

72nd Annual Fair



March 9 - 14, 2020

Student Abstracts

Fair Categories

	Life Sciences	Physical Sciences
7th & 8th Grade Team	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)

Special Categories

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

Special Category 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

233

Fair Category

PS

Project Number

6001

Title: Temperature Dependence of the Electrochemical Conversion of Methane to Methanol

Student Name(s): S. Hillenmeyer

Abstract:

The efficient conversion of gaseous methane to liquid methanol remains a challenging issue that scientists face today. If an efficient, industrial-scale conversion can be developed, methanol can replace natural gas due to it being highly reactive, safe to handle, and easy to transport and store. Additionally, methane is an extremely potent greenhouse gas (86x more powerful than CO₂) that is released in harmful amounts each year. Converting methane to methanol would not only help the natural gas industry but also our planet. The goal of my project is to determine the temperature dependence of methane binding to a working electrode made of hematite in a three-electrode electrochemical cell. Open Circuit Potential (OCP) tests, which can give information about the surface of the working electrode, were run using a heating and cooling circulator that cycled from 0 °C to 80 °C at a rate of 0.5 °C per min. The difference between the OCPs of electrodes with and without methane flowing was measured. The more negative the difference, the more adsorption was occurring. Due to the much larger magnitude of the difference at lower temperatures, we hypothesize that adsorption is primarily occurring through physisorption rather than chemisorption. In order to build confidence in these results, in-situ Fourier Transformed Infrared Spectroscopy (FTIR) scanning will be performed on the hematite electrode as a direct method of measuring methane adsorption on the electrode surface.

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

ET EE 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

244

Fair Category

PS

Project
Number

6002

Title: A Better Way For Play

Student Name(s): A. Norton

Abstract:

The purpose of A Better Way For Play was to create a biodegradable softball. This is in the hope to lower the amount of sports pollution coming from softball, since many softballs are being left in the environment. To do so, the polyurethane core was replaced with cork, and the rest of the softball remained constant. This is to ensure that all the mechanics operated the same as they did before. To make the softball, the cork ball is wrapped in softball yarn and then held together by a leather cover. The seams are created by the use of red linen thread. For testing, throughout three trials for both the biodegradable softball and the regular softball, the speed and time traveled were obtained. To do so a stopwatch was used for the time and a radar gun was used to track the speed. For the collected data, both softballs averaged about the same. The regular softball averaged 40.3 miles per hour and 0.66 seconds for throwing and 54 miles per hour and 0.83 seconds for pitching. The biodegradable softball averaged 43 miles per hour and 0.72 seconds for throwing and 51.6 miles per hour and 0.81 seconds for pitching. In conclusion, the biodegradable softball was very successful, and the results produced were very similar to a regular softball. As it was able to function and follow the same mechanics. Overall, this experiment provided a very strong basis in the development of a biodegradable softball.

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

EM PH

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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

192

Fair Category

PS

Project Number

6003

Title: Utilizing Alpha-Particle Decay as a Catalyst for Ionization and a Source of Clean Energy

Student Name(s): L. Apostolides

Abstract:

The objective of this engineering project was to investigate the potential utilization of alpha decay's interaction with hydrogen as a clean source of energy. The project was completed in two main phases. The first step was to design a model in which little to no voltage is applied yet there is a spontaneous flow of electrons to generate current. The application of p-n junctions was investigated as well as galvanic cells that use spontaneous redox reactions; however, magnets were decisively the most effective option in order to achieve current at potentially high voltages. The second phase involved mathematical calculations to determine the efficiency, power, and applicability of the system. These calculations included the kinetic energy of the electrons, the velocity, and the total voltage and current potentially generated based on accurate averages. The system is capable of producing an extremely high voltage at relatively low current, making it ideal for sending energy through the National Grid. The amount of time it takes for the system to reach this maximum capacity can only be determined through many trials using radioactive materials and finding the average time it takes to reach the capacity.

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

ET EE MA

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 vertebrate animals controlled substances

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

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

247

Fair Category

PS

Project Number

6004

Title: Spatiotemporal mapping and statistical analysis of native, endemic, and invasive floras using vegetation index data from multispectral optical imagery in the Galapagos islands

Student Name(s): A. Radulescu

Abstract:

Expansion of invasive flora has been a problem in the Galápagos Islands. Traditionally, research in the Galápagos has been primarily conducted through field work, which is time consuming and does not guarantee it will provide sufficient spatial coverage considering 97% of the islands are not inhabited and, therefore, would benefit greatly from a viable remote sensing approach. The hypothesis being tested is that there are statistical differences between the Normalized Difference Vegetation Index (NDVI) values of endemic, native, and invasive plant species in the Galápagos Islands as observed by satellite-based multispectral optical imagery (Landsat 1-5, 7, 8 and Sentinel-2). Twenty-one satellite images, originally acquired between 1984 and 2019, were downloaded from the US Geological Survey EarthExplorer database. Using ArcMap 10.7, each image was processed to calculate NDVI. A database was created to record NDVI values for thirteen plants (classified as invasive, native, or endemic). NDVI was assigned to each plant based on a vegetation map created from previous research. Generally, invasive plants exhibit the highest average NDVI (0.71), followed by endemic plants (average NDVI of 0.69), and then native plants (average NDVI of 0.66). Moranativa was previously classified as NaQ (native questionable), but has NDVI values greater than invasive plants (average NDVI of 0.77). A reclassification of moranativa may be necessary. Finally, It may not be completely feasible to map out individual flora using only NDVI, but some plants may be easier to distinguish from others based on degree of NDVI overlap (interquartile range).

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EV EA PS

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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

91

Fair Category

PS

Project Number

6005

Title: The Effects of Different Chemical Fertilizers on Phosphorus Absorption in Chrysanthemum Morifolium

Student Name(s): E. Brown

Abstract:

This study tested the effects of different chemical fertilizers on a plant's absorption of phosphorus. Phosphorus is a type of macronutrient that is essential for the survival of most plants, including Chrysanthemum morifolium. This study tested the effects of different chemical fertilizers on the absorption of phosphorus. This was done by fertilizing eighteen different Chrysanthemum morifolium plants and testing the phosphorus levels of the soil over time. It was found that no fertilizer, as well as bone meal, decreased phosphorus absorption the most and ammonium sulfate decreased phosphorus absorption the least.

**Technical Disciplines Selected by the Student
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BI CH PS

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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

169

Fair Category

PS

Project
Number

6006

Title: Curdling Milk

Student Name(s): A. Garcia Lantigua

Abstract:

The reason I'm conducting this project is to help others be aware of the chemicals or substances that can make milk curdle. I'd like to let them know what they should be cautious of so that no incidents happen when cooking something or attempting to do something that involves milk. In this project, I would like to figure out if the substance mixed with the milk affects the curdling process. So far, I've found in my research that enzymes are mostly responsible for the curdling of milk, thus I could use beverages that have a lot of enzymes, like orange juice perhaps. I believe that oranges probably have a fair amount of enzymes, so I predict that it'll probably curdle it the fastest. In the real world, this type of information will be useful to those that use cooking recipes that require the mixing of milk and juice, perhaps they won't want curdled milk, and this is a great way to make them cautious of the substances they use.

Technical Disciplines Selected by the Student
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CH

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

254

Fair Category

PS

Project Number

6007

Title: Monitoring Infant Vital Signs Through a Car Seat Embedded Piezoelectric Sensor Network

Student Name(s): G. Guzzo

Abstract:

The heat stroke-induced fatality rate for children in vehicles increased by nearly 20% from 2017 to 2019. Even the most cautious of parents are not immune to forgetting their children. This project seeks to optimize a network of piezoelectric sensors within a car seat to program a system that can communicate when a child is at risk via a mobile app by monitoring data trends.

The first phase of this project involved selecting sensors that could monitor the conditions of the vehicle and the infant's breathing and heart rate. A sensor puck, with the capability to transmit the temperature, relative humidity, and UV index in the car via Bluetooth, was selected. To monitor breathing and heart rate, a Bluetooth transmitter was paired with two force sensor plated antennas. These sensors are optimized to take accurate measurements without direct contact. A cut-off frequency was assigned of 0.2-1.9 Hz: an infant's expected breathing frequencies.

The second phase was to design an app-embedded assessment program that could determine if a child was at risk to alert caregivers. Data from each sensor is sent to the app-linked database in real-time. The assessment protocol for temperature, relative humidity, and UV index alerts parents when any has reached an unsafe value or is dangerously trending. A sudden yet consistent change in breathing or heart rate triggers the alert system. In this system, the guardian is initially alerted. If the problem persists and no response is acquired, emergency

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AT EE CS

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

4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

257

Fair Category

PS

Project Number

6008

Title: Delivery of Medical Supplies Using Autonomous Thrust Vectoring UAVs to Developing Countries In Response To Natural Disasters

Student Name(s): T. Fouts

Abstract:

The purpose of this project was to create a drone delivery system that utilized fixed-wing vehicles and quadcopters to deliver medical supplies to areas that have suffered from natural disasters. The delivery system consists of cargo planes capable of flying long distances and drones that can deliver supplies from the cargo plane to the ground. The fixed-wing cargo plane flies over a disaster site and deploys quadcopters to deliver supplies to the ground. The quadcopter commutes between the plane and the ground to deliver medical supplies. The first step was to design a fixed-wing plane representing the cargo aircraft capable of flying a predetermined pattern. The fixed-wing plane flew an elliptical pattern and carried a drogue to symbolize the back of a cargo plane. Next, a quadcopter that autonomously commuted between the drogue and the ground was created. The quadcopter was designed to rotate its motors and fly as a fixed-winged plane to achieve the velocity necessary to intercept the fixed-wing aircraft and its drogue. The drone flew its nose into the drogue, symbolizing a successful interception. Both the drone and the fixed-wing plane flew autonomously to provide accuracy while docking. The drone and the fixed-wing plane used a GPS to navigate to a rendezvous position. It was concluded that autonomous drones are a viable method of delivering medical supplies efficiently. More development is necessary to increase the interception accuracy of the drone and to further stabilize the drone while transitioning from a quadcopter to a fixed wing vehicle.

**Technical Disciplines Selected by the Student
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EE CS ET

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- Yes No

CSEF Official Abstract and Certification

Word Count

248

Fair Category

PS

Project Number

6009

Title: Using Bio-metric Artificial Intelligence to Identify Physical Symptoms of Common Skin Conditions

Student Name(s): A. Mehta

Abstract:

Skin conditions affect every one in three Americans. Getting accurately diagnosed for a skin condition can be a challenging process. In an attempt to simplify this process, I used bio-metric artificial intelligence to identify common skin conditions. This program will allow for consumers to correctly justify skin conditions that one be symptomatic of, simply by taking a photograph. In order to pursue this, the original procedure had to be refined. In the newly created procedure, I worked with tensorflow neural networking and machine learning. Neural networks are a set of algorithms mimicked after the human brain, that are designed to recognize patterns. Neural networks are best featured in object detection for recognizing patterns like edges, shapes, colors, and textures to identify an object. The program was trained to identify patterns between hundreds of pictures of ringworm. Next, I tested three common skin conditions through pictures in the program and see the correlation between them and ringworm. Firstly, I found that the program recognized a strong correlation with ringworm with an average correlation of +0.863155. Next, I had tested vulgar psoriasis pictures to see if the program would falsely identify vulgar psoriasis as ringworm because they have similar features. The average correlation was +0.50561. There is a clear gap in correlations between the two tests. Finally, I tested psoriatic erythroderma, the average correlation was +0.329403. I can conclude that the program did succeed in its task as it could properly recognize differences between the three similar skin conditions.

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CS AT 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

237

Fair Category

PS

Project
Number

6010

Title: Using Protein Core Density to Predict Model Accuracy

Student Name(s): T. Lu

Abstract:

Proteins fold into three-dimensional shapes and consist of amino acids, known individually as a residue. Accurately modeling proteins is essential for understanding their functions. Critical assessment of protein structure prediction (CASP) is a database with protein predictions created using any modeling method. The protein core, which is not exposed to the solvent surrounding the protein, has consistent density between different proteins. Density is measured through packing fraction, which describes how close atoms are. This project aimed to compare accuracy of protein core predictions from older CASP results from 2004 (CASP6) to newer results from 2014, 2016, and 2018 (CASP11, 12, and 13). The independent variable was the year the model was created. The dependent variable was the accuracy of the predicted core and was measured by comparing predicted packing fraction and proportion of core residues (fraction core) to that of actual proteins. It was hypothesized that CASP11, 12, and 13 would have greater accuracy in predicting packing fraction and fraction core compared to CASP6. Packing fraction and fraction core were calculated for each CASP year and plotted against values from actual proteins (obtained from a protein database called Dunbrack1.8). CASP13 was most accurate in predicting packing fraction and fraction core while CASP6 was the least accurate for both. This supports the initial hypothesis. The next step is to use this data to determine if there is a relationship between predicted core accuracy and overall model accuracy.

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

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

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

244

Fair Category

PS

Project
Number

6012

Title: Multi-Wavelength Identification of Black Hole Candidates in the M13 Globular Cluster

Student Name(s): A. Granquist

Abstract:

I present the identification of the most promising black hole candidates in the Milky Way globular cluster M13. I utilized source-finding programs in conjunction with X-ray catalogs and radio data from the Karl G. Jansky Very Large Array (VLA), as well as a Hubble Space Telescope image of M13, to identify candidates and determine the likelihood of each being a black hole. The sources identified most closely match the L_r/L_x (radio luminosity/X-ray luminosity) correlation of black holes, and the most likely sources also have optical counterparts (which would signify the presence of a companion star in an X-ray binary, indicating the likelihood of the radio/X-ray source being a black hole). These sources have radio luminosities between 5.3×10^{27} and 1.3×10^{28} erg/s, and have X-ray luminosities between 4.4×10^{30} and 2.6×10^{32} erg/s, rendering the candidates too X-ray-faint to be neutron stars and too radio-bright to be white dwarfs. Several radio sources without X-ray matches were observed in both the 5 GHz and 7.4 GHz basebands of the VLA observation; their spectral indices close to zero indicate the possibility of them being black holes. Finding black holes in globular clusters helps fine-tune models for the causes of gravitational wave events which have been recently detected by the Laser-Interferometer Gravitational-Wave Observatory (LIGO) and helps predict the abundance of black holes in globular clusters.

Technical Disciplines Selected by the Student
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PH

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

256

Fair Category

PS

Project
Number

6013

Title: Effective Removal of Systemic Pesticides from Fresh Fruits

Student Name(s): E. Haddad

Abstract:

Daily consumption of fruits and vegetables are essential for a healthy diet with proper cleaning of toxic pesticides and fungicides. Study from UMass Amherst demonstrated that soaking apples with sodium bicarbonate solution proved partially effective to remove surface but not penetrated residues of common systemic fungicide thiabendazole (TBZ).

This research studied the penetration and removal of TBZ in apples, cucumbers, and grapes. Furthermore, tested my hypothesis of applying sodium bicarbonate/ultrasound-bath to enhance removal of penetrated TBZ, due to its strong vibrational mixing.

HPLC-MS was applied for quantitative analysis due to high sensitivity of UV spectroscopy combined with mass spectroscopy to verify peak purity. Refined HPLC conditions and calibration curve were established at 0.25 ppm to 200 ppm concentration range with $R^2=0.9962$, allowing detection limits as low as 0.25 ppm levels of TBZ. Residual TBZ in non-organic apple tested with 22.1 ppm on peel (9 cm²) and 12.4 ppm inside the fruit (3x3x0.5 cm³). Organic apples, cucumbers, and grapes soaked in 100 ppm TBZ in 1:1 MeOH/Water solution for 17 h resulted with surface residue of 25 ppm, 2.1 ppm and 0.1 ppm and with penetrated residue of 23.2 ppm, 0 ppm and 0 ppm respectively. Ultrasound treatment reduced the surface and the penetrated levels in apple to 17.5 and 15.3 ppm respectively.

Technical Disciplines Selected by the Student
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CH EM AT

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- Yes No

CSEF Official Abstract and Certification

Word Count

182

Fair Category

PS

Project
Number

6014

Title: Investigation of the Mechanism of Epoxide Synthesis by Mesoporous Manganese-Promoted Cerium Oxide Catalysts by Reactive Oxygen Species Detection

Student Name(s): E. Hollander

Abstract:

We studied the use of cyclooctene as the model reactant and mesoporous manganese-promoted cerium oxide as the catalyst for the production of the epoxide cyclooctene oxide with dimethylformamide as the solvent. Manganese-promoted Cerium oxide serves as a suitable catalyst because of its high, tunable surface area. This study investigated the mechanism of the aforementioned reaction, or the intermediate steps involved in the reaction. This was done by conducting reactive oxygen species (ROS) studies and radical trapping experiments, wherein different ROS, unstable forms of oxygen molecules generated in some reactions, were detected. By identifying ROS, a proposed mechanism of the reaction was developed. It was hypothesized that if Manganese-promoted Cerium oxide is used as a catalyst in converting C₈H₁₄ into C₈H₁₄O, then the ROS hydroxyl radical, singlet oxygen, and superoxide anion would be detected. The independent variable was the catalyst, while the dependent variable was the ROS detected. The epoxidation reaction was done by student, as was some analysis. The ROS singlet oxygen and superoxide anion were detected during this study. Results were used to propose a plausible reaction mechanism.

Technical Disciplines Selected by the Student
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CH

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- Yes No

CSEF Official Abstract and Certification

Word Count

250

Fair Category

PS

Project Number

6015

Title: The Academic Gender Gap in High School:

Are Boys Being Left Behind?

Student Name(s): J. Li

Abstract:

My goal was to assess the gender disparity in high school academics and to explore the factors impacting this occurrence. Data of students achieving academic high honors in Guilford High School over past seven years was collected from newspapers. The gender ratio was analyzed to find trends by grades, graduating class, etc. Finally, the 2019 New Haven Register Senior Spotlight (NHRSS) recognized by Yale University, which presented six top seniors from 24 local public high schools, was analyzed to measure academic performance by gender throughout the area.

The results showed that over the first three years, girls appeared 1.5 times more than boys in high honors, yet the percentage of girls continued to increase after 2015. The class of 2016 was an exception, consistently yielding a larger proportion of boys than girls. Looking at performance by grades (i.e., freshman, sophomore, etc.), it was clear that the percentage of boys in high honors was consistently lower than that of girls over the seven years regardless of which grade was being examined. Within each graduating class, however, boys appeared to perform better as juniors and seniors. Although the percentage of high honor boys in any given class increased as time passed, the overall percentage is clearly on the decline. Furthermore, there was a significant majority of girls nominated in the NHRSS, affirming the findings of high honors' percentages. Thus, this study demonstrates that girls have been performing academically better than boys and that the gap between the two is continuing to stretch.

Technical Disciplines Selected by the Student
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BE MA

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4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

214

Fair Category

PS

Project
Number

6016

Title: Optimization of Energy Storage of Capacitors with Hydrogel Electrolyte

Student Name(s): E. Ngo

Abstract:

Hydrogels are drawing increasing research interest due to their structural crosslinked network of polymer chains with interstitial filled with water. These properties allow for hydrogels to be characterized as both flexible and wet, creating ideal candidates for electrolyte materials in flexible energy storage devices, such as supercapacitors and rechargeable batteries. Further, these materials have controlled chemistries that allow for novel functionalities into the existing hydrogels, permitting the fabrication of unprecedented energy storage devices with additional functions. One such energy storage device is the supercapacitor, which can be supplemented by self-healing, wet, and stretchable features. Herein, hydrogel electrolytes (B-PVA/NaOH) are prepared, stretched, and cut into parallel electrolyte layers of identical size. When the microstructure of a polymer through cross-linking is altered, it can result in different macroscopic properties of capacitance and flexibility. As such, physical qualities were observed after samples of various ratios of components were fabricated. Hydrogels were flattened with a constant pressure of 8 kg and observing the thickness of the sample after a period of 24 hours. Ionic conductivity was measured using a multimeter for all samples. Results demonstrated that a gel comprised of 8% polyvinyl alcohol; 6% boric acid; 10% sodium hydroxide had optimal ionic conductivity. Signs of self-healing within the gels are currently being investigated.

Technical Disciplines Selected by the Student
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EE EN ET

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- Yes No

CSEF Official Abstract and Certification

Word Count

244

Fair Category

PS

Project Number

6017

Title: Effects of Swept Delta Fin Parameters on Model Rocket Performance

Student Name(s): R. Lemone

Abstract:

The purpose of this project was to investigate how the parameters (root chord length, span length, and sweep angle) of swept delta fins affect the apogee of a model rocket. Specifically, it was to alter these variables in order to determine how to maximize the height reached by the model rocket. I chose to do this project because it could aid model rocket and rocket design as a whole. By figuring out how to make a rocket go as high as possible, manufacturers can create better, more efficient rockets. To accomplish the objective, I created eleven sets of fins to fly on 45.70cm length and .24cm diameter model rocket utilizing Estes C11-3 motors. These fins were all different, so as to have four fins to test against each parameter. I then launched the various rocket combinations, utilizing an altimeter attached to the rocket in order to track height. The results from the experiment support that a lower root chord length, lower fin span length, and higher fin sweep angle all increase the apogee a rocket will reach. For example, when testing sweep angle, the 60 degree fin variation reached 217m while the 0 degree fin variation only reached 187m. It is likely that the reason behind these results is that they both lower mass and optimize the aerodynamic properties of the fin. This research may be utilized to improve the performance of both model rockets as well as sounding rockets that use tail fins.

Technical Disciplines Selected by the Student
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EE

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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

252

Fair Category

PS

Project Number

6018

Title: Environmentally Safe Remediation of Synthetic Motor Oil Spills Using Plant Products

Student Name(s): M. Chhatre

Abstract:

Oil spills have a damaging effect on the environment, marine life, and contribute to climate change and pollution. Currently, oil spills are cleaned up using booms and skimmers, chemical dispersants, or burning the oil. Although effective, these methods cause harm to the environment. Burning oil releases harmful gases into the atmosphere causing pollution, and increasing greenhouse gases while dispersants harm the marine life. Environmental friendly methods of oil spill remediation have been researched, using sawdust and bacteria. This study investigated environmental friendly remediation methods for synthetic motor oil which is used in vehicles today. The natural substrates tested were sawdust, bamboo, psyllium husk, and alkali-treated sawdust (ATSD). Alkali treatment removes lignin and increases the pore size, thus the hypothesis guiding this study was that ATSD would absorb the most oil. In the first stage of the study each substrate was tested for absorption of methylene blue, followed by gravimetry to determine the amount of oil sequestered by each substrate, and these oil samples were subjected to gas chromatography. ATSD gave the best results with all three methods by absorbing 94% methylene blue, 90% oil removal by gravimetry and 99% by gas chromatography. The theoretical portion of this study compared use of ATSD to oil-spill methods commonly used to treat oil spills showing how ATSD, a by-product of the wood industry, was the most natural and cost-effective substitute for current oil spill remediation. Further studies can include developing a mathematical model for cost analysis using ATSD in oil cleanup.

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

CH EV PS

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 vertebrate animals controlled substances

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

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

192

Fair Category

PS

Project Number

6019

Title: Texting-and-Driving Safety Device: Utilizing a Hydraulic Braking System Activated by a Touch-Sensor Steering Wheel to Increase Driver Engagement.

Student Name(s): N. Levi

Abstract:

The objective of this project was to create a simple safety device that detects when a driver takes their hand(s) off the steering wheel, and applies proper safety protocol to decelerate the vehicle. After detecting disengagement, the device turns on the braking lights to alert the cars around them of a possible dangerous moving vehicle. Simultaneously, the device applies a slow brake using a hydraulic braking system and prohibits the driver's ability to accelerate to higher speeds while not having both hands on the wheel. Trials were initially conducted to determine the time taken to perform different phone-related activities (while stationary). Using the found interval, the safety device was designed to turn on an LED (the brakes) and to engage the hydraulic braking system (built from scratch) if the electrical loop created between the touch sensors and the participant was broken. The device was made by assembling a hydraulic braking system, writing a code on Arduino Uno using C, and creating a replica steering wheel with touch sensors on either side. Ultimately, the final product demonstrated a safe braking system that safely slowed the car when driver disengagement was detected.

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

EE AT EN

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

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- Yes No

CSEF Official Abstract and Certification

Word Count

245

Fair Category

PS

Project Number

6020

Title: Calculating An Individual's Economic Cost of Solar Panels Based On Consumer Input

Student Name(s): H. Young

Abstract:

While the installation of solar panels provides numerous environmental and economic benefits, many homeowners are undereducated and view this process as prohibitively expensive. However, through the utilization of a solar estimator program, homeowners can input their own personalized information, which will calculate a rough approximation of their potential cost. To do so, I developed a program that provides consumers with an estimation of the cost to install solar panels specific to their homes. I began this process by doing preliminary research and collecting data points that impact a consumer's cost, such as statistics on how one's geographical location, square footage, solar panel company of choice, and Solar Score influences their price. I then utilized a JavaScript compiler and coded statements that align with each state and square footage which will be included if applicable. Within the program, I also developed code that calculates their average costs after the prices of each company provided were accounted for, and determines whether a consumer would be in the higher or lower estimated price range, based off of their Solar Score. Once complete, I ran the code numerous times to fix any errors, and later experimented with several data points that potential consumers might enter, to test how it operates with different inputs, and found that it is a functional program. The estimate provided may still vary from a consumer's actual cost, as other solar incentives could have an impact, however the program still does provide a fair approximation.

Technical Disciplines Selected by the Student
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EA CS EV

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CSEF Official Abstract and Certification

Word Count

242

Fair Category

PS

Project Number

6021

Title: Utilizing a Silicone-based Thermal Coating to Improve Heating Efficiency

Student Name(s): T. Davis

Abstract:

During cold seasons, poorly designed windows are major sources of energy inefficiency resulting in significant heat loss. This heat loss leads to energy spent heating the space which equates to greater expenses undertaken. A temporary window film highly absorbent of radiant energy (like the one being proposed) can result in the promotion of heat gain and a cost-efficient alternative. A copper (II) sulfate/graphene oxide solution will be mixed with a silicon gel prior to being spread into a film across a glass surface. Factors such as absorbance and opacity are graphically measured using an original design and several apparatuses.

The mean luminosity of the control (195.988 lux) proved to be greater than the mean luminosity of prototype film B (154.8896 lux). In regards to absorbance, the percent increase of temperature for film B had an increase of 10.07382% while percent increase of temperature for the control was 8.813165%. This data indicates that while the prototype film has higher absorbance, it also has decreased visibility. Conclusively, the synthesis of a silicon-based thermal coating was successful.

Potential future applications include mass manufacturing and the application of this silicon-based thermal film to the windows of homes, vehicles, and offices. Future research may lead to development of a protocol resulting in a film with greater thickness and equal transparency. Greater thickness would allow an individual to grip and apply/remove the film to a glass surface in a quick and reusable manner.

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

EN AT ET

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- Yes No

CSEF Official Abstract and Certification

Word Count

230

Fair Category

PS

Project
Number

6022

Title: The Utilization of Flavonoids for the Prevention of Paint Degradation via Exposure to Ultraviolet Radiation

Student Name(s): L. Ghavami

Abstract:

Paint degradation is the process in which the binder and pigments of a coating deteriorate and react with one another, resulting in the alteration of color, and oftentimes the peeling or blistering of paint. The flavonoids rutin and quercetin dihydrate were suspended in acrylic binder as to demonstrate an environmentally friendly and plant based avenue of UV protection. Methodology included mixing dispersions of rutin and quercetin dihydrate powders at varying concentrations, then painting them onto glass microscope cover slips. Control samples were made only with acrylic binder. UV/Visible absorption spectra of all samples were measured using a Perkin Elmer Lambda 800 spectrophotometer at Yale under the supervision of Dr. Rui Chen. It was found that rutin had a broader absorption spectrum (268-447nm) than quercetin dihydrate (470-570nm), though the peaks in both spectra were close together (378nm for quercetin dihydrate, and 369nm for rutin). Based on visual observations and the magnitude of absorption, colloids of rutin or quercetin powders and wet acrylic binder with about 1.25% flavonoid powder absorb around 90% of incident UV light. These results demonstrate the prospective use of plant derived flavonoid compounds as UV protection for paint. Future work includes the use of extracts in binder to for more environmentally friendly sourcing, degradation testing of the the aforementioned colloids, and testing for reactions between the colloid and other substrates such as vinyl, wood, and painted wood.

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

CH

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

232

Fair Category

PS

Project Number

6023

Title: Motorized Cleaning Brush for Increased Efficiency of Solar Panels

Student Name(s): J. DiAngelo

Abstract:

The goal of this experiment was to design a device that would attach to a household array of solar panels and clean them to maximize the volts generated. The pulley and belt system was designed so a brush could continuously sweep down the panel. A 24V motor powered the device, and a 7.2V battery powered the motor. Two of the 15mm wide pulleys were tightened to the center of two of the aluminum rods, which were inserted through the low voltage staples. The wooden boards were all screwed to the wooden base, and the solar panel was attached to the wooden boards. The brush was secured to the belt using Velcro and nylon thread. One piece of Velcro was stitched to the brush, and the other glued to the belt. The device was tested by sprinkling ½ cup of dry soil onto the panel, followed by the brush, which swept the panel. When tested, the device increased the voltage of the solar panel by an average of 2.123V, proving the device to have accomplished the original goal. The theoretical experiment concluded if 10% of Americans used solar panels, CO2 emissions would be reduced by 49.41 grams of CO2/kwh. If the population of people in the U.S. who use solar panels increased, natural gas power plants would need to generate less energy, and therefore less CO2 would be emitted into the atmosphere.

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

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

259

Fair Category

PS

Project Number

6024

Title: Differentially Private M-band Wavelet-Based Mechanisms in Machine Learning Environments

Student Name(s): K. Choi

Abstract:

Although scary, data collection is inevitable. Our society needs data to improve. But despite massive data breaches such as the 2017 Equifax settlement, data collection does not necessarily entail privacy loss. “Differential privacy” prevents the re-identification of anonymized data by using computer mechanisms to obscure data with randomized numbers (noise). These mechanisms preserve user privacy by adding just enough noise to datasets to make individuals undetectable. However, current mechanisms are not complex enough and neglect next-generation quantum hacking techniques. Overly-secure mechanisms, on the other hand, compromise the data’s statistical integrity, preventing analysts from learning from the data. I hypothesize that creating a mechanism based on quantum cryptographic algorithms will fix these two issues because the algorithms would be complex enough to prevent next-generation hacking but would also add only a small amount of noise to preserve the data’s statistical trends. Using mathematical and quantum principles, I create the “pseudo-quantum mechanism,” a next-generation cryptographic technique that irreversibly embeds noise into data using inverse trigonometric functions and pseudo-quantum steganography. I then code and test my pseudo-quantum mechanism in five machine learning environments using MATLAB and Python. My pseudo-quantum mechanism achieves more than 94% classification accuracy for all privacy values tested, reaching a maximum accuracy of 99.14%. Thus, my pseudo-quantum mechanism successfully retains both differential privacy and statistical learnability, validating the hypothesis. My research links the two branches of differential privacy and quantum computing, and it shines a light on what data privacy in machine learning could look like in the future.

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

CS MA

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

252

Fair Category

PS

Project Number

6025

Title: Optimization of a Real-Time Sinkhole Detection System Using Localization Methodology, Machine Learning Algorithms, and Limestone Dissolution Modeling

Student Name(s): S. Wang

Abstract:

Twenty percent of land in the United States alone is susceptible to sinkholes. Sinkholes form in karst landscapes through water table erosion and limestone dissolution, posing major public health threats. Current techniques for sinkhole detection (LIDAR, GPR) are not only inaccurate and inefficient, but also lack real-time capabilities. This project used designs derived from civil engineering [the structural health monitoring system (SHMS) and the wireless sensor network (WSN)] and computer science [the Internet of Things (IoT) and Artificial Intelligence/Machine Learning Algorithms (ML)] to engineer a novel sinkhole detection system. SHMS and WSN were used to develop a sensor network to diagnose underground structural state in real time by modeling the limestone dissolution process. IoT was applied to create a user friendly interface, and ML algorithms were developed to analyze the data in real-time, generate predictions, and automate the system. A Discrete Element Method (DEM) computational model of limestone dissolution and a trilateration localization methodology were used to train ML algorithms. To test the detection system and sensing devices, sinkholes were physically modeled. The sensor data was analyzed in real-time through ML Algorithms. Testing resulted in high accuracy, with a 99% localization accuracy and a 95% time prediction accuracy. The device operates at less than 5% of the cost of current sinkhole detection methods. The detection system accurately and efficiently detected future sinkhole occurrences in real time, and when advanced, has the potential to not only reduce property damage, but more importantly, eliminate the public health threat of sinkholes.

**Technical Disciplines Selected by the Student
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EA AT 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

255

Fair Category

PS

Project Number

6026

Title: Decoding Algorithms for Correction of X-Z and Spatially Correlated Errors in Topological Quantum Computing

Student Name(s): S. Florin

Abstract:

Topological quantum error correction uses the topology of surfaces like the plane or torus to correct quantum errors, helping quantum computing to be successful. However, topological quantum error correction assumes that all errors occur independently. In this project, both spatial correlation and X-Z correlation are considered. In the error model used, staircase-shaped errors of fixed unknown length are considered, providing the spatial correlation. Also, instead of treating Pauli Y errors as a combination of X and Z errors, they are considered separately by having X, Y, and Z chains occur with equal probability. This forces the decoder to consider X-Z correlation. The decoder is a variation of the minimum-weight perfect matching (MWPM) algorithm. Instead of using the taxicab distance on the lattice as the weight of an edge, weight is defined using a combination of functions on distance and the overlap of chains. The distance function has a spike at the predicted staircase distance. The overlap function peaks at no overlap and maximum overlap to account for Y errors. This algorithm is applied twice; once for X syndromes and once for Z syndromes. This information is combined to give the most likely error chains. The traditional MWPM decoder has an error threshold at ~11%, beyond which the success rate dramatically declines. The revised decoder has a higher success rate and remains useful beyond this threshold, to as much as 17%. Both of the weight functions used in this research can be generalized to broader forms of spatial and X-Z correlation.

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

PH MA CS

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

166

Fair Category

PS

Project
Number

6027

Title: Microplastic Concentrations in the Mianus River: Filtering, Measuring, and Mapping

Student Name(s): R. Winston

Abstract:

The objective of this experiment was to determine the concentration of microplastics in the mouth of the Mianus River and adjacent areas of the Long Island Sound. Samples taken along the Mianus River and the surrounding waters were filtered, and microplastics isolated and counted in order to determine the concentration. With this information, a microplastic-concentration map of the Mianus River and neighboring region of the Long Island Sound was created. The initial phase focused on locating and visiting multiple docks and harbors adjacent to and on the Long Island Sound and the Mianus River. Water samples were collected using a 50 μm plankton net. The samples were vacuum filtered using a 47 μm gridded filters in a microfiltration apparatus. The quantification of the concentrations of microplastics came in the final phase in which microplastics were counted under a stereomicroscope, divided by the volume of the sampling area, and mapped at their respective test sites to see the effect that location had on the concentration of microplastics.

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

EV EM

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4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

238

Fair Category

PS

Project Number

6028

Title: Testing the Effectiveness of the Raspberry Pi Sense HAT in Comparison to a Traditional Weather Station

Student Name(s): C. Spallone

Abstract:

Emerging countries lack accurate information regarding weather and climate. These gaps in knowledge prevent proper preparation for meteorological events and limit weather awareness in specific regions. Without proper recognition of future weather patterns, threatening conditions become more common occurrences, especially in the face of climate change. An inexpensive weather station was developed using the Raspberry Pi computer and its popular add-on, the Sense HAT. The effectiveness of the device was tested in comparison to a heavily researched and reputable station produced by Ambient. If meteorological data collected during the same time period aligned similarly between the two systems, the Raspberry Pi station could be deemed effective. The results of the data collected by the Raspberry Pi and Sense HAT displayed several similarities to that of the Ambient weather station. The temperature data was consistently within two degrees Fahrenheit, the pressure data within 0.2-0.3 inHg, and the humidity data within 10% of the Ambient readings. The completed research introduces and details an additional use for the Raspberry Pi computer and the Sense HAT. The station is able to gather weather data efficiently, enabling scientists to implement small stations in areas which lack sufficient observational data. With this information, citizens of these regions can adequately prepare in advance of a dangerous weather event, therefore saving lives. The data will also add to the global bank of climate information, allowing for a more accurate modeled representation of our future world.

**Technical Disciplines Selected by the Student
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EA 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

249

Fair Category

PS

Project Number

6029

Title: Estimating Ice Elevations Using a Bayesian Model and Satellite Image Data with Minimal Error

Student Name(s): A. Satish

Abstract:

If completely melted, ice sheets could raise global sea levels by 60 meters. Satellite datasets provide an aerial view of these ice sheets, however, they do not measure thickness. A Bayesian model provides probabilistic inference that continuously updates the certainty of a given hypothesis. Bayesian mathematical models allow for more accurate estimations of ice sheets' thickness. NASA's GRACE mission satellite data covering multiple time periods is the control for this experiment. The prediction models using varying mathematical functions for 200 mascons on a Greenland ice sheet are developed in Python through the Jupyter notebook to determine the trend in ice sheet thickness, and the corresponding sea level. Using the model's output data, it was shown that as ice mass decreases, sea level increases. Due to prior understanding of this true relationship between ice elevations and sea level, the model shows accuracy. The trend shows minimal error due to NASA removing error from the initial data. The error of each model is calculated using Python to determine the prediction's accuracy and effectiveness in future prediction. This study fuels an understanding of efficient mathematical models to understand the risks of melting ice sheets in the near future. It allows researchers to predict ice mass in other ice sheets and consider global effects of an increase in sea level. It also leads to the creation of more efficient mathematical models to analyze large, unknown datasets more accurately in other areas of scientific research, showing that this research has implications beyond environmental application.

**Technical Disciplines Selected by the Student
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MA EV

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- Yes No

CSEF Official Abstract and Certification

Word Count

235

Fair Category

PS

Project Number

6030

Title: Increasing the efficiency of a household methane gas recovery system as a reliable energy source in rural Guatemala

Student Name(s): J. Lee

Abstract:

Methane gas is a common byproduct in any process of rot and degradation of organic matter. When decomposition occurs, this gas is emitted directly into the atmosphere. Methane is the simplest alkane hydrocarbon that exists. Its chemical formula is CH₄, meaning there are four hydrogen atoms and one carbon, which are linked by covalent bonds. Methane is found in nature in the form of gas at normal temperatures and pressures. In addition, it is colorless and odorless, despite being produced by the rot of plants. It is a non-toxic gas, and the only real danger is that of burns if it were to ignite. There are several ways to generate methane gas in homes, and the amount of methane gas generated by the decomposition of organic matter varies depending on the type of matter in question. An experiment was designed to measure the efficiency of decomposition by examining the relationship between the amount of raw material and the amount of gas generated by three different mixtures of organic matter: 1. food waste; 2. animal waste (excrement) 3. equal parts mixture of food debris and animal waste. The results gave insight into which of the three mixtures is the most efficient in methane gas generation and, therefore, which would be the most suitable for methane gas generation systems for homes, one that occupies the least amount of space while generating an equal amount of gas.

**Technical Disciplines Selected by the Student
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EV EM ET

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- Yes No

CSEF Official Abstract and Certification

Word Count

180

Fair Category

PS

Project
Number

6032

Title: A Novel Computer-aided Cloud Type Classification Method Based on Convolutional Neural Network with Squeeze-and-Excitation

Student Name(s): J. Li

Abstract:

Cloud plays a vital role in circulation of water and energy by modulating radiative effects. As important as cloud cover, cloud-type variations are powerful in modifying the radiation field of the earth-atmosphere system. Our ability to effectively identify cloud types are severely limited by experts' experience. Therefore, automatic classification of cloud types is a promising tool for a wide range of applications in meteorology. In this work, we propose Convolutional Neural Network with Squeeze-and-Excitation for classifying the images of clouds. We use a data set called CCSN which includes 10 basic cloud types in addition with contrails. Our solution achieves 94.498% accuracy after 50 epochs, better than AlexNet and RetNet, indicating that the solution is robust and practical. Lastly, remote access to the cloud-based forecasting system was enabled through a web server using Flask framework, which allows long-distance classification of cloud images. At the same time, the description of the predicted cloud type and most likely upcoming weather in the region where the cloud image is captured are displayed and introduced to end users.

**Technical Disciplines Selected by the Student
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CS PH EV

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- Yes No

CSEF Official Abstract and Certification

Word Count

248

Fair Category

PS

Project Number

6033

Title: Accounting for discrepancies in galaxy rotational curves using halo density profiles and cold dark matter theory

Student Name(s): D. Peters

Abstract:

Dark matter is a highly discussed phenomenon in the fields of cosmology and astrophysics. This project focuses on dark matter and formulating a theory on discrepancies in cosmology, specifically relating to dwarf spheroidal galaxies (dSphs) and mass-to-light (M/L) ratios. Dsph galaxies provide more specific information in terms of mass, radii, luminosity, and mass-to-light ratios. My research concentrates on galaxies with a high M/L ratio within the gravitational pull of the Milky Way, such as the galaxy Sextans. I learned that Sextans redshifts light and causes a gravitational effect. In addition, through cold dark matter theory, I discovered that dark matter is causing these effects and forms in small clumps that are extremely dense, causing this notable gravitational pull. In addition, I found the inverse square law for gravity breaks down when $r=0$ (r as the distance between particles) and when r is infinite. Over long distances, galaxies like Sextans should not have an effect on other celestial objects. However, dark matter galaxies create gravitational effects, illustrating how a dark matter component needs to be factored into this law and the subsequent equations derived from it. Overall, I theorize that dark matter is the missing component from many of these equations, but it resides specific galaxies such as dSphs that form dark matter haloes. I will demonstrate what I will discover in the future as my capabilities grow in addition to equations I hope to unravel as I progress in this field.

**Technical Disciplines Selected by the Student
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PH

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

249

Fair Category

PS

Project Number

6034

Title: The Effect of Simulated MSG-1 Martian Soil on the Growth Rates of Plants

Student Name(s): P. Gilbert

Abstract:

Space exploration allows the human race to determine its place in the universe and progress towards an advanced civilization. This project aids Martian colonization by determining growth rates of plants in the simulated MSG-1 Martian soil (SMS) mixed with Earth soil (ES) in different ratios. It was hypothesized that if there is a difference in pH and macronutrients in ES and SMS, there will also be differences in growth rates of specific plants. It was hypothesized that a 1:1 ratio of ES to SMS will yield optimal plant growth. Macronutrients (potassium, nitrogen, phosphorus) and the pH of ES and SMS were tested using nutrient test kits and pH strips. Plant growth tests followed. Sixteen planters were filled with four different ratios of ES and SMS, allowing for duplicates of each soil and seed combination. Five of each seed type (radish, potato, tomato, and mizuna lettuce) were planted in each soil mix and placed in a lighted greenhouse. Watering occurred regularly. The growth rates (the number of germinated seeds and plant height) were measured over 8 days. Results thus far show differences in pH and macronutrients between ES and SMS; plant growth results demonstrate a 3:1 ES:SMS ratio is optimal for growth and that mizuna lettuce is the optimal crop for plant growth. The implications of these results are immense; they allow for further research in refining survival techniques in space. This experiment can support the possibility of Martian colonization and further the possibilities of future space exploration.

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

PH PS 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

257

Fair Category

PS

Project Number

6035

Title: Enhancement of a Flow-Through, Solar Water Disinfection System using Combined UV/Riboflavin Photocatalytic Treatment

Student Name(s): C. Speaker

Abstract:

An improved solar water disinfection (SODIS) system was developed using riboflavin as a photocatalyst to enhance the antimicrobial efficacy of ultraviolet radiation. Greater efficiency is critical to the 2 million people in the developing world who depend on SODIS systems and are deprived of clean water when UV radiation is blocked by atmospheric conditions. The ability of 0.1% riboflavin to enhance the bactericidal effect of UV was investigated in a PET water plastic bottle system containing 10^5 CFU/ml of Escherichia coli at an illumination distance of 12 inches. Addition of riboflavin to the water prior to UV irradiation produced a measurable increase in disinfection: 5-minutes of UV treatment alone reduced viable E. coli by 0.5 log units, while combined UV-riboflavin treatment reduced viable bacteria by 2 log units. In the second phase of the investigation, a prototype flow-through SODIS system with a compound-parabolic solar collector was constructed to evaluate the feasibility of a practical, high-output water disinfection system employing riboflavin as a photocatalyst. In the prototype system, with 1.6L of E. coli at 10^5 CFU/ml, bactericidal effect increased by more than 1.5 log units after both 10 and 15 minutes of 0.1% riboflavin-enhanced UV irradiation, confirming results obtained in the stationary water bottle system. Investigations into fluence and flow rate are now underway to determine optimal conditions for the prototype system, which is made from inexpensive and readily available materials and can thus be easily constructed in regions of the world where water purification is most needed.

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):

- 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

255

Fair Category

PS

Project Number

6036

Title: Using an Automated Coating System to Optimize Nitric Oxide Release Patterns of Antibacterial Catheters

Student Name(s): A. Slanski

Abstract:

Intravascular (IV) catheters are essential medical devices used for monitoring, the deliverance of medications, and more. IV catheters are also one of the leading causes of hospital infection, due largely to biofilm formation. These infections lead to longer hospital stays and increased costs. While infections can be treated with antibiotics, increased resistance and the ineffectiveness of antibiotic locking at clearing biofilms. An antiseptic catheter, however, could circumvent these issues entirely. This project will create an antibiotic catheter by functionalizing polydimethylsiloxane (PDMS) catheters with nitric oxide (NO). Catheters were spin-cast and NO-releasing coatings were added using a dip coating system. One coating is composed of diazeniumdiolated dimethyl-1,6- hexadamine (DMHD-N₂O₂) and polylacticglycolic acid, and the other is composed of DMHD-N₂O₂ and the polymer poly-3-hydroxybutyrate. The amount of coating and order of layers will be changed to achieve optimal release. NO release will be measured using a sievers Nitric Oxide Analyser. The NO release data will reveal quantity was released over time and will

be compared to previous data of bactericidal NO release. The final prototype will ideally have a release pattern with rising levels for 72 hours and maintain a high level for another 24. The release should then drop off to a lesser level, releasing for 24 more hours. If successful, this catheter will use a natural compound created within the body's immune system to prevent

catheter infections. The release pattern of this catheter is optimized to prevent biofilm formation, the primary cause of catheter infections and chronic infections.

**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

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- Yes No

CSEF Official Abstract and Certification

Word Count

251

Fair Category

PS

Project Number

6037

Title: Methods for Protecting Small U.S. Business Databases from Cyber Attacks

Student Name(s): K. Grewal

Abstract:

Thousands of small businesses are targeted by SQL Injection attacks every day, costing clients and businesses millions every year. Many of these businesses simply lack awareness of the issue, or don't have easy access to effective protections. This project is meant to compare some of the best protection methods and determine which is the most effective and manageable for a smaller business. In order to determine this, five defense methods that are known to prevent SQL Injection were chosen. Each of these varies in application difficulty. These were then applied to identical databases that were programmed from scratch using PHP, HTML, and SQL, and were hosted locally on the same computer. Each database was then attacked with the same SQL injection code. The amount of data stolen was recorded per method, in order to test the ability of each method to recognize and invalidate injected code. The time it took for each injection attack to complete was also recorded, to test how efficient a database was. Injection was stopped after five minutes. The results of these methods that consisted of more specific treatments to statements within a database proved to be much more effective than methods that were more general and those that attempted to protect large spans of statements with less code. The methods that were more vulnerable were the types of protection more commonly used by smaller companies, showing that it is imperative that it becomes common practice to use prepared statements rather than the typical input-based methods.

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

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- Yes No

CSEF Official Abstract and Certification

Word Count

251

Fair Category

PS

Project
Number

6038

Title: Object Detection Universal System (O.D.U.S.)

Student Name(s): S. Bhardwaj

Abstract:

The Object Detection Universal System (O.D.U.S) is a wearable device which acts as an aid for the visually impaired to navigate through their surroundings and maneuver around objects without any obstructions. O.D.U.S. utilizes two Raspberry Pi single-board computers, a Raspberry Pi A+ and Raspberry Pi Zero W, four ultrasonic sensors, four vibration motors, two buttons, and two battery packs, all housed on a glove and a hat connected over wireless. The Ultrasonic Sensors are placed on the hat in the four directions, front, back, left, and right. All four of the sensors collect data, and the program, written in Python, on the Raspberry Pi A+ will parse that data and produce an output based on the closest distance measured in the radius of up to three feet. The outputs on the hat are a computer generated voice that converts the data in a user friendly format. There is also a buzzer positioned on the hat that produces a set of tones, based upon the distance of an object close to the user. These modes can be set by one of the two buttons on the hat, pressing the right button activates the speaking voice, and pressing the left button activates the buzzer. The data from the Ultrasonic Distance Sensors will be sent to the Raspberry Pi Zero W, positioned on the glove, and one of the four vibration motors, located in the front, back, left, and right which vibrate producing a noiseless alert. This data is transmitted over Bluetooth.

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

AT CS 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

162

Fair Category

PS

Project
Number

6039

Title: Odachi Retrosynthesis Engine: Graph Convolutional Networks for
Template Free, Topologically-Guided Organic Retrosynthesis

Student Name(s): R. Mallarapu

Abstract:

The development of novel synthetic methodologies is a main driving force in theoretical and practical

organic chemistry and has applications in the production of innovative pharmaceuticals or agrochemicals. Retrosynthesis, a synthetic design methodology that systematically identifies bond disconnections in target molecules, is the root of all synthetic planning. Despite this, little has been done on the computational automation of retrosynthesis. Our research asked whether a deep-learning model could be developed to predict retrosynthetic disconnections with no template-based reaction rules. We report the successful development of the Odachi Retrosynthesis Engine, a graph convolutional network that can identify retrosynthetically similar clusters over molecules and find corresponding disconnections. The model uses spectral graph convolutions to identify topological synthetic contexts. We also develop a website (retrosynthesis.com) to host the engine and allow chemists to utilize the model for synthetic design. This work is the first application of graph convolutional networks to the retrosynthesis problem, and enables the development of efficient and advanced synthetic strategies.

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

CS CH 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

PS

Project Number

6041

Title: Building a logistic system to sort packages based on volume or mass using communication between sensors and computers

Student Name(s): C. Shi

Abstract:

In this project, I want to make people understand how the very common method of a logistics sorting system works and how the sensor and the modules work together to let the computer process information and perform tasks.

This mini sorting system mainly includes: host computer, mechanical arm, photoelectric sensor, and data acquisition module

Procedure of building the mini model of the logistic system

-I chose the proper ADAM module to collect the analog input signal and purchased three modules from <https://www.advantech.com>.

-The USB-RS485 converter module is connected to the computer by wiring COM cable

-After preparing power supplier to analog-digital converter module, I wired AC220V-DC24 power adaptor to ADAM-4017.

-I also completed the signal wiring from ADAM-4017 to ADAM-4561 to make sure the data flows through perfectly.

-Then I installed ADAM utility software from their website on the host computer to identify all the modules in this system.

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

AT CS EE

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

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

246

Fair Category

PS

Project Number

6042

Title: Electronic Sealants for Moisture Resistance in IPC-B-25A Boards

Student Name(s): N. Simons

Abstract:

Machinery is seen as durable and long-lasting, but in fact, many parts are quite fragile. One part of the machinery needing protection is the PCB that provides the code for all the machinery. Any movement or signals run through these boards before any action being completed. A danger to these boards is moisture since it has the ability to corrode and causing short circuits in the boards. This is especially vital in today's world where extreme environments are being shown every day to these machines. A common defense against moisture is a sealant, typically silicone. In this experiment, Electronic Sealants for Moisture Resistance in IPC-B-25A Boards, silicone sealants were tested opposite of epoxy resin sealants in research to find if the epoxy resin is more efficient than the standard silicone. This experiment was done through coating PCBs using the following sealants: epoxy resin, silicone, and no sealant at all then submerged in a 20% mass saltwater solution. After 3 days of experimentation, six of the uncoated, 4 of the epoxy resin and none of the silicone coated PCBs showed physical signs of corrosion.

Due to these results and that buying silicone is 13 times less per fluid ounce than purchasing epoxy resin, silicone is more cost-efficient to a company attempting to protect the PCBs. Further research should look into different forms of silicone and epoxy resin to see if any other sealants could outperform the common practice silicone sealant in protecting PCBs.

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

AT EN CH

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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

251

Fair Category

PS

Project Number

6043

Title: Development of A Serious Game for Flood Mitigation: Game Engine Development

Student Name(s): J. Feuerstein

Abstract:

The frequency of natural disasters, along with their extensive effects, have grown significantly worldwide. Recent studies emphasize the importance of public awareness and training of first responders in disaster preparedness and response activities. However, the current strategies used to increase awareness of disaster risks in communities are ineffective. Developments in Serious Games, the genre of video games with a primary focus other than entertainment, have proven themselves a medium capable of fulfilling this need. Serious Games have existed for many years and have made substantial positive impacts in areas such as health, safety, and construction. Furthermore, the Stop Disasters Game has proven the potential of a serious game within the field of natural disaster amelioration. The primary objective of this project was to create a Serious Game with the goal of educating the public, students, and stakeholders on flood prevention and mitigation techniques, such that they are more aptly prepared for future flooding events. In order to accomplish this, global flood data was incorporated into the game; this allows for accurate flood simulation. The game also utilizes the Google Maps API to allow the user to play the game using any location in the world as the game area. To account for these factors, the game was designed in JavaScript, not within a premade game engine. Aspects of the game, such as its global adaptability and usage of real-time data allow it to be a customizable and accurate experience with the ability to educate the masses on a global issue.

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

AT CS EM

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

4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

253

Fair Category

PS

Project Number

6044

Title: The Application of Q-Learning in Flood Rescue

Student Name(s): J. Moran

Abstract:

My science fair project is about the application of Q-Learning in flood rescue. Q-Learning is a branch of reinforcement learning where over iterations a computer program builds up a database which it uses to continuously become better and better at finding the optimal solution to a problem. To apply this concept to flood survival I created a small simulation where a boat has to reach a target while navigating through debris spread throughout the water. In a matter of seconds the computer can run through thousands of these simulations. Every time the simulation ends it essentially makes a note of the steps it took to reach that point and receives either a positive or negative reward. A positive reward will make that set of actions more likely in future simulations, and a negative reward will make those actions less likely. This is what lets the program improve over time.

The main conclusion I can draw from my experiment is that Q-Learning is an effective way to solve problems such as navigating a boat through a field of debris quickly and efficiently. Because the program is improving after every simulation and moving closer and closer to the optimal solution, it is more efficient than computing every possible path and it can likely match, if not exceed the speed of a human attempting to find the optimal path. For these reasons, I believe that Q-Learning has the potential to have a very positive effect if applied in flood rescue and survival.

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

CS 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

185

Fair Category

PS

Project Number

6045

Title: Design of a Novel Electricity Generator Capable of Capturing Wasted Wind Energy

Student Name(s): L. Marshall

Abstract:

The goal of this project was to design and construct a device that could generate electrical energy from wind energy. This process was mainly possible by the use of fans, magnets, and coil because of Faraday's Law. In short, Faraday's Law states that a voltage will be produced in the coil if there is a change in the coil's magnetic environment. As a result of this, the device was able to convert the wind energy from the fan into electrical energy. The electrical energy was measured in the form of power. Three different averages were recorded: 4.89×10^{-6} watts, 5.63×10^{-6} watts, 5.44×10^{-6} watts. These numbers are small, but they prove that the device worked and that it could successfully take wind energy and convert it into electrical energy. This project has the possibility of being taken to a larger scale. As mentioned in the introduction, devices similar to this one could be placed in architectural panels or next to highways in order to capture wasted wind energy. This would then be a relatively inexpensive way to generate free electrical energy.

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

EE ET

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

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4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

133

Fair Category

PS

Project Number

6047

Title: Is Copper Wire Obsolete?

Student Name(s): D. Boudreau

Abstract:

Copper wire is the back bone of our electrical grid. It is very efficient at carrying electricity, and while it is relatively inexpensive, the metal has intrinsic value. It is commonly stolen and this problem is most prevalent in rural areas. Can we develop a way to transport electricity that prevents people from stealing the wire.

This experiment works to develop a method to transport electricity through a conduit other than pure copper. Ideally the conduit will be liquid base in the desire to dissipate heat. The goal is to have roughly the same or less resistance as current copper wires technology. Various electrolytes are explored by measurement of their electrical resistance. Future applications of a successful candidate may also be used to replace the highly flammable electrolyte used in lithium ion batteries.

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

EE CH ET

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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

6048

Title: Augmented Reality Chemistry

Student Name(s): E. Feldman

Abstract:

The purpose of this project was to create an augmented reality (AR) app that would make learning Chemistry more interactive. Based on the popularity of other AR educational apps, the hypothesis was that the app will increase student engagement in a Chemistry environment. The app was programmed in Unity using Blender to create atomic models and Vuforia to provide image recognition software with Chemistry information from online and professional sources. To test the effectiveness of the app an experiment was conducted with 2 Chemistry classes using an 11 question test proceeding the lesson and 30 minutes to complete the assessment. Observational data was recorded during and after the lab. The class that used the app scored an average of 124% higher than the class that did not use the app. The students with the app were observed to be more engaged and organized in larger groups compared to the students without the app. Students who used the app reported that “[The app] makes it funner to learn [Chemistry] instead of using the boring book” and “I like that I can actually see [the atoms] and move [them].” Students without the app remarked that “[The textbook is] too confusing,” “too old,” and “too boring.” The next step would involve testing the app with different variables and differentiating it for different types of learners. Eventually, the goal is to create apps for all academic subjects in the school system to help students learn more effectively.

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

AT CS CH

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

258

Fair Category

PS

Project Number

6049

Title: Subtractive Manufacturing Techniques for making Inexpensive Thermoplastic Microlens Array

Student Name(s): A. Lacunza

Abstract:

Microlens array applications have grown over the past years, however, they have only been found in advanced technology. Recently, researchers have found a way to increase their light-collection efficiency and incorporate microlens array into day-to-day technology such as solar panels and three-dimensional visual system. However, microlens arrays are not readily available and are expensive to fabricate due to the precision and machinery required to manufacture them.

This project seeks to identify optimal manufacturing techniques for microlens array with an easily accessible, table top CNC mill. Clear sheets of Poly-carbonate (PC) and Poly-Styrene (PS) were used to make the lenses, as these are readily available, easy to machine, and low cost. The lenses were designed using Autodesk Inventor CAD software and their optical performance simulated through ZEMAX Opticstudio, an optical design program. Afterward, the Autodesk HSM computer-aided manufacturing (CAM) software was used to convert the file from numerical control (NC) to creating detailed instructions (G-code) for a machine to run. The project explored different CAM software methods for developing tool paths to mill the desired shape and quality. The Scallop, Radial, and Parallel methods were tested using two different mill tools. Each tool path was tested out on the plastic sheets and later examined under a microscope to see key features, clarity, and flaws. It was found out that the Scallop tool path with an 1/8 flat end mill provided the best results in terms of shape and accuracy while the Parallel tool path gave rough cuts and inaccurate dome shape.

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

EN EE AT

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

4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

229

Fair Category

PS

Project Number

6052

Title: Generating electricity from heat differential of a greenhouse

Student Name(s): Y. Masood

Abstract:

Electrical power is increasingly coming from renewable resources. Power generation is going away from fossil fuels and turning towards sources such as solar, wind, hydroelectric, geothermal, and nuclear. Can the heat differential between the inside and outside of a greenhouse be used to generate electricity? A section of our school greenhouse was removed and replaced with a series of Peltier Tiles. These tiles generate electricity by using temperature differentials. One side is heated and the other side cools and this creates a DC current of electrons. 9 tiles were arranged with center supports and wired in both series and parallel in order to generate enough wattage to light a LED light and a meter. The greenhouse was selected because of the temperature difference particularly in the winter. Theoretically there is a greater difference in winter and therefore a greater current. A temperature difference between the interior and exterior of a greenhouse will always exist, so if a current can be made to power lights it could be a sustainable source of thermal and electrical power. This research is the beginning to explore if the value of the electricity is great enough to offset the cost of the hardware. This arrangement of tiles could be used in cold environments where it is cold outside and warmer inside, or in hot desert climates where it is hot outside and cooler inside.

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

AT 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

215

Fair Category

PS

Project Number

6056

Title: How climate change will effect local ecosystems

Student Name(s): O. Kelsey

Abstract:

The purpose of the experiment was to determine the effects of climate change in the CT area in the next 30 years as linked to climate change. show some of the minor changes to look out for as climate change starts to affect the Connecticut area. The procedure was to find specific locations to analyze within Connecticut and determine the effects a change in climate will have on mosquito populations, invasive species, changes in temperatures, and ocean acidification. I went through each source pulling relevant information and eliminating resources that were either not needed, not credible, or not relevant. I kept all of my notes on a google doc to keep everything organized and ready. My data concluded that Connecticut is going to be expecting an increase in invasive species over the next thirty years as well as invasive diseases. Mosquito activity will be expected to expand by at least ten days within the coming years. Connecticut will be expecting more critical heat days and the ocean along Connecticut's coast will be subject to ocean acidification. There will be an increase in insect populations as bug predators such as the brown bat are at higher risk of dying. Connecticut should also expect the incoming of trophic cascades and a change in its everyday food webs.

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

EA EV PS

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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

197

Fair Category

PS

Project Number

6057

Title: A Hybrid Machine Learning Model with Cost-Function Based Outlier Removal and Its Application on Credit Rating

Student Name(s): A. Mu

Abstract:

The ability to allocate capital efficiently and profitably is of great significance to financial institutions. Banks and credit companies often have sizeable loan portfolios, making it necessary to develop accurate credit scoring models. Slight improvement in credit scoring accuracy can reduce lenders' risk and translate to significant future savings. The release of the Basel Accords has prompted further development into credit scoring models. Machine learning techniques such as support vector machines, neural networks, and logistic regression learning, are widely explored and utilized. This paper establishes a methodology to build hybrid machine learning models, aiming to combine the power of different machine learning algorithms on different types of features and hypothesis. In particular, the methodology is tested for a crediting problem. After a logistic regression-based feature treatment is introduced in the preprocessing of training data, a generic cost-based outlier removal was utilized in the hybrid machine learning model. Together with the combination of three types of machine learning algorithms (support vector machine, decision tree, and logistic regression), the new hybrid models showed improvement in performance compared with benchmark models of SVM, DT, and LR. This new methodology can be further explored with other algorithms and applications.

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

CS

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

4. Is this project a continuation? Yes No

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

Fair Category

PS

Project
Number

6058

Title: Creating and Testing Different Designs of Titanium Dioxide Films in Perovskite Solar Cells in Order to Increase Efficiency

Student Name(s): A. Paliwal

Abstract:

Perovskite solar cells are an upcoming type of solar cell that boast similar efficiencies to current alternatives and use less rare materials. Since perovskites are cheaper alternatives to current solar panels, this project aimed to try to improve their efficiency to compete with them. Perovskites cells are made up of many layers with different functions, one of which is the electron transport layer(ETL). If the effectiveness of this layer is increased so will the efficiency of the cell. The two common ways to make this layer are spin coating(SC) and spray pyrolysis(SP). This experiment aims to compare these two different methods and see which is the better option. In this experiment, three main procedures are used: SC, SP, and cyclic voltammetry(CV). SP and SC were used to make the layers and differ in how the TiO₂ solution was applied onto the cell. Then, CV was used to gauge the effectiveness of the ETL at blocking positive charges. The data found suggested that SP was the better option since it was better at blocking and has better scalability with respect to manufacturing for when the perovskite solar panels are being manufactured en masse. The implications of these results are better decision making abilities of researchers in choosing the right way to make the ETL so they can focus on improving the other sections. This further connects to improving perovskites since they provide the potential for cheaper cells which means more widespread availability and feasibility of renewable energy for the future.

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

ET EE 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

264

Fair Category

PS

Project Number

6059

Title: Scale-up of Water-Splitting Hydrogen Production Using Piezo-Electrochemical Nanostructures and Ambient Processes

Student Name(s): Z. Mester

Abstract:

As society continues to deplete nonrenewable energy sources at an alarming rate, the need for alternate, renewal fuels is pressing. In addition to their limited resource, the use of fossil fuels continues to release CO₂ greenhouse gases into the environment, contributing to global warming. Unfortunately, these alternate energy platforms are not sufficient to power an ever-growing world population. Hydrogen is a widespread, zero-emission energy resource that can be synthesized via the electrolysis of water, however the process is net energy negative. A simple method to convert our plentiful water resources to hydrogen, with little energy inputs, is needed. In this research, a Piezo-electrochemical device (PeD) was designed and constructed using ZnO piezo-microstructures (fabricated easily from eggshell membranes), so that electrolysis of large, standing bodies of water can produce hydrogen gas, without energy inputs, driven solely by traffic-induced vibrations of an “over-the-water” bridge structure. Using the final, iterative design of the PeD, made from 2” ID PVC piping, and originally 3D-designed/printed hydrogen production chambers, a constant 1.32ml H₂ was produced per mm² of ZnO microfiber used within the PeD, immediately after vibrations begin, using a laboratory ultrasonic cleaner to simulate bridge traffic vibrations. In subsequent field-testing on the I-95 Mianus River Bridge, as much as 2.64ml H₂/mm² production was achieved. In a reasonable scale-up, where 2x2cm ZnO microfibers are used within the PeD, as much as 1.1L of H₂ can be produced, continually, at little cost beyond the ~\$15 (PeD) construction fee, providing a green-energy solution whose cost-benefit is unmatched.

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

EN ET 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

250

Fair Category

PS

Project Number

6060

Title: The Effect of Axial Tilt of Hyperboloidal Gears on Mechanical Efficiency

Student Name(s): A. Anuar

Abstract:

Mechanical contraptions utilize gears almost ubiquitously to transmit rotational speed or force. Most complex devices transmit loads between different axes, leading to the use of different types of gears, such as bevel or miter gears, for said transition. One seemingly esoteric type of gear not typically used industrially for this purpose of transition between axes is the hyperboloidal gear. The goal of this research project is to explore and expand on the obscurity of the hyperboloidal gear in addition to making it a feasible alternative to the bevel gear.

A hyperboloidal gear is shaped like its name suggests, with properties that allow it to have straight teeth around a circular body. A greater skew of the teeth from a cylindrical gear results in a greater angle skew of the gear's axis to a new axis. This is the main focus of the research project: A load of 1 kg was applied to 3D printed hyperboloidal gear pairs with different axial skew angles and the input force required to lift said load a distance of 1 meter was measured in order to obtain the efficiency of each gear pair. With this, a relationship between axial skew and gear efficiency could be established, in order to ascertain whether or not the hyperboloidal gear could be a viable alternative to the bevel gear. The research of this project suggests that a greater axial tilt of the hyperboloidal gear pair from a normal 0° to a skew of 90° results in lesser mechanical efficiency.

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

EE MA 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

249

Fair Category

PS

Project Number

6061

Title: Soil Anthropogenic Carbon Dioxide Sequestration Using Biochar

Student Name(s): M. Worthington

Abstract:

Carbon dioxide is a harmful greenhouse gas that causes climate change which creates and extreme weather conditions. Biochar, a common soil fertilizer made by pyrolyzed organic matter, can sequester carbon dioxide in soil to decrease its atmospheric concentrations. This study carried out a 24-hour experiment examining high and low surface area biochars, measuring to be 353 m²g⁻¹ and 228 m²g⁻¹ respectively, and the addition of 4 mL of water on carbon dioxide to determine their effects on biochar's ability to sequester carbon dioxide in soil. Results showed that high and low surface area biochar amendments without water increased atmospheric carbon dioxide concentrations by 198.6% and 360.2% respectively. Carbon was possibly deposited due to the turnover of soil labile carbon from adding biochar to soil. The high and low amendments with water showed significantly higher concentrations of 1260.5% and 1010.5% increases respectively. Water possibly drove carbon dioxide out of the soil's pore space. Tests showed a steady decrease in carbon dioxide concentrations in the last 12 hours of testing, so further research examining these variables over a longer period of time could show that biochar eventually sequesters carbon dioxide instead of depositing it. This study suggests biochar amendment is not an effective material to mitigate carbon dioxide emissions in soil. This research is for the lay consumer looking to decrease their carbon footprint. Also, this research could be shared with various organizations who find efficient ways to sequester carbon dioxide to mitigate the effects of climate change.

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

EA

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

4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

252

Fair Category

PS

Project
Number

6062

Title: The Effect of Crosslinking Agent and Media on Swelling Properties of Bulk Alginate Hydrogels

Student Name(s): C. Erber

Abstract:

In order to advance drug-delivery techniques and tissue engineering, there is a need to characterize the swelling properties of materials used in the field. Alginate, a commonly used hydrogel, was tested with two variables in mind: the media it was in (DMEM, NaCl) and the crosslinker used to create it (CaCl₂, BaCl₂). Samples of the four combinations were created and imaged over the course of 24 hours using a phase-contrast microscope. Sample diameter was measured and used to calculate the percent change between each timepoint. From this data, it was found that swelling properties of alginate bulk hydrogels were impacted by both the media it was in and the crosslinker. Overall, CaCl₂ gel samples had a consistent increase in diameter regardless of the media. CaCl₂ gels placed in NaCl had a higher overall percent change of 29.7% compared to 17.2% in DMEM. BaCl₂ gels exhibited different swelling properties depending on the media. In NaCl, BaCl₂ gels had a constant rise in percent change but had less overall percent change than CaCl₂ gels in NaCl. In DMEM, BaCl₂ gel samples experienced abnormal swelling properties with an initial decrease in diameter until the 60-minute timepoint and then a constant increase from then on. These results indicate the importance of characterizing swelling properties of alginate hydrogels as different media and crosslinkers affect a drug's ability to be released at the targeted area in the body. In the case of tissue engineering, it can affect research done on regeneration of skin and scaffolding.

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

EN ME

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 vertebrate animals controlled substances

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

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

4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

166

Fair Category

PS

Project
Number

6064

Title: Deducing and Neutralizing Clopyralid Concentration in Bagged Compost

Student Name(s): L. Borcharding

Abstract:

The purpose of this study was to find a scientific method of separating Carboxylic Herbicides from compost to provide herbicide free compost for farmers. The objective was to use heat, dispersants, and microbes, in various combinations, to separate and remove Clopyralid (a carboxylic herbicide) from compost. Commercial compost was purchased and laced with varying concentrations of Clopyralid. Bioassays were conducted in order to establish a limiting baseline in which bioassay-plant growth was negatively impacted by the presence of Clopyralid. Once the baseline was established heat, dispersants, and microbes were added in an effort to separate the Clopyralid from the compost. Bioassays were repeated and results analyzed to determine the effectiveness of each neutralizing combination. In a tangential experiment, school-made compost was created and tested for herbicide contamination using the same bioassay techniques. It was concluded that putting compost, mixed with the microbes found in Bokashi, in a dark and humid space for two weeks most efficiently allowed the breakdown of herbicides, creating clean compost.

Technical Disciplines Selected by the Student
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EM EV MI

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

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

4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

252

Fair Category

PS

Project Number

6065

Title: Remediating Pharmaceutical Pollution: Testing the Effectiveness of Boron-Doped Graphene in Adsorbing Aqueous Acetaminophen

Student Name(s): M. Amoruso

Abstract:

Water pollution is a global problem. Pharmaceutical residue in drinking water, such as acetaminophen, have been found to interfere with regular fetal, reproductive, and endocrine development of aquatic organisms such as fish. Graphene and graphene oxide have been tested to desalinate sea water. It is hypothesized that water contaminated with acetaminophen will be purified after filtration using powdered boron-doped graphene. A spectrophotometer was used to measure absorbance to create a calibration curve. The calibration solutions were created using a modified Reckitt Benckiser procedure. Filtration was ultimately employed using 2 ppm solutions of acetaminophen. The solutions were filtered through a filtration apparatus, containing either boron-doped graphene, graphene oxide, graphene, or activated charcoal within a dual layer of glass fiber filters. The resulting concentrations of the solutions were measured using the spectrophotometer. Results suggest that powdered activated charcoal is the most efficient means of removing acetaminophen from water. Testing in several trials demonstrated that activated charcoal exhibited an average 72.6% removal rate. Boron-doped graphene was not as efficient, displaying an average rate of 32.5% removal in several trials. A double mass trial of activated charcoal was tested, and this exhibited a removal rate of 80%. Future work includes testing activated charcoal from different sources and in various forms on acetaminophen solutions, and exploring a combination of boron-doped graphene and activated charcoal, with the goal of creating a consistently efficient filter. This work could lead to additional measures being taken at wastewater treatment plants to target acetaminophen removal using this filter.

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

EM CH EN

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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

267

Fair Category

PS

Project Number

6066

Title: Development of a Superhydrophobic Coating for Vehicular Surfaces to Promote Spontaneous Water Droplet Trampolining, Repulsion, and Reduced Icing Tendencies at Normal Pressures

Student Name(s): C. Rissola

Abstract:

Icing of water disrupts airflow around the tail and wing of aircraft, causing drag. The aircraft's ability to stay air bound, and the pilot's ability to control of the aircraft are threatened under these conditions. Icing is similarly problematic for ground transportation, hindering a driver's view, or vehicular function. Current efforts to de-ice in sub-freezing temperature, especially on aircrafts, remains costly and time consuming. As such, the need to repel water droplets and reduce icing tendencies on contact surfaces is important. In this research, a superhydrophobic (SH) coating was developed for both clear-window and hard-surfaces, that repels water, lowers the freezing-point of surface-contacted water, and subsequently lengthens the time taken for freezing, at pressures of flight and sea level. Made from Capstone ST-100 and SWCNTs (5:1m/m) in acetic acid, the SH-coating was spray-deposited on structural, aluminum surfaces at a concentration of 120 μ g/cm². Water trampolining was evident at 1atm & 0.3atm, with 30% transmission through the coating. Window models were SH-coated at 40 μ g/cm², producing water trampolining with only 7% reduction in clarity. Both SH-coating models were robust, with minimal wear in 24-hours of simulated rainfall. The SH coating lowered the freezing point of water on windows by 16oC, and 15oC for aluminum. Thermal image analysis of the super-cooling of surface contact water (15 μ l droplet) on SH-aluminum highlights a 192% increase in "time to freeze" for water, from 3min (untreated) to 5min:46secs. Similarly, for SH-plastic, a 570% increase in "time to freeze" is realized, from 2min:31sec (untreated) to 14min:22sec.

**Technical Disciplines Selected by the Student
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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

248

Fair Category

PS

Project Number

6067

Title: Developing Sustainable Black Hydrogels for Efficient Solar-Thermal Desalination

Student Name(s): D. Lee

Abstract:

Water scarcity is one of the foremost challenges of the 21st century. A promising sustainable method to address this issue is solar-thermal desalination (STD). Solar-thermal desalination channels solar heat to distill saltwater, but its conversion efficiency is restricted due to the thermodynamic limit of the heat of vaporization. Addressing this problem is crucial to the commercial viability of STD. To tackle this problem, an advanced black polymeric material was synthesized to place over large bodies of saltwater so that these bodies of water will evaporate with higher efficiency during solar desalination. This material, referred to as a hydrogel, was synthesized using chitosan, polyvinyl acetate, and polypyrrolidone. The energy consumption per mass of released vapor of the water with the hydrogel on top was calculated and compared to bulk water. The water with the hydrogel placed on top indeed showed lower energy consumption per mass of released vapor compared to bulk water. Also, when observed under an infrared camera, the surface of the water, which absorbs heat during STD, the hydrogel shows less parasitic heat losses that also limit the efficiency of STD due to the hydrogel's insulating properties. This hydrogel has the potential to dramatically improve the efficiency of STD when placed over water. Because STD is a much more sustainable way to desalinate water compared to current methods, the improvement of its efficiency through the enhanced harnessing of solar heat and resulting commercial viability is a very promising approach to address the global water crisis.

Technical Disciplines Selected by the Student
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CH EN EV

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4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

233

Fair Category

PS

Project
Number

6068

Title: Development of a Novel Neural Network Architecture for Improved Multiclass Classification

Student Name(s): J. Meindl

Abstract:

Neural networks are a popular tool for multiclass classification due to their ability to find non-linear and complex relationships between features within data. However, when used for multiclass classification, some classes are predicted incorrectly by models more often than others. Additionally, these incorrect predictions often trend towards specific misclassifications, as some classes appear similar to each other. For example, with handwritten digit recognition, the digits 5 and 6 are often misclassified in place of each other. In this research, a novel neural network architecture was designed to alleviate commonly misclassified or swapped classes. In the model, output nodes are grouped together, allowing for direct comparison of a pair of commonly misclassified digits. These groups are created by splits within the hidden layers, forming multiple networks within the overall framework. The output pairs from all of the groups in the model are then combined to form the output layer. Additionally, to compare many different pairs of classes, each classification appears multiple times within the output layer. This novel model was tested on the MNIST dataset, a popular dataset containing labeled handwritten digits. In comparison with a dense neural network of similar size and efficiency, our proposed architecture outperformed the traditional network in terms of classification accuracy. Therefore, this model has the potential to improve upon past neural network implementations with potentially far reaching consequences in applications ranging from optical recognition to medical diagnosis.

**Technical Disciplines Selected by the Student
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CS MA AT

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4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

249

Fair Category

PS

Project Number

6069

Title: Analysis of Heat Shock Protein Cross Protection for Nitrifying Bacteria in Adverse Conditions

Student Name(s): J. Newman

Abstract:

Acid rain puts the nitrogen cycle at risk by killing the nitrifying bacteria and making it unable to metabolize the toxic compounds. This results in a buildup of ammonia from decaying material, which makes soil not viable for vegetation to develop. A way of currently solving this problem is the process of transporting viable soil into an area of unhealthy soil. However, the newly transplanted bacteria can die from the acid rain. A natural protein found in all living organisms called Heat Shock Proteins (HSPs), are released when stress is induced upon an organism, and as a result, the protein helps the organism reach homeostasis. A natural phenomenon of HSPs, is that the organism becomes resistant to other adverse conditions. This experiment consists of growing a culture of nitrifying bacteria, making two concentrated samples, heat shocking one of the samples with a water bath, and using a LaMotte Smart 2 Colorimeter to measure the concentration of the ammonia, nitrite, and nitrate for the two different groups. Electrophoresis is used to prove the HSPs are present. The current baseline of data conducted does not show the HSP bacteria to be as effective, however data in the temperature suggests possible reasons for this anomaly. Thus, the experiment needs to be reconducted with a higher priority of making sure the temperature is stable and consistent. The application of this protocol for nitrifying bacteria can allow for only a single transplant needed, preventing ecosystems from being hurt, and making it more cost effective.

**Technical Disciplines Selected by the Student
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MI EV CB

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

241

Fair Category

PS

Project
Number

6070

Title: Improving Wind Turbine Efficiency by Maximizing Surface Area and Decreasing Attack Angle

Student Name(s): M. Chandy

Abstract:

The amount of energy generated by a wind turbine is largely dependent on the volume and velocity of wind as well as the angle of attack. The purpose of this investigation was to determine the best design to maximize the volume and velocity of wind gathered (dependent on the surface area available to collect wind) while keeping the angle of the wind perpendicular to the rotor. One design that was anticipated to be effective in this manner was the use of a funnel placed in front of a wind turbine rotor, which was hypothesized to decrease the attack angle by curving the wind inward. To analyze the effect of a funnel on the flow of wind, computational fluid dynamics (CFD) simulations were conducted to evaluate several potential designs, including a funnel in the shape of a frustum cone, a curved trumpet-like funnel, and others. The control group was the pure movement of a cylinder of air. The use of the frustum cone proved to generally increase the velocity of the air although the perpendicularity of the wind flow appeared to be compromised. The trumpet-like funnel appeared to yield about the same velocity as the frustum cone while having a more favorable incident angle to the wind turbine rotor. This could provide potentially useful information in the future design of wind turbine systems, although the feasibility of placing a funnel in front of a wind turbine remains to be investigated.

**Technical Disciplines Selected by the Student
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ET EE

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4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

259

Fair Category

PS

Project Number

6071

Title: Cooling and Acoustic Performance of Contra-Rotating Fan Configurations

Student Name(s): A. Bryant

Abstract:

Active cooling of heat sinks using fans is common for high-performance computers in order to operate at cooler temperatures, therefore it is essential to research alternative fan

configurations in order to extract the maximum possible performance from a system. Contra-rotating fans are commonplace in aviation, and promise to offer more performance, however this fan configuration is seldom used within the computing environment. In order to measure and compare the cooling performance and acoustic performance of contra-rotating configurations to standard fan configurations, a test computer was assembled and the central processing unit (CPU) temperature was logged once every two seconds for five minutes. The results showed that out of the two contra-rotating fan configurations tested, configuration 2 had the greatest performance outperforming series fan configuration 1, and contra-rotating fan configuration 1 had the least performance. The acoustic measurements showed that both contra-rotating configurations had higher noise levels than any of the other tested fan configurations. These results supported the hypothesis. The results were most likely found because as the wake of the first contra-rotating fan enters the second fan it creates turbulence leading to greater perceived noise, and this phenomenon can explain why contra-rotating fan configuration 1 experienced such poor performance. The difference between the clockwise and counterclockwise designs caused the downstream wake from the clockwise fan to interact poorly with the slightly different counterclockwise fan. Because of the properties of contra-rotating fans, they are ideal for the server environment where noise is not a concern and cooling performance takes priority.

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

EE CS

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4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

264

Fair Category

PS

Project Number

6072

Title: Creation of a CO₂-free Energy via a Solar-Powered Cu₂O Nanowire Microbial -Algae Photosynthetic Bioreactor

Student Name(s): M. Minichetti

Abstract:

Global Warming remains at the forefront, as the continued burning of fossil fuels persist in releasing carbon dioxide into the atmosphere. A scalable, renewable energy resource, that lessens our dependence on fossil fuels, while having minimal impact on our environment, is needed. Microbial fuel cells have received much attention as a means to create energy from bacteria decomposition of wastewater, however the process produces CO₂. Conversely, fuel cells based on algae photosynthesis require CO₂-inputs to increase the technology's efficacy. In this research, a proposed algae-microbial hybrid energy cell (AMHEC) was developed, that combines the energy productions of algae photosynthesis and microbial decomposition, in a self-CO₂-scrubbing AMHEC that employs a fabricated, increased surface area Cu₂O nanowire cathode. In use, CO₂ that is produced by anodic wastewater degradation is actively recycled into the cathode chamber, for reuse during algae photosynthesis. Recycled-AMHEC performance increased by ~133% relative to a closed-chamber system, from (5-day) sustained output of 0.15V (closed) to 0.35V. Versus literature attempts at wastewater-algae hybrid cells, the increased energy efficiency of the self-CO₂-scrubbing AMHEC is clear; polarization response is 50% higher, and the maximum power achieved (202μW) is 55% higher than previously reported data (130μW). Increased performance is directly attributed to algae longevity within the recycled system. For the closed system, 83% algae loss in 5days results in 74% output loss; for the recycled system, only 50% loss in viable algae results in 49% reduction in performance. When compared to power densities of typical microbial cells (26mW/m²), the self-CO₂-scrubbing AMHEC produces 78mW/m².

**Technical Disciplines Selected by the Student
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ET EN EM

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

4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

246

Fair Category

PS

Project Number

6073

Title: From Manhattan Project to Biases in Fourier Coefficients in Families of Elliptic Curves

Student Name(s): M. Wu

Abstract:

Given the inability to theoretically describe the energy levels of atoms more complicated than hydrogen, due to the complexities of the mathematics, physicists developed statistical approaches. Based on extensive numerical data, Wigner conjectured that Random Matrix Theory (RMT) models heavy nuclei; their very complexity makes them amenable to statistical modeling. RMT successfully describes numerous phenomena, from energy levels of heavy nuclei to spacings between zeros of the Riemann Zeta Function (which govern the properties of the prime numbers, the basic building blocks of numbers). There is a remarkable agreement with the main term predicted by RMT, but lower-order terms, governing rates of convergence, are largely unknown and beyond standard RMT models. I explore these in an important generalization, elliptic curves. These are given by $y^2 = x^3 + ax + b$. The set of rational solutions form a group with finite rank; the distribution of the rank remains mysterious, and has applications in elliptic curve cryptography. Miller proposed there is a bias in the second moments of the Fourier coefficients of the elliptic curve L-functions (the generalization of the zeta function); this has applications in understanding ranks, notably a Clay Millennium Prize Problem (the Birch and Swinnerton-Dyer Conjecture). I confirmed this conjecture in several new families (including the first ever two-parameter families $y^2 = x^3 + A(T,S)x + B(T,S)$ with A, B polynomials with integer coefficients), and showed that a stronger version of the conjecture is almost surely false.

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

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

222

Fair Category

PS

Project
Number

6074

Title: Lignocellulosic Manuscript Models Restoration Using Neutralization Reactions

Student Name(s): C. Meyer

Abstract:

Historical records serve as crucial sources of information for historians. These documents naturally deteriorate over time due to interactions with the environment that gradually decrease pH. The increased acidity of the documents, in turn, causes the degradation of the paper. This process is expedited by the presence of iron-gall ink, widely used in European writing between the 4th and 20th centuries, due to the ink's acidity. To preserve these items of cultural heritage and historical relevance for future generations, the degradation of historical documents must be countered through chemical means. This can be achieved via the conservation process of deacidification, which decreases the acidity of records, and as a result slows degradation. Calcium propanoate, calcium carbonate, and magnesium oxide have been previously tested as deacidification agents and determined to be successful at elevating pH; however, each substance has been tested under different conditions. To determine which substance is the most effective, conditions such as paper preparation and ink formulation must be equalized in order to determine relative success. Groundwood paper with iron-gall ink was designed to simulate historical records. Before and after the application of a deacidification agent, measurements of pH were taken using a pH meter. The deacidification agent that, on average, increases the pH of the paper most significantly is most applicable to future historical record preservation study.

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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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

6075

Title: Corrosion on Transportation Infrastructure and Vehicles by Popular Deicing Chemicals

Student Name(s): A. Sadlowski

Abstract:

Deicers keep roads safe for travel during inclement weather by minimizing the formation of ice. However, deicers also significantly damage both transportation infrastructure and vehicles. Some formulations of ice melt are more corrosive than others due to acidity and molecular structure. The goal of this project is to determine which ones would be better to use to minimize damage and to determine if temperature has any effect on the rate of corrosion. The deicers tested were Safe Paw (predominantly urea), CaCl_2 , MgCl_2 , NaCl , Beet Juice, and Ice Slicer (combo product), with a water control. Steel metal sheets were cleaned and cut into eight 4" X 6" pieces. Brine samples of each deicer were prepared as recommended, using a melt water assumption. The samples were dipped in the brines for varying amounts of time in an 18°C environment, from 5 minutes, to 5 hours, simulating various drive times. They were stored in different temperatures. The corrosion was assessed after 10 days using an average color determining algorithm, with the inverse of the blue in the average RGB indicating corrosion levels. The corrosion results in decreasing order were, CaCl_2 , NaCl , Ice Slicer, Beet juice, MgCl_2 , Water, and then Safe Paw. It was found that the acidic salts were more corrosive than the more basic beet juice and Safe Paw, likely due to increased cathode reaction. Warmer temperatures allowed the hygroscopic deicers to collect moisture, causing more corrosion.

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

ET CH 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

244

Fair Category

PS

Project Number

6076

Title: Analyzing the Effects of Airflow on an Electrohydrodynamic Thrust Apparatus

Student Name(s): J. Trahanas

Abstract:

Most modern forms of propulsion utilize the combustion of fossil fuels to move turbines or propeller blades around an axis and create thrust. Although they have been refined to serve a variety of purposes, propulsion methods with moving parts pose two significant problems: a loss in efficiency due to heat and friction, and the generation of sound. This is where electrohydrodynamic (EHD) thrust, also referred to as “electric wind,” can be applied. Electric wind is a phenomenon that occurs when a pair of asymmetrical electrodes is placed under large voltage differences. The smaller of the two electrodes, also known as the emitter, creates a corona: a cloud of ionized air surrounding the electrode. The larger of the two electrodes is either powered with voltage of an opposing polarity, or linked to ground. This causes a flow of ions across the interelectrode gap that collide with neutral air atoms and cause a net movement of air. The goal of this research was to determine the effect of airflow of varying speeds over the electrohydrodynamic thrust apparatus in order to optimize flight. The results suggested that air speeds between 0 and 1-1.5 m/s were most optimal for producing thrust, while any airspeeds beyond that could be severely detrimental to flight. In addition, the shortest interelectrode gap (3 centimeters) was the most effective at high speeds, highlighted by a 44% increase in generated air current even when exposed to 3.7 m/s of initial air current.

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

221

Fair Category

PS

Project Number

6078

Title: Automated Collection of Aquatic Surface Level Polyethylene (PET)

Student Name(s): K. Weng

Abstract:

With the growing plastic epidemic, about 22 million pounds of plastic is entering the Great Lakes and about 12.7 million tons of plastic is entering our oceans every year. While clean up is happening, collection is slow. This is due to only passive methods of collection being implemented, like nets and “bins” in the water, this is not only manually exhausting and inefficient, but time consuming as well. In order to clean up past build ups effectively, this is an automated way for surface level plastic collection. That way, the robot will autonomously travel to the plastic instead of depending on plastics to travel to it. The robot has a mounted net and uses propellers to travel in the water, collecting pieces of plastic of surface level plastics through the use of a joystick powered by Arduino. For the sake of time and money, the robot is only a 3D prototype of the larger scale robot that would be put into the oceans. The robot is printed in PLA, which is a form of recyclable plastic. The electronic components are in a sealed, watertight box to ensure that they don't short circuited if water splashes onto it. If used in conjunction with passive methods of collection, this robot could bring us one step closer to complete plastic removal of our waterways.

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

EE CS

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 vertebrate animals controlled substances

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

4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

237

Fair Category

PS

Project Number

6080

Title: Designing a Ground Collision Avoidance System to Inhibit Controlled Flight Into Terrain Accidents For Single Engine Aircraft

Student Name(s): M. Beaudette

Abstract:

Controlled flight into terrain (CFIT) is an accident in which an airworthy aircraft, under pilot control, is unintentionally flown into the ground, a mountain, or an obstacle. CFIT accidents were identified as a cause of 25% of USAF accidents. The main goal of this project is to design a ground collision avoidance system (GCAS) that will identify CFIT accidents before they occur. Many articles regarding CFIT and GCAS systems highlighted that these did not appear in small aircraft. The GCAS software was flashed onto an Arduino. To identify a CFIT accident is impending the code uses Airspeed (knots), altitude, and pitch. These values were supplied by the accelerometer, to determine airspeed, the barometer/GPS to determine altitude, and the gyroscope, to determine pitch. The data produced was fed into an algorithm that calculated the time before collision with the ground. If the time exceeded a threshold, the code sounded an alarm. In addition, the code used map data to determine the highest points. From that the code took a radius of highest points and compared it to the aircraft's altitude. If the code identified that the aircraft's altitude conflicted with a high point, the pilot was told to increase altitude. As proof of concept, the system was placed into an enclosure that can fit in a cockpit. The outcome is to provide a small, affordable system that will decrease CFIT accidents and can be retrofitted by pilots.

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

CS EE 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

107

Fair Category

PS

Project Number

6081

Title: Do Your Nostrils Taste

Student Name(s): D. Manick-Highsmith

Abstract:

The purpose of this project is to explore the connection between the senses of smell and taste. We started with giving subjects taffy and asking if they can identify the flavor of taffy created and if they can tell the difference between different flavors. We found that it was hard for them to taste the flavors given to them. So moving forward we are planning on using different flavors. We are going to have the subjects smell a concoction of fragrances and eat taffy to investigate the connection of the senses; taste and smell, and ask if they taste what they are smelling or taste the taffy.

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

BI

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

- human subjects potentially hazardous biological agents
 vertebrate animals controlled substances

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

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

4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

114

Fair Category

PS

Project
Number

6082

Title: Prosthetic Arm Design

Student Name(s): T. Adebowale

Abstract:

The purpose of this project was to design and create a prosthetic hand made of recycled materials to better meet the needs of patients that would use this device. This arm is environmentally friendly and unique in its makeup and functionality. This hand better resembles an actual hand, making it easier to use. The weight and size, determined by the aluminums and plastics used, provide maximum comfort for the patient, giving a more natural feel. The next step of this project is to make the arm fully functional by adding electrical attachments that will be implemented. These attachments would give the arm full functionality, easily allowing the patient to move the fingers and wrist.

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

EN AT ME

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 vertebrate animals controlled substances

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

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

4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

231

Fair Category

PS

Project Number

6083

Title: Robotic Pancreatoduodenectomy (PD) versus Open PD in the Current Era: A Meta-Analysis of Literature and Development of an Algorithm for Optimal Surgical Approach based on Desired Post and Perioperative Outcomes

Student Name(s): E. Zhang

Abstract:

Pancreatic cancer remains a challenging disease to manage due to the complex biological behavior of the neoplasm. Pancreaticoduodenectomy (PD), among the most challenging and complex gastrointestinal surgeries performed, is designed for the treatment of pancreatic head malignancies. With the introduction of robotic technology, the ability to resect complex cancers has been refined to allow the introduction of minimally invasive methods. The recent enthusiasm of RPD has prompted a multitude of reports to assess the efficacy and feasibility of this novel technique. However, they are largely single-institutional, without evidence of randomized control trials, or obsolete; the differences between the two approaches have not been fully compared and considered with an adequate sample size in the modern era.

Multiple medical databases (PubMed, Medline, and Google Scholar) were queried to identify studies comparing the outcomes of RAPD and OPD. Twenty non-randomized controlled trials involving over 14,000 patients passed the selection criteria. RAPD had longer operative time, but less blood loss, less wound infection, a lower blood transfusion rate, and shorter hospitalization. This meta-analysis was able to confirm equivalency or improvements in certain oncologic outcomes using RPD when compared with OPD. The conclusion was in the form of an algorithm that matched desired/optimal patient outcome to method of operation. Furthermore, data provided by the present study will provide evidence for clinical practice and is expected to improve perioperative and postoperative outcomes.

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

CS 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

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

6084

Title: RandGAN: Testing the Limits of Small Neural Networks

Student Name(s): A. Pourkavoos

Abstract:

This project investigates the power of small recurrent neural network (RNN) models to generate and predict pseudorandom bits by using generative adversarial networks (GANs). Three RNN models were implemented in Pytorch: the simple recurrent network (SRN), gated recurrent unit (GRU), and long short term memory (LSTM). For 64 iterations, the RNN inputs a bit and its previous internal state, and it outputs a bit and a modified internal state, eventually producing a string of 64 bits. Each GAN consisted of two RNNs: a generator and a predictor. The generator produced a string of bits iteratively, and the predictor took the generator's previous bit outputs as input. The predictor was trained to anticipate the generator's next output at every iteration, and the generator was trained to prevent the predictor from doing so. The generator was thus incentivized to create an unpredictable (random) string. Within each of the nine combinations of models, both networks stored their internal states in either three or four neurons, and each GAN was trained three times, for a total of 54 training sessions. The generator outputs were analyzed for repeating patterns, and three sequences were found with apparent aperiodicity. Additionally, some generators repeated sequences with a nested pattern, a notable example being the first 13 bits of the Fibonacci word, implying that the network which produced it had learned to count to 13 in a Fibonacci base system. Further research would involve analyzing the evolution of the networks' internal states over time from a dynamical systems perspective.

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

CS MA 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

194

Fair Category

PS

Project Number

6085

Title: Electrical Ondes Martenot

Student Name(s): M. Cox

Abstract:

The electric Ondes Martenot is a unique instrument, loosely based on the French instrument, the Ondes Martenot. The circuit that generates the sound purely consists of discrete components rather than ICs for deeper understanding of resistors, capacitors, and transistors. The project revolves around the multivibrator circuit where an electrical current oscillates at a specific frequency dependent on the resistance and capacitance values of specific components in the circuit. In order to change the pitch produced by the multivibrator, the user moves a string, that is wrapped around a potentiometer and another pulley, with a ring. When the string moves, the potentiometer changes resistance and ultimately the pitch. The lower the resistance in the potentiometer, the higher the pitch, and vice versa. However, the sound produced solely by the multivibrator is too pure. To add a sense of harmony, another capacitor is put in secession of one of the capacitors in the multivibrator circuit. Capacitors, in series, diminish in capacitance. Since capacitors in the circuit also affect the frequency, there is a pitch difference between the first capacitor and the second. Then, a separate multivibrator oscillates between the two pitches to create a fuller sound.

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

EE CS

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

4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

249

Fair Category

PS

Project Number

6086

Title: Development of Artificial Neural Networks That Can Process Acoustic Features in Order to Identify Toxic Speech Expressed Through Text

Student Name(s): M. Razanau

Abstract:

The Internet has provided many benefits to society as it facilitates sharing of information, but also gives people with malicious intent a tool to spread hateful speech. Due to one's anonymity online, people are able to post verbal attacks without concern of being identified or punished. By using autonomous systems to identify this offensive speech, platforms can better monitor shared content. In this research, a text classification system has been developed, using machine learning combined with affective computing to detect the underlying emotion in text and identify toxic speech. A three-part classification system was developed for this purpose. The first layer uses an emotion classifier that can identify the emotion within a sound file. A training dataset of 120 samples was used, using 24 features extracted from each sound file including pitch, syllables, and acoustic landmarks. Upon training, the emotion classifier had an overall 90% accuracy. Using the transcript of the sound file, this classifier helped create a dataset used to train the second and third classification layers, with the first able to identify aggression within text and the second able to provide a toxicity score. The second text classifier was trained using 40,092 samples consisting of aggressive and neutral text. Aggressive phrases were concatenated with a keyword and run through the third classifier. The third text classifier was trained using 159,571 samples, achieving a 93% ROC accuracy. These results show the promising potential of text classification and affective computing systems to more accurately identify toxic speech online.

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

CS 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

252

Fair Category

PS

Project Number

6087

Title: The Power Saver

Student Name(s): A. Bhamidipati

Abstract:

Do you know that many devices draw power from your outlets even when they're not in active use? This is called Phantom power, on an average \$100/year per household is lost due to this power drain. The key design idea was to control the electricity flow programmatically by sensing the active draw and use of electromagnetic relay switches. I started with designing a logic schematic to approach various inputs to achieve the desired output. Using the schematic, I determined that I needed relays(electromagnetic programmable switches), and a Current Sensor chip(INA_219). I connected the outlet to relay, the relay to the INA_219, INA_219 to the microcontroller which then goes to any device plugged in. A python program monitors and controls the electricity flow. The first time I tested the device with the program, the current sensor burnt out as the shunt resistor was not rated to handle the 120v current. I then bought a different current sensor known as the ACS_712, this chip only outputs an analog signal. To convert this into a digital signal I purchased an ADS1115. Now to sense when the device is plugged into the outlet, a motion sensor was connected. I used a phone charger to test my device, and took data on the current consumption when plugged in while not charging and while charging, over the course of 5 minutes. The device successfully turned the relay switch on during an active use and turned it off when not in use.

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

AT EE CS

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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

227

Fair Category

PS

Project Number

6088

Title: Developing and Testing a 3D Printed Structure for Use as a Sea Ice Substitute

Student Name(s): P. London

Abstract:

The Arctic is melting fast. With sea ice declining at a rate of 12.85 percent per decade, it is projected to be nearly gone by 2035. The rapid loss of sea ice has become a growing problem for marine mammals and ecosystems of the Arctic and surrounding regions. The goal of this project was to create a baseline 3D printed structure (the “print”) that can serve as a localized, small-scale sea ice substitute. The optimal design for the print was created using information collected from research articles and tested with multiple procedures. A comprehensive buoyancy test was performed using different scaled prints to determine the relationship between print size and weight capacity. Strength tests using an MTS uniaxial load frame were performed to determine structural integrity in simulated conditions and a puncture test was performed to determine how the print reacts when compromised in water. Once the data was compiled, known values of real conditions such as salinity, water density and temperature of arctic water were used to mathematically extrapolate results to fit real world conditions. By doing this, these experiments serve as an accurate predictor of the 3D printed structures success in the real world. Implications of this project include using the printed platforms in targeted locations with at-risk marine mammal populations, which has the potential to inhibit population decline and possibly facilitate growth.

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

EN EM

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

177

Fair Category

PS

Project Number

6089

Title: The effect of different prosthetic materials on animal rehabilitation

Student Name(s): A. Rios

Abstract:

A prosthetic is an artificial device used for missing limbs and parts of the body. Prosthetics can be made of plastics, wood, metals and rubber. The need for animal rehabilitation has increased within the last few years especially due to wildfires and natural disasters. While prosthetics can be made of many materials, it's important to ensure they are eco-friendly and effective. Animals can lose limbs due to other wildlife, trauma, disease, or a congenital disorder. Understanding the importance of finding the right material for animal prosthetics can save many lives and further the exploration of the animal science field. It's also important to find a cost effective material for the prosthetics to widen the availability for all animals in need. If wild animals aren't given the opportunity to have a prosthetic they will be defenseless and in pain. Supplying these rehabilitation methods will provide all animals with a second chance at life. A good material for prosthetics would be lightweight metals that include titanium and aluminum. Both can be recycled into new materials or be reused.

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

AS EN ME

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

4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

247

Fair Category

PS

Project Number

6090

Title: How Different Substructures React to Soil Liquefaction

Student Name(s): J. Shanks

Abstract:

My project analyzed how different foundation designs reacted to soil liquefaction during an earthquake. To do this I constructed a shaking table to replicate the shaking conditions of an earthquake. A clear box was placed on the shaking table to demonstrate the top horizontal layers of the earth's crust. Placed within the box was a 1 cm layer of rocks and a 4 cm layer of dried dirt. I tested three common foundation designs and a control building with no foundation. Foundation one consisted of a raft foundation, which is a large flat foundation. Foundation two consisted of a friction pile foundation that has large piles that are driven into the ground but not to the layer of rock. The last foundation tested was an end bearing pile foundation that goes all the way to the layer of rock. To construct these foundations I 3D printed a model building with a 50 gram weight in it and the 3 model foundations. These foundations were tested in three soil conditions: dry soil, soil with 1 part water 14 parts dirt, and soil with 2 parts water 14 parts dirt. In each foundation test the table was shaking for ten seconds. In each test the displacement of the foundation was measured for depth, distance and direction. From these tests I concluded that the end bearing foundation worked the best overall but would be the most expensive to build and in extremely wet soil the raft foundation worked the best.

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

EN

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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

260

Fair Category

PS

Project Number

6091

Title: Incorporation of TiO₂-Ag Nanostructures into LDPE Bags, to Create an Antifungal Plastic Wrap to Reduce Food Waste

Student Name(s): A. Mark

Abstract:

Increased awareness in personal health have influenced consumers towards cleaner eating habits, and intake of freshly prepared foods. Decreased intake of processed foods has led to increased food waste, as non-preservative, natural foods typically have shorter shelf lives. In light of this unwanted trend, scientists are left to formulate new ways of maintaining shelf life, beyond GMO preservative additives. Most recent investigations point to the use of silver nanoparticle (AgNP)-infused wax coatings to maintain produce, which others have infused plastics with organic compounds, to create active packaging. In this research, low-density polyethylene food wrap (LDPE) was spray-coated with 25µg/cm² AgNP-TiO₂ (ATP), followed by brief-150 °C heating, to uniquely secure the nanocomposite mixture into the polymer. Measure of fungal growth on fresh, non-preservative bread, covered with the ATP-LDPE wrap, highlights

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

CH EN MI

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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

170

Fair Category

PS

Project
Number

6092

Title: A rapid and sensitive method for the determination of sulfonamides in water samples: combination of monolith based extraction with liquid chromatography-mass spectrometry analysis

Student Name(s): Y. Zhang

Abstract:

The occurrence of veterinary pharmaceutical compounds in surface waters is an important emerging environmental issue, so sensitive and selective measuring of these compounds in complicated real samples attracts more and more attention worldwide. A polymer monolith containing methacrylic acid (MAA) and ethylene dimethacrylate (EDMA) was prepared on the vial insert and applied in the qualitative and quantitative analysis of sulfonamides. Based on the ion-exchange interactions between the carboxyl groups in the monoliths and the amino groups in analytes, sulfonamides were effectively extracted by the monolith coated vial insert. To achieve satisfactory analysis, major factors that affect extraction efficiency were investigated, including the pH value and salt concentration content. Lastly, determination of sulfonamides in water samples was conducted by the combination of monolith based extraction with liquid chromatography-mass spectrometry analysis. Results show that the limits of quantification for the five sulfonamides were 0.7-9.4 ng/mL. The developed method was applied for simultaneous detection of five sulfonamides in environmental water samples, with satisfactory recovery (89.4%–125%) and reproducibility (RSDs < 11%).

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

AT CH BI

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

4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

254

Fair Category

PS

Project Number

6093

Title: Biomimicry of Woodpecker Anatomy to Improve Helmet Design in Prevention of Chronic Traumatic Encephalopathy

Student Name(s): J. Oei, . Oei

Abstract:

Chronic traumatic encephalopathy (CTE) is an incurable neurodegenerative disease affecting people who have had repetitive concussive events. In a 2017 study, 99% of former NFL players observed had CTE. Over 3.8 million concussions are recorded per year in the United States, with 2.5 million of them being student athletes.

A woodpecker has the ability to withstand the force of approximately 1,000 g's when pecking wood without substantial brain damage. A woodpecker does so 20 times per second, 12000 times per day. In comparison, a football player experiences a typical concussion at 95 g's.

The tri-layer padding system designed was inspired by the woodpecker's unique anatomy. This included a combination of sorbothane, a shock absorbing material that converts energy to heat, to mimic the ability of a woodpecker's brain to convert energy to heat; Neoprene to mimic the spongy layer of the woodpecker's skull; and viscoelastic memory foam, which will keep the helmet close to the skull, to mimic the small space between the woodpecker's brain and the spongy layer.

The average percent energy dissipated by the tri-layer protective system is 70%, compared to an average of 16% by the padding currently used. Thereby, a hit of 95 g's (3,040 lbf-ft) will be reduced to 28 g's (900 lbf-ft). This is below the average hit from football helmets of 40 g's.

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

EN AT EE

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 vertebrate animals controlled substances

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

6094

Title: Designing an Application to Increase Students' Understanding of Mathematics

Student Name(s): P. Scully

Abstract:

There are a large number of students who do not learn math well from traditional methods, largely due to lack of engagement or instant feedback. Many apps have been created to help them, but they often struggle to effectively combine engagement and teaching. To better aid these students, an educational android application based on the 24 game, where players use four numbers and arithmetic operations to reach 24, was created. This solution was created using Android Studio by the student with guidance from the mentor. The initial focus was on creating the basic game, which had instructions and the ability to play 24 on different difficulties, with easy mode having only addition and subtraction, normal mode having the arithmetic operations, and hard mode having exponents too. Afterwards, an algorithm to always generate numbers that combine to 24 was added. While trials with human participants were not conducted yet, predicted results include that the app improved students' understanding of arithmetic and engaged students. These students would be in upper elementary school, and these results would be indicated by improvements in scores from pretest to posttest and positive feedback on the survey. This application can help students who struggle with mathematics by engaging them and helping them to hone their math skills. With this help, these students will be able to do better in school and develop a greater appreciation for the world of mathematics. This application may also provide the opportunity for more successful students to also hone their skills.

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

CS MA BE

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

6095

Title: Index Of Refraction- Calculate the sugar content of a liquid by measuring the index of refraction using a laser pointer.

Student Name(s): S. Ahmed

Abstract:

The physics of refraction is used to measure the sugar content of a liquid solution using a laser pointer and a hollow prism. The amount of refraction, or how much a light wave bends when it travels from one medium to another, is related to the indices of refraction by a mathematical formula called Snell's Law. Snell's Law uses the angle of a light ray entering a material, called the angle of incidence, θ_1 , and the indices of refraction of the two materials (air and water, in this case) to calculate how much the light ray will refract as it passes from one material into the other. "How much the light refracts" is expressed mathematically as an angle called the angle of refraction, θ_2 . Both angles of incidence and the angle of refraction are measured from a line perpendicular to the surface the light interacts with called the surface normal. The experiment is done first with an empty prism, then it is filled with water. The same process is repeated and all points (light entering, refracted beam, laser beam on the paper and the distances between each point) are recorded in the data table. The experiment is repeated for four standard sugar solutions as a method of comparison (0%, 5%, 10%, and 15%). Finally, the sugar content of an unknown juice is estimated by finding the angle of minimum deviation and the index of refraction using Snell's law and then comparing it to the known sugar solution's indices of refraction.

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

PH 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

229

Fair Category

PS

Project Number

6096

Title: Predicting Core Temperature based on Exercise Intensity and Subjective Variables while in the Heat

Student Name(s): T. Jefferson

Abstract:

INTRODUCTION

Since 2008, exertional heat illnesses (EHIs) among US military members have increased by 60% (Hasemyer, 2019). Heat acclimatization is one strategy to reduce EHIs (Mincy, 2019). Core temperature monitoring is essential for appropriate acclimatization and safety, yet proper monitoring can be costly and inconvenient. Therefore, the purpose of my project is to determine if various perceptual measures predict core temperature while exercising in the heat.

METHODS

Twenty-eight athletes completed 5 visits (60 min of treadmill activity per visit; core temperature 38.5 - 39.9 deg C) in a heat chamber (40 deg C, 50% humidity). Core temperature, perceptual measures (Rating of Perceived Exertion, Fatigue, Thermal, Thirst) were recorded and exercise intensity were analysed using step-wise linear regression (SPSS v 25.0).

RESULTS

R2 values (alpha=0.05) were as follows: Day 1 (exercise intensity 2.4%; Fatigue 6.1%; others 0.7%); Day 2 (exercise intensity 2.7%; thermal 7.6%; others 3.2%); Day 3 (exercise intensity 6.0%; thermal 5.4%; others 1.7%); Day 4 (exercise intensity 5.1%; thermal 5.5%; others 0.6%); Day 5 (exercise intensity 8.1%; thermal 13.8%; others 0.4%).

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

ME

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- Yes No

CSEF Official Abstract and Certification

Word Count

229

Fair Category

PS

Project Number

6097

Title: Enhanced Sensing of Propylene Glycol Vapor for E-Cigarette Detection

Student Name(s): J. Gerlach

Abstract:

Between 2017 and 2018 the percentage of high school aged children who reported e-cigarette use in the past 30 days increased by 75%, according to the National Youth Tobacco Survey. Because the use of e-cigarettes, commonly referred to as “vaping,” is so prevalent among youth, schools and other institutions need to be able to detect and stop e-cigarette usage as it happens. Current e-cigarette detectors on the market tend to be expensive and inaccurate. The purpose of this project was to create a less expensive and more accurate e-cigarette detection method, by sensing propylene glycol, a substance commonly found in the vapor from e-cigarettes. In order to simulate an e-cigarette, a dilute solution of propylene glycol was aerosolized and released into a container with a volume of 100 liters. To detect the propylene glycol, infrared spectroscopy was used since propylene glycol vapor absorbs light in the range of 5 μ m to 15 μ m. An infrared light source was shined through a duct that circulated the air in the container. The light from the duct then shined through a slit to an infrared light sensor. The data from the sensor was then amplified with a voltage divider circuit and then read with an Arduino Uno board. Using this method a 300ml puff of propylene glycol vapor was able to be detected in a 100L container.

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

AT CH EN

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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

204

Fair Category

PS

Project Number

6098

Title: Concentration of Microplastics in Different Bodies of Water in Darien, CT

Student Name(s): L. Karl

Abstract:

Microplastics are small particles of plastic that have been broken down from larger types of plastic. Plastics easily enter different bodies of water due to runoff. Microplastics are extremely toxic to animals and the marine ecosystem as a whole. Two bodies of water, Goodwives River, a fresh-water stream, and Holly Pond, a brackish inlet of Long Island Sound, were tested for microplastic amounts. For each of the 12 sample days, a water sample was collected in both bodies of water. Then a dye, hematoxylin delafield, was put into the water sample that highlighted the amount of microplastics in that sample. The microplastics were counted using a microscope. Holly Pond had a higher amount of microplastics because it is a still-moving body of water that accumulates microplastics. Goodwives River is a running body of water so microplastics are constantly flowing through the river. Holly Pond collects the freshwater from rivers, so it had a larger accumulation of microplastics. It was found that Holly Pond, on average, had around double the concentration of microplastics than Goodwives River. Also, Holly Pond had higher averages on days after it rained. With these results, my community will hopefully become more aware of the relevance of plastic pollution.

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

EV

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 vertebrate animals controlled substances

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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

254

Fair Category

PS

Project
Number

6099

Title: How does the amount of CO₂ in Car exhaust differ as the Age of the car differs

Student Name(s): C. Alino

Abstract:

The purpose of the science fair project was to find the approximate amount of CO₂ in car exhaust and see how that amount has changes when the CO₂ comes from older vs newer cars; the hypothesis being the older cars would have much more CO₂ as compared to the more recent cars. Then research was used to find out how the earth might change if everyone were to use transportation that doesn't involve releasing CO₂ into the atmosphere. For the experimental phase the amount of CO₂ found in car exhaust and how that amount differs over time was investigated through titrations. Car exhaust from a 1989 car and a more recent 2011 car was collected and stored in balloons. Then it was bubbled through NaOH which had a drop of phenolphthalein as an indicator. HCl was slowly added until the solution turned completely colorless. The amount of HCl used indicated how much CO₂ was in the car exhaust, the less HCl used the more CO₂ there was. After titrating, the older cars averaged a molarity of $3.852 \cdot 10^{-5}$ moles/Liter as compared to the more recent car which averaged a molarity of $2.193 \cdot 10^{-5}$ moles/Liter. For the theoretical phase, through research it was found that the total amount of CO₂ released annually is $3.2 \cdot 10^{10}$ metric tons and 23% of that CO₂ is released due to transportation. Using that info, it was found CO₂ released annually would decrease to $2.464 \cdot 10^{10}$ metric tons if the factor of transportation was taken out.

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

CH EV EM

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

4. Is this project a continuation? Yes No

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

6100

Title: Creating and Implementing a Model that Predicts Concentrations of the Air Pollutant NO₂ in Springfield, Massachusetts

Student Name(s): A. Su

Abstract:

Nitrogen dioxide (NO₂) is a gaseous air pollutant that can come from sources like transportation emissions and industrial combustion. Past studies show NO₂ is linked to health risks such as asthma. The study area, Springfield, Massachusetts, has a high pediatric asthma rate and is threatened by environmental injustice. This project used ArcMap 10.5.1, a Geographic Information System-based application, to predict and model NO₂ concentrations in parts per billion for Springfield. The predictors were roads within 50m, rail lines within 300m, and open land areas within 300m of a city grid point. It was hypothesized concentrations will be higher along roads and rail lines and lower in open land areas. In ArcMap, a buffer was created around grid points placed every 50m in Springfield. The Intersect tool was used to see if predictors were within the specified distance of each point. The number generated was plugged into a linear regression equation—previously generated by mentor using the statistical programming language R—to calculate estimated NO₂ concentrations, then rounded and adjusted to account for negative and extreme estimates. The symbology of the map was changed to visualize the concentrations. The highest concentrations were along the highway with the next highest concentrations along rail lines. The hypothesis is supported. Additionally, environmental justice data from the 2010 Census show that there is more NO₂ among minority/low-income and minority/low-income/limited English areas. The data can be used to encourage a reduction of emissions, switch to cleaner energy, and increase efforts to achieve environmental justice.

**Technical Disciplines Selected by the Student
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EV ME

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- Yes No

CSEF Official Abstract and Certification

Word Count

188

Fair Category

PS

Project Number

6101

Title: Improving Solar Energy

Student Name(s): E. Demers

Abstract:

Scientists today are looking for ways to improve the creation, productivity, and carbon footprint left by solar energy. The collection of solar energy has not been perfected as of yet, and have mixed results in their productivity. In my project, I attempted to create basic solar energy panels out of oxidized copper. Copper produces electricity when placed in different liquids, and can produce greater results of electricity than sulfur if the right compound is used. By placing pieces of copper in saline, a mere 20 microamps were produced. Similarly, when placed in lemon juice, only 60 microamps occurred. After trying other liquids, both the lemon juice and sailing were combined, and by using a 1 part saline to 9 parts lemon juice over 350 microamps were produced. After changing multiple other factors in this experiment. It was hypothesized that the lemon would produce the largest amount of electricity, but after an accident in the lab, the saline and lemon mixture proved to be more efficient. Hopefully more experiments with copper and other liquids can be done in the future, and a highly productive solar panel can be created.

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

ET EE 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

251

Fair Category

PS

Project
Number

6102

Title: Determining the Efficiency of Machine Learning for Missile Detection and Tracking

Student Name(s): J. Krucinski

Abstract:

In today's world, missile detection and tracking plays a key role in national security. It is vital that nations intercept any missiles before they strike assets or civilians. My research is focused on one aspect of missile defense in the form of streaks in images, which are distinct signatures that have an elongated or extended spread across several pixels. Current approaches to this task involve physics-based analytical and probabilistic models, however, Machine Learning is yet to be applied. Therefore, the question I am trying to answer is: Can Machine Learning techniques perform missile detection and tracking more efficiently, with fewer computations, and faster than current methods? If so, this research could make significant contributions to the global missile defense industry and potentially save many lives and assets. To address this question, I have used generated image data with and without streaks for training a streak detector neural network (NN) as well as a streak/missile locator NN. To initially simplify the problem, I will work with less and/or smaller image data that I normalize and preprocess using autoencoding, a denoising tool. This will help me find promising neural network models, as there are many parameters to adjust and lots of data to train on. After finding such models, I will expand to larger datasets and compare various metrics of performance to current methods. Currently, I have trained the detector NN to work on the small images and will use this capability on large images and in the localization task.

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

CS MA

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

242

Fair Category

PS

Project
Number

6103

Title: Utilization of Piezoelectric Elements Within a Designed Apparatus for Situational Power Generation from Ocean Waves

Student Name(s): E. Pernek

Abstract:

Among an age of changing climate and corresponding worsening storms and increasing ferocity battering coasts and areas such as the Caribbean, electricity and emergency power generation appears to be an issue during extreme conditions under natural disasters such as hurricanes. Methods of utilizing the energy contained within the orbital paths of water molecules within waves could be more affordable, effective and renewable. This collection of energy utilizes the properties of Piezoelectric disks and a freely moving element within a track-system that moves by the energy of the waves and causes collisions with the piezo-elements on a constant basis. This system is a ring that floats on the surface of the water, and within the ring is a piling or pole to keep it stationary and possibly even store the battery in a watertight compartment. Preliminary testing of the piezo-elements for the experiment show that they output very minimal power, though they are only budget elements, and a real world example would produce more energy if it were of better quality and in greater numbers than within the proposed model. The potential energy output would depend on the mass of the ball, its push on the piezo due to gravity, and vertical displacement of the entire unit due to the wave action. After the energy is harvested, the electricity will be sent to a battery or directly to storage on land or to the grid within a real-world application.

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

ET AT 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

250

Fair Category

PST

Project Number

6501

Title: Effects of an Electromagnetic Field on the Growth and Structure of Different Crystals

Student Name(s): F. Barria, S. Kota

Abstract:

The purpose of this project was to be able to replicate crystals in a different type of environment than one in which they were traditionally grown, and examine the relationship between crystal growth in a magnetic field, micro-structure of the crystal and macroscopic properties. This process would simulate microgravity, which is found in space, and it would be used to grow crystals. Following multiple experiments, the role of heat and electromagnetism would be evident in the changes found in different crystals and therefore a proper conclusion could be formed.

Copper sulfate crystals were grown from salt solutions. One batch was allowed to grow on the lab table while the other sample was placed inside a solenoid, inducing a magnetic field with a current of 5 amps. First attempts revealed that the temperature inside of the solenoid rose to 45 degrees Celsius so it was unclear whether the changes that occurred were due to the magnetic field or the heat. A third sample was placed inside an oven at 45 degrees Celsius to help better determine the effect of only a magnetic field. The crystals were originally a bright blue color and then with the magnetic field it turned into a pale blue with a flaky texture that differed from our original trial. The oven samples also turned pale blue, but still had most of their crystallization. X-ray diffraction was run to determine if the crystal structure grown in the magnetic field differed; the results were inconclusive at this time.

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

EN PH 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

141

Fair Category

PST

Project Number

6503

Title: Creation of an efficient fluid coolant system through the use of ferrofluid

Student Name(s): C. Boateng, F. Brown

Abstract:

The purpose of this engineering project was to find a more energy efficient solution to appliances and industrial cooling systems that reduce corrosion and biofouling of current water-cooling systems. The first phase involved the design and construction of a water coolant system in which water could flow through a circular tube and cool down a piece of brass copper and the subsequent construction of a similar system using ferrofluid in place of water. This was a complicated process, especially construction of the ferrofluid cooling-system, and many months were spent designing-building-redesigning. During the second phase, the two systems were compared for electrical efficiency of temperature reduction and a comparison of evidence of biofouling. Results were analyzed and initial data trends indicate the complexity of the ferrofluid cooling system does not make it more efficient, even though biofouling was reduced.

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

EN AT 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

197

Fair Category

PST

Project Number

6506

Title: The Effect of Various Cooling Speeds on The Bending Strength of 3D Printed Objects

Student Name(s): Z. Bachofner, C. Bell

Abstract:

3D printing is a rapidly expanding technology. It allows for complex objects to be created out of a spool of raw material, whether it be metal, ceramics or plastic, with the latter being the most common. As its use becomes more widespread to individual consumers, as well as small companies, the question of practicality arises. The most common form of 3D printing is fused deposition modeling, in which material is extruded layer by layer. This method allows for many properties to be tweaked to affect the outcome of parts. It was hypothesized that parts cooled at lower rates of speed would produce a greater bending strength than those cooled at higher rates. An Ender 3 printer was used to test this relationship using parts sliced in Cura. The parts were cooled at fan speed intervals increasing by 20%. They were then suspended with measured weights attached in order to break them and calculate bending moments. No correlation was found between the variables. It could be that fan speed simply does not affect this type of stress. If this is true, this setting can be changed in order to adjust for other desired properties in the resulting part.

**Technical Disciplines Selected by the Student
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EN AT PH

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- Yes No

CSEF Official Abstract and Certification

Word Count

234

Fair Category

PST

Project Number

6508

Title: An Evaluation of Fluid Multi-Drug Screening Kit for Preliminary Drug Detection

Student Name(s): E. Mansourian, T. Pardo

Abstract:

Within the last decade, the number of automobile accidents caused by a driver under-the-influence has doubled. In response to these drug-related accidents, disposable drug tests have been developed for on-road detection. The purpose of drug testing is to prevent future drug-related automobile accidents. This drug test is designed for preliminary drug detection as it is both fast and simple. The hypothesis of this experiment states that the Saliva Confirm Oral Fluid Multi-Screening Drug Kit will be most accurate when testing samples containing the highest concentrations of drugs. The test was used to evaluate fluid samples containing drugs from the following classifications: barbiturates, benzodiazepines, cannabinoids, opioids, and ethanol. Certified drug free saliva samples were spiked using a variety of drug concentrations, including 100, 1000, 10,000 and 1,000,000 microL/ng. Analytes were spiked by mixing the saliva and the concentrations in a petri-dish. The results of the experiment indicated many of the metabolites that derive from the original drug were not able to be detected. While the higher concentrations were found to test positive more often than lower concentrations, the dosages were too high to be found in a human and therefore did not reflect the true accuracy of the test. This oral fluid drug test is not an adequate tool for preliminary substance detection because it did not respond accurately to both high and low concentrations of drugs.

Technical Disciplines Selected by the Student
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CH BI AT

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- Yes No

CSEF Official Abstract and Certification

Word Count

233

Fair Category

PST

Project Number

6509

Title: Optimization of Energy Production through Active Augmentation of Hydro-Turbine Body and Blade Design.

Student Name(s): A. Sathish, N. Sivakumar

Abstract:

Most blade designs for turbines rely on a fixed camber design, where no parts of the turbine move to adjust to its surroundings. By developing a method to sense surrounding conditions, and then actively adjusting aspects of the turbine we allow for increased efficiency in variable situations. This results in higher power output than the current design. Currently, situation adapting turbines are mounted on the axial-flow direction, changing the fin blades through rotation of the entirety of the turbine body. This takes an immense amount of energy. We aim to fix this problem by mounting the turbine in the radial-flow direction. We are able to model camber movement through the constriction of a cable, that is fastened between different joints, similar to how a finger functions and bends at certain joints. It is this tension that causes the turbine to curve at different degrees, allowing it to be variably changed by an electronic system. A microcontroller is then added, providing a programmable way to introduce tension to the cable allowing for the change in the degree of the camber of the blades. The Arduino is also connected to a flow rate sensor that actively monitors the water flow rate. Through a deep learning algorithm, the controller automatically adds tension, causing the cable to change the camber in real-time to match the most effective camber degree possible in any given circumstance.

**Technical Disciplines Selected by the Student
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ET EE AT

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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

6510

Title: Desalination and Purification of Seawater Using Solar-Powered Electrodialysis

Student Name(s): G. Kapp, M. Montgomery

Abstract:

The purpose of this study was to create a means by which seawater can be purified through electrodialysis. This electrodialysis was solar-powered, with a focus on optimizing water purified per volt. The entire project was composed of three main parts. The first was the construction of the apparatus that houses the exchange membranes. The second was the testing functionality and efficiency to create the maximal water purified per volt ratio. Different voltages and speeds were tested until a successful ratio was reached. The solar panel was attached in stage three, using the data collected in stage two to ensure maximal efficiency. The model shown serves the intended purpose of the project only as a small scale model that can be expanded for maximal functionality.

Technical Disciplines Selected by the Student
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EM EE ET

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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

229

Fair Category

PST

Project Number

6511

Title: Net Zero Family Center

Student Name(s): E. Mora, K. Petty

Abstract:

As time goes on our world is using more and more fossil fuels which is leading to climate change and global warming. We have seen the consequences all around us but people have made ways to reverse the consequences and reduce the uses of fossil fuels. Some of these ideas have been put into housing, apartments and some other public buildings, but most buildings still run on fossil fuels. Some people have heard of the net-zero homes like Earth ships and they do very well. So we experimented with the idea of a net-zero multipurpose building. In this experiment, we researched ways to produce and save energy, ways to save water, ways to recycle and compost but we mainly focused on the gym section. We also made a model of it. In this building, we planned to make the floors in the building (except for the pool, locker room, kitchen) out of Pavegen Tiles (<https://pavegen.com/home/>). We also planned to use gym machines from ECO-POWER™ LINE FROM SPORTS ART EQUIPMENT (<https://www.gosportsart.com/eco-powr-line/>). We calculated the wattage/kilowatts of the Gym and of the tiled rooms and the energy-producing machines. From our research, we have concluded that the gym would not only power the gym room but other rooms around the gym and the gym itself would be a net-zero building.

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

AT EN 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

241

Fair Category

PST

Project Number

6512

Title: Optimizing the Design of the Lateral Reconstruction Nail with the use of Finite Element Analysis in Order to Improve the Healing Process of Subtrochanteric Femur Fractures

Student Name(s): S. Lee, D. Sugarmann

Abstract:

The lateral reconstruction nail (LRN) is an implant device that has been designed to aid the healing process of subtrochanteric femur fractures. The current LRN model has failed to support patients' weights before the fracture is able to fully heal. This problem developed the goal of this research, which is to use Finite Element Analysis (FEA), an analytical technique used to calculate and identify an object's areas of weaknesses, in order to optimize the reliability and effectiveness of the LRN. It was hypothesized that if modifications are made to the LRN based on identified weak areas, then the nail's durability will increase. The independent variable of the study was the modifications made to the LRN. The dependent variable was the strength of the model, measured using stress and strain data. To conduct this study, a series of FEA tests were run on a CAD model of the current LRN through the computer program "Solidworks." With the combination of this data and literature review, individual modifications were made to the implant's CAD model. The new design was then imported into "Solidworks" to run the same tests again. This study has designed a new LRN with increased durability. Future research includes making a physical version of the LRN and testing it using cadaver femurs. With this research, patients that suffer from subtrochanteric femur fractures of all weights and bone strengths will have the opportunity to experience a more reliable and safe healing process.

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

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

187

Fair Category

PST

Project Number

6514

Title: Child Bike Safety System

Student Name(s): J. LaRue, K. Young

Abstract:

The Child Bike Safety System (CBSS) is an innovative safety device for tricycles that provides security for developing children learning to ride. The system allows parents to give their child full independence of riding while maintaining complete control. The CBSS is a device that is added to an existing tricycle and is equipped with an Arduino Uno microcontroller, a servo activated brake, and an ultrasonic distance sensor. When an object is detected and a possible collision is evident the Arduino Uno activates the rear brake. Once the obstruction is removed the brake releases allowing the child to continue to ride. Parents maintain communication with the tricycle through radio. If the parent deems the child to be at risk of high speeds and / or entering a restricted area the rear brake can be activated to slow the child to a stop. In addition, if communication is ever lost the bike will remain locked to ensure the child's safety. The current prototype has a maximum weight capacity of 50 pounds and future improvements will include an increase in weight capacity, parent regulated geofences and a regulated speed limit.

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

EE 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

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- Yes No

CSEF Official Abstract and Certification

Word Count

259

Fair Category

PST

Project Number

6515

Title: Creating and Testing Novel Plant-based Bioplastics for Strength and Decomposition Rates

Student Name(s): T. O'Meara, P. Van Wagenen, A. Uygur

Abstract:

Plant-based bioplastics are vital because traditional plastics—derived from fossil fuels—take an extremely long time to decompose, causing pollution and global warming. Compared to traditional plastic, bioplastics have a faster decomposition rate, a much lower carbon footprint, and lower energy costs to manufacture. Bioplastics break down naturally in the environment because of its renewable materials. In this study, novel plant-based materials were used to create and test bioplastic materials. When creating a new bioplastic, we experimented with different ingredients, particularly plant-based starches and kelp. For example, in addition to kelp, tapioca starch and psyllium husk were tested. For the most successful bioplastic, the amount of plasticizer was varied to produce optimum results. A traditional polymer-based plastic was tested as a control, and a cornstarch-based bioplastic was used as the control bioplastic. The basic procedure included heating and allowing the mixture of plant-based starch, glycerin, water, and acetic acid to set. Strength and decomposition testing followed. It was found that the psyllium bioplastic with a greater level of the plasticizer glycerin was the strongest and most like traditional plastic. Cornstarch and tapioca had the greatest decomposition rates, where regular plastic had the lowest, as expected. The need for sustainable materials for the preservation of future ecosystems is the motivation for bioplastic production. Through our experimentation, we concluded that we will continue to develop the psyllium-based bioplastic due to its strength and flexibility, so that it may be used to replace commonly used plastic products, such as water bottles, bags, and plastic packaging.

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

EV EM EN

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 vertebrate animals controlled substances

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

247

Fair Category

PST

Project Number

6517

Title: Cyber Attack Identification in the Electric Power Grid by Anomaly Detection

Student Name(s): T. Brunette, C. Reed

Abstract:

Power grids are subject to physical and cyber security attacks. A way to help mitigate this threat is to reduce response time by analyzing data reported to detect inconsistencies which could represent a breach or malfunction within the grid. These potential failures would be reported and then inspected by a cybersecurity technician who would enact a response.

To design such a system, a digital model of the power grid was created by programming a configuration structure with the reported values. That data is analyzed for indications of an outage, malfunction, or potential breach. A graphical data structure representing the power grid equipment and each of its measurements was made. A program was created to analyze the data from each node within the structure for inconsistencies.

A physical model was made to test the functionality of the program. The model consists of a transmission transformer, two distribution transformers, and consumer loads. Arduino microcontrollers and Vernier current and voltage sensors were used to measure and relay data from the model to the program. This data is analyzed and displayed, showing the status of the grid.

After analyzing how our software responded to data anomalies, we know that this program can be effective in practical scenarios. When false data was injected that didn't match what was reported elsewhere, the program would alert technicians with data about the anomaly, allowing for an expedited response. The lessened response time will decrease the likelihood of a successful cyber attack on the power grid.

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

CS ET 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

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- Yes No

CSEF Official Abstract and Certification

Word Count

238

Fair Category

PST

Project Number

6519

Title: Design a Multi-Dimensional Interface for a Smart Rescue Hoist to minimize Helicopter Pilot Overload and Enhance Safety

Student Name(s): M. Morse, Q. Cunningham

Abstract:

Rescue hoists around the world have improved but are not as safe as they could be. The problem was to design a smart rescue hoist to be implemented on helicopters to enhance safety and decrease pilot overload while increasing situational awareness. The first step of the research procedure was to conduct research on existing rescue hoists in order to identify the components being used for the remaining parts of the project. The second step was to create conceptual designs(CoD) using CAD software and to perform risk analysis using a risk cube. Then, trade studies were performed on all CoD's to ensure the best design was chosen. Next, a human factors evaluation, a project budget were created. The fifth step was to design a prototype for the final conceptual design by using Arduino UNO and related items. The sixth step was to test the Arduino design for feasibility and compliance with the project goals. The last step was to perform stress analysis through computer modeling to determine the proper cable and to find that the margin of safety is less than 1. The Arduino testing was successful and the chosen cable was strong enough for the load requirements, allowing the team to conclude that this is a feasible design. The team hopes that a real-world application for this design would be for a manufacturer to recognize the improvements and to possibly implement some components into their design.

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

EE AT 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

147

Fair Category

PST

Project Number

6520

Title: Condensation and Collection of Cooling Tower Steam:

An Effort to Recycle Usable Water

Student Name(s): A. Arjomand, M. Konzerowsky

Abstract:

The objective of this project was to develop a device that can efficiently capture water released from the plumes of nuclear cooling towers and collect it for industrial and agricultural use. The capture prototypes were classified under three broad categories: a passive method, a cooling method, and an ionization method. Unlike the passive method, the ionization prototype involves a current passing through a metal mesh in an attempt to attract the water droplets towards the metal. Each prototype was scored using a coefficient of the volume of water it collected compared to its power withdrawal per hour. The project was conducted in four stages: replicating the cooling tower environment, designing the capture prototypes, testing for water output, and redesigning as necessary. Results were collected and initial data suggests ionization was better than the passive prototype by 20%, however under low voltage conditions they proved to be statistically insignificant.

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

EE AT 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

133

Fair Category

PST

Project Number

6521

Title: Renewable powered street lights

Student Name(s): J. Comfort, J. Vasso, M. Bish

Abstract:

Our idea is to make street lights that run on renewable power to save money and power to the impoverished places and third world countries, powered using attachable power plants based on their geography such as solar, hydroelectric, and wind power. The lights will run on Solar, Hydroelectric, and wind power. For a demonstration, we want to make a little 12v system displaying the circuit as well as the prototype of the actual structure of the light poles to show the judges what our idea is because we don't have the money nor materials to make a full-sized pole. The hypothesis for this idea would be if communities that cannot access power then we will build these street lights in order to give them light so they feel safer during the night.

Technical Disciplines Selected by the Student
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AT EE 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

254

Fair Category

PST

Project Number

6522

Title: Augmentation of Static Omnidirectional Venturi Flow Systems to Optimize the Efficiency of Wind Energy Harvesters While Mitigating Acoustical Sensitivity and Other Adverse Environmental Impacts

Student Name(s): J. Bell, D. Kakkar

Abstract:

By embedding the turbine into the wind-column and redirecting the airflow through a venturi system, we are able to produce comparable and enhanced power outputs while achieving a reduction in the environmental impact. It reduces the potential of bird collisions and acoustical pollution from infrasound frequencies. As such, our systems are suitable for all environments and mitigate against potential siting, political, and environmental concerns.

Our system is effective due to Bernoulli's Principle. Using the continuity equation, different variations were designed in CAD (Computer-Aided Design) by changing the intake area, the venturi narrow diameter, and the fin count.

We 3D printed the prototype CAD files using the Prusa i3 MK2s. We subsequently conducted a smoke analysis to test the directional flow in a proof of concept.

The second phase of the investigation was to use Computational Fluid Dynamics to find the optimal variation of our initial design. By simulating the system, steady-state without the turbine, and then simulating the turbine and tube, we achieve faster simulation times. We obtained the rotational speed, torque, and power production to discover the most power-efficient design. CFD allows us to simulate the best design on a real-world scale. We've seen more than a 30% increase in wind speed. With efficiency adjustments, greater outputs can be achieved. The variation with the most wind speed had an average intake area to venturi wind-column area ratio of 7.57. However, the system which produced the most amount of power was the system with a ratio of 3.65.

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

ET 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

250

Fair Category

PST

Project Number

6523

Title: Studying the Benefits Of Reinforcing Bioplastic with Silk Fibers and Bamboo

Student Name(s): G. Bennett, E. de Alessandrini, S. Curto

Abstract:

It is believed that reinforcing bioplastics with silk fibers and bamboo powder will make them stronger and potentially add antibacterial properties. By creating an affordable and environmentally-friendly plastic, we can help to reduce waste. This is significant because global warming has become a prevalent issue in today's world and the main contributing factor is pollution from plastics. Green banana flour, tapioca starch, as well as other starches were used as the base and corn starch was used as a control. Traditional plastic was also tested. To further strengthen our bioplastic, we added silk and bamboo in various quantities. We tested tear strength and biodegradability as a measure of success, and antibacterial studies are pending. It was expected that once we reinforce the bioplastic with silk and bamboo, that the resulting bioplastic will ultimately be as strong as traditional plastic. It will also be antibacterial, so it could potentially be used for medical purposes, maximizing its benefits. With both of these features, this versatile bioplastic can essentially be used as an environmentally friendly alternative to regular plastic. Our reinforced bioplastic can potentially help to reduce both food and material waste from supermarkets or dry-cleaners by implementing the silk fibers or by the plant starches not being used. The biodegradability of our product can reduce the amount of waste and greenhouse gases that accumulate from the petroleum-made plastic that sits in landfills. Its affordability and antibacterial properties will also make our bioplastic an ideal candidate for medical usage.

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

EN EV EM

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4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

222

Fair Category

PST

Project Number

6524

Title: Chemical recycling of cable waste

Student Name(s): M. Roh, Y. Wang

Abstract:

Copper can be found in all aspects of our lives. Because it is malleable, resistant, and a great conductor of electricity, its value is significant in the modern world, making it the most lucrative metals you can recycle. However, according to CPC's Bisbee, the process of stripping used cables into bare copper is labor-intensive in the U.S. fledgling cable recycling industry, while incinerating cables with PVC insulation is environmentally harmful. Also, there is a significant loss of copper during the traditional method, making it inefficient considering the cost and labor force input.

Therefore, we can conclude that the crux of cable-recycling technology would be:

1. Increasing efficiency
2. Finding a less-manpower consuming, safe method
3. Maximizing profit

Hence, to meet these qualifications, we propose a new method of recycling used cables by dissolving the PVC insulation in certain solvents.

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

CH EM

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4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

233

Fair Category

PST

Project Number

6525

Title: Saving The Environment One Drop of Water at a Time: Integrating Charcoal Into Plant Soil to Lengthen the Time Span of Plant Watering and Help Conserve Water and Prevent Droughts

Student Name(s): A. Zoghol, A. Kabatilo, Z. Kabatilo

Abstract:

Horticultural charcoal is generated from plant materials that is non-toxic. It also contains many tiny pores in the charcoal, which hold water and bind nutrients. This becomes a supply later to the plant making it an efficient and organic-friendly way to improve the soil. Firstly we had to go through a procedure process to experiment with this. To conduct this, we went through a series of steps required to ensure the health and growth of our plants. This step by step planting process which consisted of choosing the right soil and planting each plant an inch deep in the different soils. We examined the plants on a daily bases and noticed a change in behavior between the ones growing in the charcoal and the ones without. The results, as we hypothesized, favored the plant growing in the soil with charcoal chunks. We know this because the moisture in the soil with charcoal was greatest as tested with a moisture meter. From the results of various test trials, the plant with charcoal incorporate soil seemed to be growing at a quicker and healthier rate than those without charcoal. This proves that if implemented on a large scale, it could make larger tracts of land available for agriculture especially in a barren place where water is very rare. This would help overcome a great number of crises that occur in the world today.

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

PS EA EM

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4. Is this project a continuation? Yes No

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

- Yes No

CSEF Official Abstract and Certification

Word Count

227

Fair Category

PST

Project Number

6526

Title: How can we use a rotating wind turbine alongside solar panels in order to passively and actively collect energy?

Student Name(s): H. Aljafar, A. Vasantlal, A. Vasantlal

Abstract:

Objective

Our question was, "How can we use a rotating wind turbine alongside solar panels in order to passively and actively collect energy?". Over the course of a month, we constructed a device that would harness wind and solar energy. Then successfully constructed a working device that charges your mobile device through a USB at a fast rate.

Materials

The body of the machine is made of a carbon fiber tube and the turbine blades cut out of carbon fiber panels. The top of the machine has two 3.5 watts 6-volt solar panels made that are wired in parallel with 22 gauge wire. Below the two solar panels is a high RPM motor that will act as our turbine. All of the wirings of the device are directed down the pole to two buck-boost converter modules. The bottom of the device has a female screw mount that is meant for cameras.

Results

The solar panels in full sunlight ran at 75% efficiency which generated a little over 5 watts of power. In relation to real-life charging speed, it would generate at times more power than a

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

EE 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

231

Fair Category

PST

Project Number

6528

Title: Effects of Ultraviolet and Infrared Light on Crystal Growth and Structure

Student Name(s): P. Grange, E. Santiago

Abstract:

Crystallography is the study of nanoscopic structure of materials and is critical in understanding the macroscopic properties in chemistry, biology and physics. Crystal shapes and sizes are very dependent on the environment they are grown in. This investigation attempts to examine the relationship between growth environment, micro-structure of the crystal and macroscopic properties. Copper Sulfate and Potassium Aluminum Sulfate crystals were grown from salt solutions and the environments studied included ambient light, total darkness, ultraviolet light and infrared light. Initial trials with an infrared light were too hot to safely grow overnight in the lab. After a few days, crystals formed in all of the samples. While the Copper Sulfate crystals behaved differently than the Aluminum Potassium crystals, each set of crystals ranged in size and texture. Overall, the Copper Sulfate crystals were smaller and tri cilindric in comparison to the Alum crystals. However, for the first trial in ambient light it produced crystals that were larger than the ones grown prior. As for the Alum crystals, they produced two different results. The solution grown in the ambient light developed much differently than the others, the texture was much thinner and “snow-flake” like while the other tests were chunkier and more of an octahedral shape. X-ray diffraction was run to determine if the crystal structure grown in each environment differed. Analysis of data is ongoing at this time.

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

CH 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

173

Fair Category

PST

Project Number

6529

Title: Optimization of the Insoles: Material Testing to Maximize Athletic Results

Student Name(s): M. Spiess, N. Altman

Abstract:

The purpose of this project was to investigate insole materials and determine which material optimally reduced ground contact during use. It was hypothesized that acetal would be the best material for this purpose as it would minimize participant ground contact (reducing friction between the ground the participant) and it has a suitable tensile strength and limited flexibility. Experimentation involved three major steps. The first involved creating the insole from the various materials. An Adidas Ultra Boost insole was used as a template and uploaded to Adobe Illustrator. Various materials were then cut to shape on the laser cutter. Insoles were tested using human participants who completed the 10-yard dash, vertical jump, and broad jump using different material insoles, 3-times-per event. Results were collected and compared to the results gathered from the the flex testing machine (design and constructed for this experiment) regarding the amount of weight each insole could support. It was concluded that acetyl was the best material to reduce ground contact, however, the results were not statistically significant.

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

EN PH AT

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4. Is this project a continuation? Yes No

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- Yes No

CSEF Official Abstract and Certification

Word Count

250

Fair Category

PST

Project Number

6531

Title: Testing a Stormwater Drain Filter to Reduce the Prevalence of Phosphates and Nitrates in the Long Island Sound

Student Name(s): A. O'Connor, A. Barnett

Abstract:

Pollutants from plant fertilizers flow through storm drains and are disposed into the Long Island Sound. This leads to eutrophication and increased growth of algae, resulting in lower dissolved oxygen levels. The effects of nutrient pollution prompted research regarding the testing of a filter to remove nutrients from stormwater. It is hypothesized that a specific filter will reduce nitrates and phosphates from simulated stormwater. The study first measured phosphate and nitrates levels in the simulated runoff (the control). The independent variable was the type of filter tested and the dependent variable was the amount of nutrients left after filtration. In phase 1, the filters tested were activated media, a phosphate sponge, and an activated carbon sponge. Phase 2 focused on an activated carbon cloth. In phase 1, the activated media and phosphate sponge were effective at reducing the level of phosphates as it decreased levels by 50% and 75%, respectively. No improvements occurred for nitrates, however. In phase 2, the first trial with the activated cloth, there was a total reduction of 70% for nitrates and 43% for phosphates. Phase 2 trial 2 showed decreases for both nitrates and phosphates again with the cloth, with 23% reduction for nitrates and 80% for phosphates. It is expected that the cloth will be able to absorb a significant amount of nutrients from local storm drains, and prevent polluted stormwater from entering the Long Island Sound so that marine ecosystems will benefit by decreases in algae blooms and increases in dissolved oxygen levels.

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

EM EV AT

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