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Intel International Science and Engineering Fair (ISEF)

USAID Science for Development Award

2015 Winners

10 young scientists

$40,000 in awards

Brilliant **solutions** for development

USA | Palestine | Brazil | Canada | Pakistan

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2015 ISEF USAID Science for Development Awards at a Glance

Winners

Raneem Hasan Alqwasmi & Amal Hashim Ali, Palestine
My School Self-Powered

Koushal Rao, USA
Effectiveness of Influenza VLP and SAR9 Vaccination

Maria Vanessa Oliveira Teodosio & Fatima Natanna de Miranda, Brazil
SOS Drought: Seeding Life through Low Cost Catchment and Desalination Systems in Semi Arid Region

Nicole Sabina Ticea, Canada
Low-Cost Disposable Device for Point-of-Care Nucleic Acid Testing of HIV: Sample-to-Answer in Less than 60 minutes for Less than $5.00

Honorable Mentions

Kelly Devens, USA
Utilizing a Piezoelectric Crystal Tree to Harvest Electrical Energy from Rainwater

Habab Idrees, Pakistan
Multi-Purpose Smart Solar Device

Kathy Liu, USA
Natural Additive-Enhanced Development of Novel All-Solid-State Batteries for Sustainable and Scalable Energy Storage

Maya Varma, USA
A Wireless Smartphone-Based System for Diagnosis of Pulmonary Illnesses

Please note that abstracts are written by the pre-college student of the winning project and to preserve the integrity of their work, the language has not been modified.

Winning Abstracts

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Intel International Science and Engineering Fair (ISEF) Winners
USAID Science for Development Award

Winning Abstract

Raneem Hasan Alqwasmi & Amal Hashim Ali

Palestine

My School Self-Powered

Abstract: This project aims to design a device that converts the kinetic energy into electrical energy in an unprecedented way; it investigates the students' kinetic energy during going up and down stairs to their classroom. This energy is used to supply the school with its own electricity without the need for an external source. The research problem estimated from the need to find alternatives for traditional energy due to lack of availability and high cost. The device contains mechanical and electrical parts and it was experimented several times to make sure it works properly and matched the scientific principle that it has been designed for. The works on the principle of pressing it down vertically by the students' movement through the transmission from serrated to another, the amount of displacement will be amplified, and transmitted to the electric generator, which will charge the batteries that will provide the power required for the inverter (12 volts), which will be converted to 220 volts. We would like to note here that we need 6 days by 4 rounds a day on the device for charging the batteries. Therefore, the batteries will light the classroom with 20-watt capacity for 4 days with 5 hours average. The energy generated by the inverter approximately equals 400 watts per hour. This model which has been designed can be used in densely populated places, such as schools, hospitals, shopping centers and courts and thus would be a springboard for multiple applications point in a world moving towards alternative energy use.

Winning Abstract

Koushal Rao

USA

Effectiveness of Influenza VLP and SAR9 Vaccination

Abstract: In April 2013 an emerging virus, influenza A (H7N9), was identified in humans in China, with a novel avian-origin. Since its re-emergence in October 2013, there have been more than 220 laboratory confirmed cases. This virus may soon become human-to-human transmissible, posing more of a threat than it already does. Therefore, the purpose of this study was to determine whether the novel COBRA technique could serve as an effective means of pandemic prevention. H7 sequences were obtained from NCBI, and a phylogenetic tree was created. Consensus groupings were made in order to maximize the number of strains equally represented by targeting conserved sites on various antigens. The final HA sequence was synthesized, transformed, and purified. A restriction digest was used to verify results. The HA was then transfected onto a VLP. Mice models were used to determine efficacy of COBRA VLP compared to traditional techniques. Standard HAI assays were used to determine antibody response. The data was astounding. Although the data did not follow the exponential curve for different dosages as expected, it raised several intriguing questions that led to notable conclusions. The COBRA VLP, at its weakest point, still elicited an immune response that was deemed significant by literary values. The COBRA H7 VLP proved to be the most efficient and effective mechanism of defense in terms of pandemic prevention because it elicited the widest and most consistent immune response. In the HAI analysis, the antibodies created by the COBRA H7 recognized more of the significant H7 strains on the panel. Thus, the hypothesis was supported.

Winning Abstract

Maria Vanessa Oliveira Teodosio & Fatima Natanna de Miranda

Brazil

SOS Drought: Seeding Life through Low Cost Catchment and Desalination Systems in Semi Arid Region

Abstract: The drought has caused several impacts in different continents of the planet. The increase of poverty and hunger has been considered as a direct consequence of droughts for the world population. It has become a global problem resulting in severe material and economic losses for the affected areas. Ceara State, semi-arid region located in Northeastern Brazil, faces the worst drought in 60 years and currently 95% of its cities are in a state of emergency. The factor that stimulates us is the need to offer the Northeastern families, a low cost alternative that can ensure a harmonious coexistence within the semiarid region. The SOS Drought Plan proposes mitigation actions and management and monitoring policies of the drought problem. With this goal we develop a cooperatively low cost collection system using banana fiber (Musa spp) as aggregate and we also develop a low-cost desalinator in order to focus on environmental, social and economic aspects of the drought. We developed water collecting systems 65% cheaper as well as desalinators using low-cost materials. The application of 25 water collecting systems and 10 desalinators were able to provide drinking water for the entire community. These results show that the water collecting system and the low-cost desalinator are efficient alternatives to mitigate the drought. They also appear to be a proactive measure with direct effect on the difficulties of access to drinking water in Northeastern Brazil which can also be applied in other regions the planet.

Winning Abstract

Nicole Sabina Ticea

Canada

Low-Cost Disposable Device for Point-of-Care Nucleic Acid Testing of HIV: Sample-to-Answer in Less than 60 minutes for Less than $5.00

Abstract: A rapid, electricity-free cartridge for nucleic acid testing (NAT) from finger-prick blood is proposed to combat the high rate of undiagnosed HIV infection in low-resource settings. The low estimated cost per test cartridge ($3.00-$5.00), coupled with the rapid turn-around time of 60 minutes, is expected to enhance early infant diagnosis and treatment, decrease the risk of transmission by undiagnosed individuals with acute infection, and increase drug regimen adherence. This technology is designed to meet the growing need for acute viral diagnosis and to provide the benefits of rapid point-of-care (POC) results. The isothermal sample-to-answer NAT approach is composed of front-end sample preparation, one-step transcription and amplification, and endpoint immunochromatographic detection. The assay successfully detected 2,000 copies of HIV RNA from a panel of patient-derived isolates, thus demonstrating primer immunity to sequence variability. The system has further displayed high sensitivity and specificity when analyzing crude patient samples. For use in POC conditions, the assay was simplified, streamlined, and integrated into a self-contained microfluidic cartridge. An iterative approach to design and prototyping guided the development of a multilayered PMMA bio-electromechanical system and PDMS large-scale-integrated chip. In response to observed limitations, a novel paper microfluidic cartridge operated solely by mechanical forces on reagent blister packs, coupled with a spring-loaded mechanism for automatic reagent release, was subsequently designed. As the first proposed NAT platform for on-location identification of viral diseases and genotypic drug resistance patterns, this system will revolutionize the POC testing paradigm.

Honorable Mention Abstracts

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Intel International Science and Engineering Fair (ISEF) Winners
USAID Science for Development Award

Honorable Mention

Kelly Devens

USA

Utilizing a Piezoelectric Crystal Tree to Harvest Electrical Energy from Rainwater

Abstract: This multiphase study was conducted to evaluate the feasibility of utilizing a piezoelectric crystal tree to harvest electrical energy from rain water to use as a clean, renewable energy source. The piezoelectric effect is the ability of certain materials to generate an electrical change when subjected to a mechanical stress, such as a vibration. A bio-inspired, PVC pipe testing stand was developed to mimic a tree. A PVDF piezoelectric crystal beam branch converted the kinetic energy of the raindrops to electrical energy. In Phase I, a leaf appendage was designed, 3D-printed, and attached to the beam to increase the efficiency of the beam and reduce the propensity of the water drops to pool and/or splatter. It was determined that of the four different scaled sizes of the leaf tested, the "small leaf" aided the piezoelectric beam in producing the most electrical energy. In Phase II, the optimal location for the water drops to strike the beam was investigated: the leaf appendage, the end of the beam with an appendage, and the control beam. The 45 trials varied three diameters of dispensing needles and five water fall heights. It was determined that targeting the leaf appendage aided the piezoelectric beam in producing the most electrical energy and could increase the beam's efficiency by 10%. In both phases, the hypotheses were accepted. In Phase III, a reconfigurable PVC tree with ten piezoelectric beam branches arranged in a cascading design was constructed to compare the electrical output of beams with and without leaf appendages. The water used by the tree is neither consumed nor contaminated and the tree can be incorporated into existing water runoff and wastewater treatment systems. The goal is to develop a sustainable, environmentally-friendly energy source.

Honorable Mention

Habab Idrees

Pakistan

Multi-Purpose Smart Solar Device

Abstract: The water storage tanks used across Pakistan are usually made of fiber or plastic. The temperature of water in these storage tanks rises unbearably in summers and falls in winters. This problem is unavoidable globally. To my finest knowledge, the solution of this problem has not been achieved with a single device maintaining the cost effectiveness, global environmental issues. Different types of geysers (Electrical, Gas) are used to raise temperature of water in winters that has high running cost and cause pollution. The solar geysers are unaffordable. There is no effective solution for keeping temperature of water low in summers. This innovative design was created by fusing the characteristics of solar devices and thermos; it uses basic phenomenon of conduction, convection, radiation, reflection, insulation and greenhouse effect. The test run of this device in summers to keep the temperature of water low, with respect to its surrounding as compare to other tanks, there was appreciable difference in temperature of 10C^0. In winters, it raised the temperature of water by 55C^0. Dual nature of this device and the cost effectiveness makes it far better than other solar devices. This device is smart because it has artificial intelligence. It adjusts itself according to its surroundings to yield maximum result. It can easily be controlled by an android application. The slight advancement in device can give us liberty to use it as solar distiller, oven, fruit dryer, and room heater. It can also be used to increase the biogas production in winters.

Honorable Mention

Kathy Liu

USA

Natural Additive-Enhanced Development of Novel All-Solid-State Batteries for Sustainable and Scalable Energy Storage

Abstract: In lieu of demands for high-density and lightweight energy storage, rechargeable lithium sulfur (Li-S) batteries hold promise as an efficient and sustainable method to address accelerating rates of energy requirements with the highest theoretical capacity (1675 mAh g-1 and energy density 2600 Wh g-1) of solid-state cathode materials to date. Challenges exist, however, from capacity loss through polysulfide dissolution throughout cycling and the electrically insulating nature of sulfur. Modern approaches suffer in regards to scalability, thus this project presents a novel all-solid-state D-glucose modified Li-S battery to enhance sulfur encapsulation and battery performance in an environmentally and economically sustainable manner. A working all-solid-state battery with modified composite cathode was successfully created showing electrochemical reversibility and good cyclability, meeting the engineering goal of creating an operative secondary battery. Further optimization of battery synthesis parameters to increase sulfur loading and chemical reversibility resulted in remarkable performance and capacity retention over 1000 cycles. Effective reduced cathode active material dissolution and increased reaction rates at the cathode interface were accomplished through D-glucose incorporation, and sulfur loading was enhanced by nickel mesh. Composite materials exhibit advantages of abundance and sustainability, achieving battery efficacy and cost competitive to modern industry cells. Highly flammable liquid electrolytes are also addressed by the all-solid-state design in this project, comprehensively making battery application in electric vehicles, portable electronics, and transportation a more secure, sustainable, and practical solution to overcoming energy demands.

Honorable Mention

Maya Varma

USA

A Wireless Smartphone-Based System for Diagnosis of Pulmonary Illnesses

Abstract: The prevalence of respiratory illnesses such as Asthma and COPD (Chronic Obstructive Pulmonary Disease) has been growing rapidly across the world. The spirometry equipment used in hospitals for pulmonary function testing costs thousands of dollars. In this project, my objective is to design a smartphone-based low-cost full-function pulmonary function analyzer that can be used to measure lung function and diagnose various respiratory illnesses. I have successfully developed a prototype of the pulmonary function analyzer and completed extensive testing of the system. The mechanical part of my system consists of a 3D-printed spirometer shell. The instantaneous flow rate during breathing is measured by a pressure sensor as air passes through a fine wire mesh in the shell. The pressure sensor output is sampled by a microcontroller, which transmits the information over a Bluetooth 4.0 link. The measurement data is received by an Android app running on a smartphone or tablet, which analyzes the data and displays it graphically. The app computes various quantitative metrics of the lung performance and compares them to their predicted values based on the user's age, gender, etc. Based on these comparisons, the app determines the probabilities of the results matching the characteristics of five different respiratory diseases: COPD, Asthma, Emphysema, Chronic Bronchitis and Restrictive Lung Disease. I used the IngMar Medical ASL 5000 breathing simulator to validate my system, by simulating the breathing patterns symptomatic of various diseases. The results show that my system classifies the air flow patterns resulting from the five different diseases and makes inferences correctly. The total cost of parts of my design is $35, allowing it to be sold commercially for under $50.