industry is filled with proprietary hardware. Expanding off the original scope addressing the lack of food delivery options at Westminster School by creating a drone, this research project aims to create a 3D-printable, open source, inexpensive, nine to ten-inch heavy payload quadcopter using established hardware standards, inspired by the RepRap movement for 3D printers. The frame design utilizes easy-to-access M3 hardware and allows for easily replaceable and upgradable 3D-printed parts. As part of our testing, we surveyed Westminster students about their usage of food delivery and pickup location distances in order to compile flight time data with our existing drone fleet and spec the electronics for the drone platform. Physical testing was performed on the drone frame consisting of durability and tolerance. First, the subcomponents underwent strength testing to ensure durability and to optimize weight to strength ratio using CAD and simulations. Second, all 3D printed parts were tested and updated for fitment, tolerances, and printability on a PRUSA i3 and Ultimaker 3D printer, certifying that all parts will fit together and require no support material if printed on most standard FDM printers. Overall, from our preliminary testing, we constructed a mostly printed drone frame with an estimated weight of 1300 grams and a max thrust of 13200 grams. Further testing is on the way regarding flying characteristics and the payload mounting system.

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

EE CS AT

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4. Is this project a continuation? Yes No

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- Yes No