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2016 ISEF USAID Science for Development Awards at a Glance

Winners

Haya Ahmed Mohamed & Mdouna Attaalla, Egypt
Desalination by Pervaporation System

Shantanu Jakhete, USA
Novel Mosquito Control: A Chemical-Free, Low-Cost Approach for Aedes aegypti Reduction via Specific Range Frequency Sweep

Chaitanya Dasharathi Karamchedu, USA
Addressing Global Water Scarcity with a Novel Hydrogel Based Desalination Technique Using Saponified Starch-g-polyacrylamide and Its Hydrophilic Properties to Harvest Fresh Water with a Low Energy and Chemical Footprint

Rahul Ramesh, USA
A Novel Algorithm for Detection of Plasmodium falciparum Parasites in Digitized Blood Samples

Honorable Mentions

Yu Ki Sim, Singapore
Early, Affordable and Rapid Viral Detection: Revolutionizing Home Diagnosis of Dengue and Zika through Lateral Flow Biosensing

Shreyas Kapur, India
Cellphone-Based Optometry using Hybrid Images

Mansi Ajey Apte, **Vishal Hareshkumar, & Dhanji Vekaria**, Kenya
Acacia xanthophloea Characterization and Preservation Techniques of Sapwood (Plant Xylem) as a Low Cost Membrane Filtration Device for Arid and Semi-Arid Areas in Kenya

Roxana Cuevas & Claudia Poblete, Chile
Seismic Alerter (Spanish: Alertador sismico)

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

Haya Ahmed Mohamed & Mdouna Attaalla

Egypt

Desalination by Pervaporation System

Abstract: Fierce national competition over water resources has prompted fears that water issues contain the seeds of violent conflict. In contrast, water scarcity is one of the biggest grand challenges that face the world especially Egypt as standard human usage of water is 3000 L/year while Egypt provides less than 500 L/year. The ability to desalinate seawater became a priority. As a result, our purpose is constructing a system of water desalination that can afford high salinity water more than 90,000 ppm with low cost, energy consumption compared to other systems, available material dependence in Egypt, good mechanical and thermal stability for the membrane and eco friendly. Therefore, pervaporation technology was chosen to deal with this significant problem by heating feed water to 80C using a membrane cell exposed to vacuum resulting in vapor permeate that is condensed to form fresh water. Prototype was constructed for addressing the effect of initial salt solution concentration (C_i) and pervaporation temperature (T_{pv}) on the water flux (J), salt rejection $(\%SR)$. The membrane was prepared by phase-inversion technique from cellulose acetate and graphene oxide, before which the membrane was subjected to pretreatment. The results confirmed J varied from (6) to (9) l/m^2h with high salt rejection 98 % at T_{pv} (80C). For the sake of saving energy the system was integrated to raise only 20C instead of 55C. Pervaporation can be used in multitude of different applications as treatment of formation water. Subsequently, this system can be applied in poor countries accessing fresh water to citizens.

Winning Abstract

Shantanu Jakhete

USA

Novel Mosquito Control: A Chemical-Free, Low-Cost Approach for Aedes aegypti Reduction via Specific Range Frequency Sweep

Abstract: Mosquito control is crucial to fighting diseases, such as zika, malaria, and dengue. Extensive research has been done on chemical-free control, such as the use of sound as a means of mosquito control. Prior research, however, single tone sound was used to repelling female mosquitoes. This project explores the novel use of a frequency sweep to attract male mosquitoes to a sound source. This device generates frequency sweep through a pre-set range using a microprocessor controller. This frequency range is determined by the wingbeat frequency of the female mosquito, specifically during the mating phase of the life cycle. The frequency sweep allows the device to emulate the sound of a female mosquito, attracting sexually-active males in the population, to the sound source. In addition, this concept compensates for any extraneous environmental factors affecting mosquito control. To evaluate efficiency of the concept, a high-voltage mesh was fitted on the device which terminates the mosquitoes caught. In the study, a population of Aedes aegypti was investigated. The study was successful, as it was proven that a variable frequency sound sweep can be used to target male Aedes aegypti. The device achieved an average death rate of 23.5 mosquitoes per minute, by reducing the male population (of 300) in cages by 29% in only 200 seconds. With this efficiency, the device can be deployed to target male mosquitos so that over time, the rate of reproduction is lowered, and the overall mosquito population is controlled, mitigating the risk of disease transmission. More importantly, since the concept exploits an inherent insect behavior, it can be applied to most insect species, and can reduce insect populations without the use of harmful chemicals, ultimately saving lives.

Winning Abstract

Chaitanya Dasharathi Karamchedu

USA

Addressing Global Water Scarcity with a Novel Hydrogel Based Desalination Technique Using Saponified Starch-g-polyacrylamide and Its Hydrophilic Properties to Harvest Fresh Water with a Low Energy and Chemical Footprint

Abstract: To address global fresh water scarcity, a novel hydrogel based seawater desalination technique using a superabsorbent starch based polymer is proposed. Current approaches rely on thermal, membrane, or hybrid approaches to desalinate water and impose high energy and environmental costs. Approximately only 3 percent (by weight) of seawater contains dissolved solids (including salt) that are bonded to less than 10 percent of seawater. This study harvested the remaining water using saponified starch-g-polyacrylamide's hydrophilic properties. This required a) the creation of a hydrogel to separate fresh water from seawater, b) the separation of the hydrogel from the brine solution, c) the dewatering of the gel resulting in aqueous sulfuric acid and d) the recovery of fresh water from the aqueous solution. The study demonstrated that a) It is possible to use such a hydrophilic starch based polymer to desalinate water without thermal or electrical energy, b) that the extracted water's conductivity is comparable to fresh water indicating that the salts have been separated, and c) that this approach has promise in mitigating the problems of pre-treatment and post-treatment during desalination. Mass and conductivity analysis confirmed that the extracted water had a total dissolved solids concentration of 513 mg/L, within the WHO guidance for good drinking water (<600 mg/L). Sustainable and accessible means for desalination have potential to improve millions of lives; the implementation of the proposed hydrogel based desalination technique can address this need with very low infrastructure investments and a high yield for irrigation needs (90%) and potable water needs (73%) with no chemical contaminants, while producing a commercially useful fertilizer ($CaSO_4$) as inert byproduct.

Winning Abstract

Rahul Ramesh

USA

A Novel Algorithm for Detection of Plasmodium falciparum Parasites in Digitized Blood Samples

Abstract: While malaria has been eradicated in the United States since 1951, it affects almost 200 million worldwide, killing half a million a year in developing regions of the world. The disease occurs when mosquitoes inject Plasmodium falciparum into the bloodstream of a human. Malaria is easily treatable when detected; however, it continues to ravage developing areas due to a lack of high-quality equipment and well-trained technicians. Recent advances in technology have resulted in the development of low-cost, smartphone-based microscopes for use in underdeveloped areas, but these devices still need trained technicians to analyze the blood samples. In this project, an algorithm was developed that automatically analyzes digitized images of Giemsa-stained blood samples to identify the presence of P. falciparum in the blood and calculate the parasite load. Using local binary pattern-based feature extraction and a cascade-based, multi-stage classifier, the algorithm identifies the presence of infected erythrocytes and counts the amount of detected parasites. The ratio of infected erythrocytes to uninfected ones is used to diagnose malaria. Testing of the algorithm on 10 infected and uninfected patients shows that the algorithm demonstrated 100% sensitivity (true positive rate) and 100% specificity (true negative rate). A smartphone implementation that works in conjunction with a portable smartphone based microscope has been developed. The work has the potential of creating an inexpensive but reliable malaria diagnosis tool that can potentially save millions of lives, especially those of children in underdeveloped countries.

Honorable Mentions

USAID FROM THE AMERICAN PEOPLE

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

Yu Ki Sim

Singapore

Early, Affordable and Rapid Viral Detection: Revolutionizing Home Diagnosis of Dengue and Zika through Lateral Flow Biosensing

Abstract: Capacity to control outbreaks and manage patient care for debilitating mosquito-borne flaviviral diseases hinges critically on early, rapid and accurate diagnosis. However, RT-PCR and MAC-ELISA, de facto standards in flavivirus diagnosis, lack efficiency and require expensive laboratory equipment, making them unaffordable to many health systems. In this work, lateral flow biosensors prove ideal as a point-of-care kit to diagnose flaviviral infections, viz. dengue and zika, the leading causes of illness and death in the tropical and sub-tropical regions. Gold nanoparticles (AuNPs) were conjugated with protective H-CALNN-OH peptide and antibodies specific for the sandwich-type capture of NS-1 proteins. Peak absorbance at 520 nm was maintained even in salt-mediated aggregation, proving AuNPs' sustained robustness and prolonged shelf-life in various physiological conditions. Cyclic voltammetry of surface-functionalized ferrocene was used to quantify the concentration of the sandwiched antigen-antibody complexes. Detection limit of 0.5-5 ng/mL was measured, a one order of magnitude improvement in comparison to current limits of 30-90 ng/mL. This increased sensitivity allows for diagnosis to be done two days post-infection (c.f. 10-14 days using current methods), better supporting disease management. Further, diagnosis results are obtainable within two hours, mitigating the compromise of rapidity for accuracy. The use of AuNPs on lateral flow biosensors shows potential to revolutionize patient care by enabling precise, prompt and cost-effective diagnosis of flaviviral infections. With simple variations made to the specific antibody attached, the utility of such kits can be maximized to cover the full spectra of flaviviral, and potentially other infectious disease diagnosis.

Honorable Mention

Shreyas Kapur
India

Cellphone based Optometry using Hybrid Images

Abstract: Measurement of refractive error of the eye requires expensive equipment which are generally not portable. My goal is to greatly simplify the process, reduce its cost and use no external hardware except a mobile device. This is done by using Hybrid Images, exploiting that the eye lens behaves like an optical low-pass filter. A Hybrid Image is a combination of low spatial frequencies of one image and high spatial frequencies of another. This creates an image that is perceived in one of two ways, as a function of the viewer's distance or refractive error. My method requires a mobile device showing a series of hybrid images, to be held at a distance with the user giving simple inputs to the mobile device. This allows us to search for the standard deviation of the Gaussian point spread function, thereby calculating the myopic prescription. I also extend this to non-trivial point spread functions and estimate the Zernike coefficients, thereby calculating the wavefront and assigning prescription. In this project I discuss the approach and verify its accuracy.

Mansi Ajey Apte, Vishal Hareshkumar & Dhanji Vekaria
Kenya

cacia xanthophloea Characterization and Preservation Techniques of apwood (Plant Xylem) as a Low Cost Membrane Filtration Device for Arid and Semi-Arid Areas in Kenya

Abstract: This project explores the water purification properties of the sapwood of Acacia Xanthophloea to provide safe and clean water to arid and semi arid areas in Kenya that is cheaper and easily accessible. Samples of the species were collected and stored in buckets of water so as to maintain the freshness of their xylem. Several tests were then carried out on the branches of the species after building a basic xylem filter, using the sapwood of the species, some plastic tubing and hose clamps. Firstly, a test was carried out to test the best direction of the flow and the rejection rate of water so as to obtain the best results of purification. Secondly, the rejection rate was measured using different lengths of sapwood so as to determine the best length of the sapwood for purification and the effect that it had on the rejection rate of the sapwood. Thirdly, because we want to implement this method of purification in arid and semi arid areas where people would collect water from a river or lake, it was important for us to test a sample of water from a naturally contaminated source so as to determine whether the sapwood would be useful to purify water from such sources. In addition to that a test was carried out to observe for how long a piece of sapwood can purify impure water until it loses its permeability. Lastly an experiment was carried out to determine how the sapwood can be preserved for longer so as to increase its productivity as a water purifier. In conclusion we realized that the sapwood from Acacia Xanthophloea can be a cheaper way of purifying water in a way that it is perfectly suitable to be used in semi-arid and arid areas for the benefit of the people considering its availability in those areas.

Honorable Mention

Roxana Cuevas & Claudia Poblete
Chile
Seismic Alerter (Spanish: Alertador sismico)

Abstract: There is still not the technology to predict seismic movement, but we can anticipate to this kind of events. Our project aims was to alert several seconds in advance, and as a consequence helping to diminish the natural disaster´s effect, such as earthquakes, This is very useful in a country that is on the tectonic fault (Nazca and Antarctic Plate) and that regularly suffer from these episodes seismic. For this we create a platform consisting of hardware (seismograph), as a means of communication, which have a line of Internet and a computer acting as a server alerts. In addition, we build an Android application to receive these alerts, then it makes tracking user state once it ends and we can manage the information that will be sent to relevant Emergency/Disaster Management agencies.