68th Anniversary

Connecticut Science & Engineering Fair

March 15 - 19, 2016

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)

Technical Disciplines

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

Technical Discipline Composites

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

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
247	PT	4009

Title: The TempBot

Student Name(s): A. Boccanfuso, S. Saffran

Abstract:

According to the Department of Meteorology and Climate Science, since 1998, 660 adolescents have died in overheated cars. Every year, children and animals are put at risk when they are accidentally left in unattended, overheated cars. This can lead to deaths and has become an issue.

The objective of this project was to create a product that alerts parents and pet owners when their car is overheating. This device has detected when a car reaches an unhealthy temperature and alerts a parent/pet owner, and this could save the lives of many children and pets. To achieve this, a temperature sensor, an Arduino, a GSM shield, and a SIM card were used. The temperature sensor was connected to an Arduino and programmed to detect the temperature of the area. The Arduino and temperature sensor were then connected to a GSM shield, which had to be programmed to send a message when the temperature reached the threshold test level.. The Arduino served as the main control of this prototype, and the shield served as the communication vehicle to send an alert message to the owner's phone. The prototype was covered by a portable 3D-printed box that was designed via a CAD program. To test the device, the temperature sensor was heated to the set threshold, and it was successful in transmitting a warning alert to the cell phone.

This device has the potential to save the lives of children and animals from the dangers of overheated cars.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) CS EE 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	Fair Category	Project Number
250	P7	5023

Title: Building a Better Battery

Student Name(s): N. Ferrucci

Abstract:

From cell phones to electric cars, battery technology is becoming more and more important in our modern world. The smaller and more powerful the battery, the more applications are possible. In this engineering experiment, I investigate building a simple battery from raw materials. The primary goal is that my battery should generate enough electricity to power a small fan. The design goals are that the battery should be: 1) based on the design of the very first battery ever made in 1800: The Voltaic Pile by Alessandro Volta; 2) made of non-toxic materials; 3) generate at least 1.5v and 75 mA; 4) mobile, compact and lightweight. I created 4 prototypes and then built a final prototype. Baking soda was used as the electrolyte in all prototypes. In my first prototype, The Single Cell Battery, I used 1" copper and aluminum discs. In my second prototype, The 4 Cell Battery, I used the concept of batteries in serial to increase voltage by stacking 4 single cell batteries. In my third prototype, Parallel Piles, I increased current by putting the 4 cell batteries in parallel. In my fourth prototype, Zinc and Graphite Battery, I increased surface area and used materials with higher electric potential – zinc and graphite. Although this prototype powered the fan, it was large and heavy. My final prototype, Magnesium and Graphite Battery, used magnesium instead of zinc enabling me to significantly reduce the size and weight of the design. The final prototype generated 3.75v and 107mA of current.

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

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3. This project was conducted at a Registered Research Institution. ☐ Yes ☒ No
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CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
252	P7	5026

Title: Hydropower Tiles: A Novel Approach to Harvesting Energy from Human Locomotion

Student Name(s): J. Oei

Abstract:

This project explores the use of a hydro pump in conjunction with a hydro turbine to design floor tiles that can be used to harvest energy caused by people walking in large public spaces. These tiles could also harvest energy from mechanical structures, such as roads and bridges that are subjected to repetitive downward force from automobile, train or other mass transportation traffic.

A prototype of such a tile was designed and built and generates 6.04 Volts, .695 A and 4.2 Watts. This is comparable to the theoretical power value of 5.15 Watts. Therefore, the efficiency of the prototype hydro power tile is 81%. The power density of the tile is .268 W/sq. in.

Although the power generated for each hydro power tile is small, many tiles put together can produce significant power. Based on the power density of the tile, an average energy usage of a home of 1.5kW, and a 10% capacity factor, Grand Central Station, The George Washington Bridge and the Sears Tower equipped with hydro power tiles can produce enough energy to power 259, 140 and 558 homes respectively. The cost of a hydro power tile system is comparable to a solar and wind power generation (5.8 cents per kWp-hr vs. 5.0 for wind and 20.0 for solar).

The hydropower tile is a scalable form of energy. The energy output is predictable (not subject to weather conditions like wind or sun). The tiles produce zero emissions and is ideal for use in high population density applications.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project) ET 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
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CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
248	LS	3042

Title: An Electronic Model of The Patellar Reflex Arc

Student Name(s): J. Snyder

Abstract:

Neuromimetics, the modeling of neural systems, has significant applications including use in artificial intelligence, robotics, and medicine. This study creates the first electronic neural net modeling the patellar reflex arc, and evaluates its accuracy in comparison to its biological counterpart in terms of neuronal firing rates, action potential (AP) waveform accuracy, and excitatory and inhibitory behavior. Multiple electronic neuron models were assessed for biological accuracy and feasibility for use in this study, and the Fitz-Hugh Nagumo model was selected. The project had two stages: virtual simulation and testing, and then physical construction and testing of the individual neurons and neural net. Using SPICE computer software, neurons were designed and optimized to simulate the firing rates (12-25 Hz) and AP waveforms produced by the Ia afferent sensory fiber, alpha motor neurons (to quadriceps and hamstring), and inhibitory interneuron. Each neuron was constructed physically from electronic components and testing was conducted, including the measurement of proper voltage potential production, transistor bias conditions, and component connectivity, to discover and eliminate sources of error in accurate AP production. The electronic neurons were then connected to form a complete analog of the biological arc, and observations of the neural cascade revealed that replication was successful, despite variance in frequencies. The analog electronic model has the potential to be implemented into robotic systems, to further the study of electronic neural circuitry to replace damaged biological neural nets, and to be scaled and integrated into neural prosthetic systems to maintain stability through proprioceptive feedback.

Technical Disciplines Selected by the Student (Listed in order of relevance to the project): EE EN CB

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3. This project was conducted at a Registered Research Institution. ☐ Yes ☒ No
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CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
195	PS	6052

Title: The Application of Eye Center Localization and Tracking in Spherical Robots

Student Name(s): H. Mo

Abstract:

The estimation of the eye centers is used in several computer vision applications such as face recognition or eye tracking, especially for the identification of latters and systems. Nevertheless, this technology hasn't been used in common people's lives and most of methods often fail to accurately estimate the eye centers in difficult scenarios, such as low resolution, low contrast, or occlusions. Therefore, I propose an objective function which can accurately find eye center location by using image gradients. This method is invariant to changes in scale, pose, contrast and variations in illumination. It is a significant improvement regarding both accuracy and robustness. At the same time, it is a revolutionary method of robotic control. It makes people experience robotics in a different way. This spherical robot will response to robot driver's eye center movement and transfer the vision of the robot in real-time back to the operator. Because of this function, I would like to call it "The Third Eye". For future development, this eye centers tracking system is very easy to transplant to other mobile devices which can help the group of people with paralysis to use their smart phones or tablet computers.

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

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3. This project was conducted at a Registered Research Institution. ☐ Yes ☒ No
4. Is this project a continuation? ☐ Yes ☒ No
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
244	PST	6521

Title: Designing a Benchtop Pump Using Ferrofluids and Electromagnets as an Actuating Mechanism

Student Name(s): S. Saxe, J. Nadelmann

Abstract:

Heart disease is the leading cause of death worldwide. Patients who progress to end-stage heart disease are limited to heart transplantations; donor shortages limit transplants to 2000 annually. An alternative treatment is a Ventricular Assist Device (VAD) which support failing hearts. Often continuous flow VADs have many complications such as GI bleeding, and blood clotting. A solution would combine the advantages of positive displacement pumps with continuous flow pumps by using ferrofluids and electromagnets; a prototype features an iron stator surrounded by four electromagnets, a polytetrafluoroethylene tube designed for blood flow, and an inner tube filled with a ferrofluid. The wires of the electromagnet were connected to a circuit board with an on/off algorithm that enabled current to be isolated to individual wires in a cyclical fashion. When current surrounded one electromagnet, a magnetic field was created that attracted the ferrofluid. Due to the flexibility of the tubing, the ferrofluid subsequently compressed the tube of blood and propelled it forward as the magnetic fields, and thus the ferrofluids, cycled. A proof of concept has demonstrated the feasibility of this actuating mechanism, where electromagnets are placed on the outside of the mechanism and subsequently use ferrofluids to move material cyclically.The pump is expected to be successful in clinical testing as the machinery does not come into direct contact with the blood, thus reducing the likelihood of postoperative GI bleeding, and stroke, while increasing the time a patient can be placed on a VAD.

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

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3. This project was conducted at a Registered Research Institution. ☒ Yes ☐ No
4. Is this project a continuation? ☐ Yes ☒ No
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☐ Yes ☒ No

CSEF Official Abstract and Certification

Word Count	Fair Category	Project Number
162	PS	6047

Title: Self-regulated LED Dimming System for Reduction of Eyestrain and Energy Consuming

Student Name(s): X. Wu

Abstract:

This Self-regulated LED Dimming System is designed for relieving eye strain in the performance of visual tasks of high contrast (ex. reading on fine prints) and for energy saving with sufficient environmental light.

The design of this system consists of two major parts: one is the brightness detector installed on a pair of glasses which is designed to measure the brightness received by users and send commands to LED driver wirelessly, the other one is a wireless automatic dimming LED driver which is designed to receive commands and adjust the brightness of LED lamp through PWM output.

After multiple tests and measurements, this system is proved to be able to control the brightness of the LED lamp received by the eyes of users in the range of 200 to 500 LUXs which is the ideal brightness for high contrast visual tasks. Secondly, the energy saving efficiency can be up to 30% by examining it in 5 different times of a day.

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

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