USAID
FROM THE AMERICAN PEOPLE

Intel International Science and Engineering Fair **(ISEF)**

USAID Science for Development Award

2019 Winners

Global Health

Energy & Water for All

Digital for Development

Humanitarian Assistance

17 young scientists

$40,000 in awards

Brilliant **solutions** for development

USA

India

Thailand

South Africa

2019 USAID Science for Development Award ISEF Winners

Global Health

1st Place:

Susanna Dorminy, USA
Freeze Protected Vaccine Cold Box for Off-Grid Locations, Year Three

2nd Place:

Daniel Fleury, USA
Deployment of a Scalable Single Shot Detector (SSD) Mobile Architecture for the Localization and Classification of Pneumonia Chest Radiographs

3rd Place:

Neil Deshmukh USA
An Adaptive, Low-Cost Device for Automated & Offline Medical Analysis Utilizing Neural Networks with Reinforcement Learning Optimization

Energy & Water for All

1st Place:

Jeancarlos Melendez, USA
Optimized Homemade Water Purification System: The Solution to the Worldwide Potable Crisis

2nd Place:

Hritik Mitha, South Africa
Improving the Harnessing of Solar Energy Using a Hybrid Photovoltaic Thermal System

3rd Place:

Akash Rathod, USA
Using Raw Bamboo Waste to Sustainably Purify Water

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.

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Sanjit Thangarasu, USA

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Global Health

PHOTO COURTESY OF USAID

Global Health

1st Place

Susanna Dorminy

USA

Freeze Protected Vaccine Cold Box for Off-Grid Locations, Year Three

Abstract: Temperature sensitive vaccines such as polio and measles must be maintained at a 2-8 degrees Celsius temperature range to avoid spoilage and insure potency. Vaccine Cold Boxes (VCBs) carry monthly vaccine supplies from district stores to local health facilities and to remote villages, making VCBs the most important link in the cold chain. The World Health Organization (WHO) requires VCBs to have a minimum 48-hour cold life, the time 10-0 degrees Celsius is maintained at 43 degrees Celsius externally. To maintain this range, standard VCBs use coolant packs which must be conditioned/warmed at room temperature for 1-2 hours if they are frozen. This is not routinely followed, leaving an estimated 75-100% of vaccines exposed to freezing temperatures according to previous studies. The researcher created a large capacity, freeze-protected VCB cooled with thermoelectric coolers (TECs) controlled by an Arduino Nano. For vaccine freeze-protection cold life testing, the 5 liter Vaccine Cold Box prototype was tested with frozen (-25 degrees Celsius) coolant packs in 43 degrees Celsius conditions for 48-88.8 hours. A removable temperature logger provided data. Upon activation, the refrigeration unit's internal temperature reached the 10-0 degrees Celsius range in 12.0 minutes and maintained the range for temperature sensitive vaccines for maximum of 71.5 hours in external temperature conditions of 43 degrees Celsius. The goal of the project was to create a large capacity freeze protected Vaccine Cold Box with a 2-8 degree Celsius range for a minimum of 48 hours in compliance with WHO standards. This new, large, freeze-protected prototype maintains 2-8 degrees Celsius with 43 degrees Celsius external temperatures using frozen coolant packs for over 71 hours

Global Health

2nd Place

Daniel Fleury

USA

Deployment of a Scalable Single Shot Detector (SSD) Mobile Architecture for the Localization and Classification of Pneumonia Chest Radiographs

Abstract: Pneumonia emerges as the leading cause of death in children under five years of age worldwide, accounting for more than 1.6 million deaths each year in this age demographic. A combined 18% of these deaths occur in children, and 99% of these complications circulate in low-middle income countries with underserved on-point clinical interventions. Consistent and scalable diagnostic protocols that eliminate problematic human false negatives/positives are essential in preventative clinical and pulmonary treatment measures. The upsurge of Convolution Neural Network (CNN)-driven object detection tasks in the previous ~2-3 years has provided a new field of manipulation for radiographic image feature map detection. This project investigates the potential of a low-latency mobile scaled Single Shot Multibox Detector (SSD) architecture in the localization and classification of Pneumonia-related radiographs. A dataset of ~5000 annotated and de-identified bacterial and viral Pneumonia chest X-Rays were derived from the NIH Clinical Center to deploy a compressed frozen inference model on both a standard Android device and cloud-based web application. Data analysis employed varying confidence thresholds on Receiver Operating Characteristic Curves (ROC), regularized and converged localization-classification loss, and broad total loss values to frame parameters of sensitivity, specificity, and performance on diverse pre-identified NIH validation datasets. Following a mini sample size validation of 200 randomized lung radiographs, SSD Mobilenet V1 attained an Area Under the Curve (AUC) of 0.93 with high threshold sensitivity of 94% and a specificity rating of 82% on a standard real-time Android video capture. The SSD model proves applicable in real time diagnostics.

Global Health

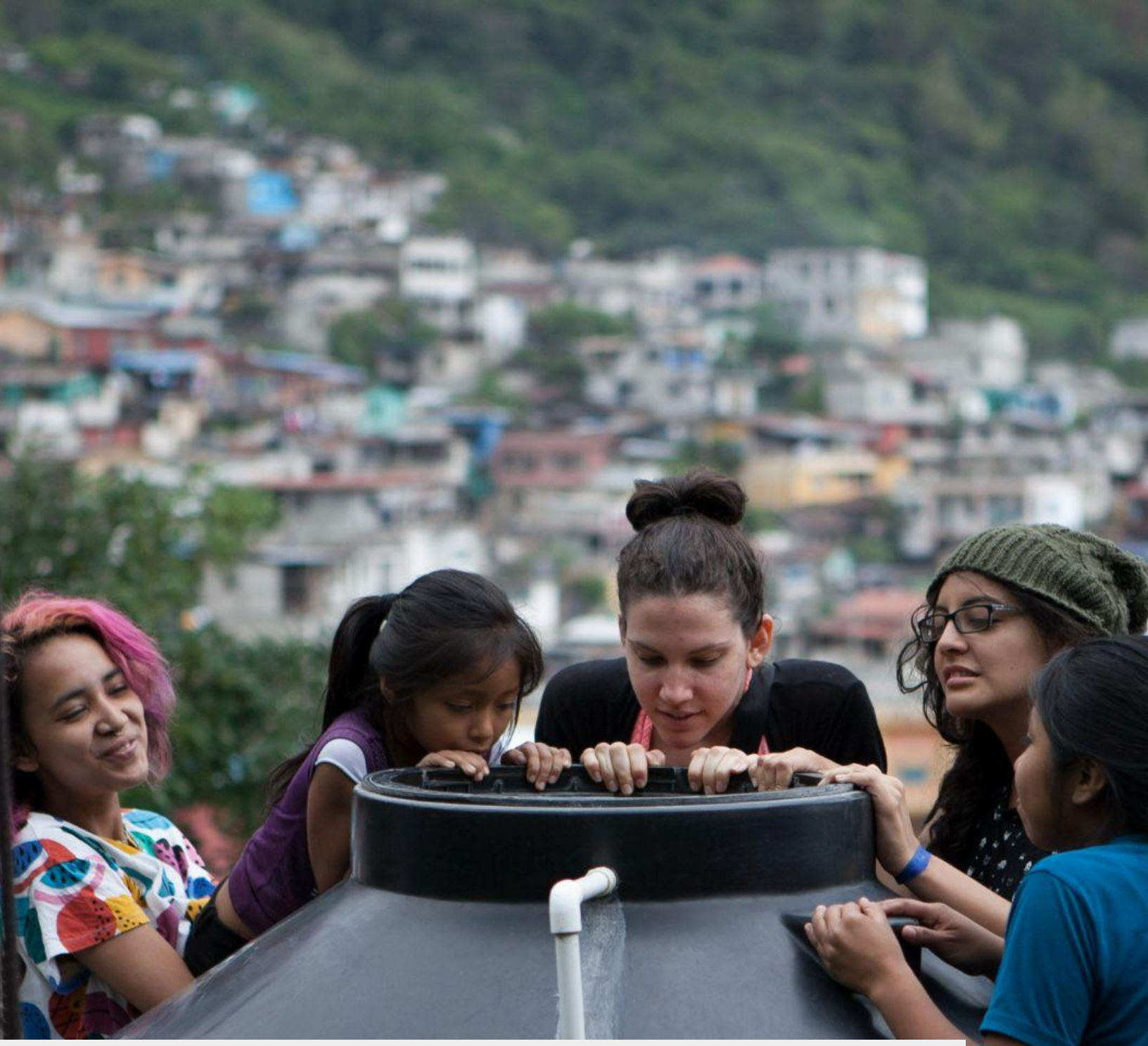
3rd Place

Neil Deshmukh

USA

An Adaptive, Low-Cost Device for Automated & Offline Medical Analysis Utilizing Neural Networks with Reinforcement Learning Optimization

Abstract: Diagnosing diseases automatically has been an immense challenge, owing to their variable properties and symptoms. On the other hand, Neural Networks (NNs) have developed into a powerful tool in the field of machine learning, one that is showing to be promising at computing diagnosis even with inconsistent variables. In this research, a low-cost device was developed for straightforward analysis and treatment of human diseases. By utilizing NNs, architecturally optimized through reinforcement learning, the device can detect diseases and conditions, all automatically, using end-to-end deep learning. It does so with an extremely high accuracy rate, comparable to medical personnel. The Deep NN algorithm can identify 1,557 various diseases, along with providing treatment advice. Biometric values such as oxygen saturation and electrocardiogram (ECG) values are calculated using a Recurrent NN (RNN), developed to detect anomalies: myocardial arrhythmias and ischemias. A Convolutional NN is on the device to identify and segment dermatological lesions. Vocal tone analysis, through an RNN, is in progress to detect cognitive decline. These algorithms all run on a Raspberry Pi processor. This device can augment doctors by speeding up the time needed for diagnosis by pre-analyzing the user and providing estimated conditions. This scalable method of detecting anomalies before they pose a threat, holds the ability to create clinical impact around the world by profoundly increasing access and scope of medical care. Overall, this device will help alert physicians to high-risk patients, while making the doctors' analysis much more efficient; therefore, saving people, while decreasing costs and time.



Energy & Water for All

PHOTO COURTESY OF USAID

1st Place

Jeancarlos Melendez

USA

Optimized Homemade Water Purification System: The Solution to the Worldwide Potable Crisis

Abstract: Having a source of potable water is essential for every country's survival. Therefore, people need to know how to supply themselves with purified drinking water in case of a crisis. As in Puerto Rico, being a month into Hurricane Maria's disaster, only 16.89% of the consumers had domestic water service. Using materials found at home, it is possible to create a purifying system which is an alternative to the conventional house water supply on which we depend for our daily lives. After taking samples of spring and river water, both were taken through the purification procedures of the built system. When the final products were obtained, they were analyzed at a laboratory for potability purposes both before and after the purifying process. Afterwards, they were compared to determine if the system was effective or not, according to the potability parameters established by the local water supplier. The results that were gathered showed a satisfying answer to our doubt on the system's effectiveness. The tests performed on the purified samples were: chlorination (0.2-4), turbidity (0.0 – 0.3) and pH (6-8) levels. Therefore, the results of chlorination (1.81- 1.87), turbidity (0.04-0.13) and pH (7.12) were accepted by the parameters before mentioned. This study showed that the built system was effective, when both purified samples were compared to the water supplier's parameters. Proving that the system is simple and effective, making it the solution to a problem we could face at some point when humanity lacks of potable drinking water.

Energy & Water for All

2nd Place

Hritik Mitha

South Africa

Improving the Harnessing of Solar Energy Using a Hybrid Photovoltaic Thermal System

Abstract: Solar photovoltaic panels are becoming increasingly competitive sources of household energy due to their continually decreasing costs. As photovoltaic panels, they are currently limited to an efficiency of 13-20%, as solar energy is only converted to electrical energy. This project aimed to increase the energy efficiency of solar panels by extracting the thermal energy that would otherwise be dissipated as waste heat. This heat also has an adverse impact on the solar panel's electrical performance and lifespan. Using readily available materials, small scale (10W electrical rating) prototypes of modified solar panels were constructed, with front and back water cooling. When operated without improved coolant circulation timing there was an increase in total energy efficiency, with the front cooled panel showing a doubling (>28%) in efficiency whilst the back cooled panel more than tripled (>42%) it's overall efficiency. Using an improved coolant circulation timing algorithm, which balanced the heat loss from the panel and the coolant pump energy consumption, further increased the overall efficiency of the front cooled and back cooled panels to (>54.1%) and (>65.9%) respectively. The back cooled panel also had an increase in electrical efficiency from 13.7% to greater than 20.3%. As the cost of modification was less than that of the photovoltaic panels the benefit of energy savings would exceed the cost of modifications making it economically viable as a household energy source. The project has achieved the engineering goals of improving the efficiency of solar panels in a practical and cost-effective manner.

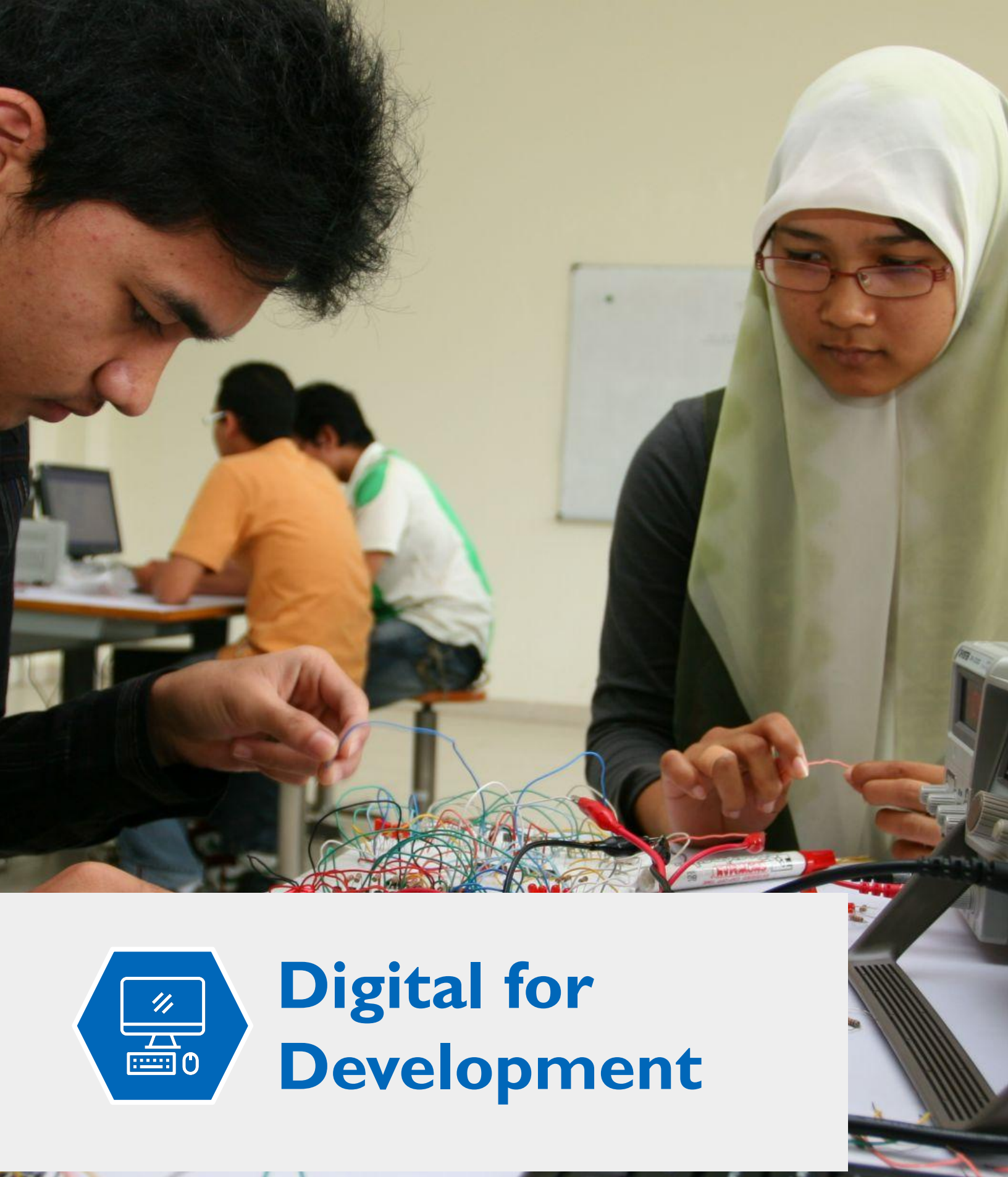
3rd Place

Akash Rathod

USA

Using Raw Bamboo Waste to Sustainably Purify Water

Abstract: Anionic dyes are commonly used in the paper, dyeing, petroleum, and textile industries, contributing to global water pollution that harms microbial populations and can be carcinogenic to mammals. However, current techniques of dye removal are largely inefficient and expensive, making them infeasible for large-scale use in developing countries. The goal of this research was to develop an eco-friendly, affordable, and sustainable technique for wastewater purification. The methodology developed in this study utilizes the reaction between the aldehyde groups of dialdehyde cellulose (DAC) and cationic Girard's Reagent T ((2-hydrazinyl-2-oxoethyl)- trimethylazaium chloride, GT) to synthesize a positively charged cellulose derivative called cationized dialdehyde cellulose (cDAC). The use of cDAC as a cheap and sustainable adsorbent is considered for the removal of negatively charged dyes such as Congo Red (CR). The influences of a variety of parameters were tested, including pH, dye concentration, contact time, and cDAC concentration. The adsorption kinetics were modeled by pseudo-first-order kinetics and pseudo-second-order kinetics. Additionally, the adsorption equilibrium data conformed to the Langmuir and Freundlich isotherm models. Promising results were obtained for the use of cDAC as a new adsorption agent for CR, with a high adsorption capacity (Qm) of 909.09 mg/g and the ability to remove 99.9% of dye from wastewater in just 15 minutes. This adsorbent opens numerous applications for sustainable and effective wastewater purification.



Digital for Development

PHOTO COURTESY OF USAID

Digital for Development

1st Place

Sanjit Thangarasu

USA

AccessO2: An Innovative, Non-Electric, Life-Saving, Oxygen Concentrator

Abstract: I have designed and constructed a human-powered oxygen concentrator based on pressure swing adsorption that operates without electricity. Millions with ailments treatable by concentrated oxygen, like hypoxemia, live in countries without access to compressed oxygen or stable electricity for oxygen generation. Although compressed oxygen cylinders are preferred, each 300 ft3 cylinder lasts only four days at 1.5 L/min flow. Portable electrical oxygen concentrators can be charged by solar power, but this may cost over $2,600 for the oxygen generator, battery and solar panel plus is weather dependent. My system will cost around $500. Under pedal power my system generates oxygen concentrations ranging from 30% to 80%, typical for use in hospitals, with flow rate sufficient to supply one patient. My system compresses air into pores in zeolite (an alumina-silicate ceramic lattice with uniform pores 5x10-10 m diameter), preferentially adsorbing nitrogen based on molecular size and chemical affinity. Because nitrogen is retained, oxygen passes through at higher concentrations. The cycle is completed by purging nitrogen from the zeolite allowing repetition. Last year, I learned Zeolite 13X only absorbs nitrogen based on pore size, requiring more pressure to achieve higher oxygen concentrations. For 2019 I replaced Zeolite 13X with Zeolite LiX, and with additional design changes generated a steady state concentration of 59% with an average flow rate over 1.5 L/min. Zeolite LiX is ionized with lithium, polarizes nitrogen, and retains nitrogen better, resulting in higher concentrations. The output is usable to treat neonates and infants suffering from infant respiratory distress syndrome.

Digital for Development

2nd Place

Lillian Petersen & Garyk Brixi

USA

A Novel Computational Tool to Inform Cost-Effective Nutrition Interventions in Sub-Saharan Africa

Abstract: Malnutrition is the leading cause of child death and treatment reaches only a small fraction of those in need due to costly recipes and inefficient supply chains. Here we develop a three-component tool to inform cost-effective nutrition interventions. First, we forecast the geospatial caseload of acute malnutrition using machine learning algorithms and reached correlations of 0.95. Second, we design software to optimize low-cost specialized nutritious foods while meeting nutritional standards. The software was applied to international and local commodity prices in 26 sub-Saharan countries and achieved ingredient cost reductions up to 60%. Prototyping of an optimized recipe in Kenya in collaboration with an NGO verified the optimizer's accuracy. Third, we develop a tool to inform production and distribution decisions of acute malnutrition treatment by modeling a supply chain of local and international procurement. We first validated the tool by modeling the current UNICEF supply chain, calculating values within 3% of actual costs. We then optimized a supply chain of current and novel recipes to minimize cost while treating the full caseload. Our parameter study of the variable costs identifies cost drivers and recommends countries that are suitable for investment in local production despite possible market shifts. Our model suggests that optimized recipes could reduce total procurement costs by 25% while improving environmental sustainability through local production and optimized supply logistics. Used in conjunction, these tools could better inform policymakers on recipes and supply chains that reach more children with lifesaving treatment within existing budgets while supporting sustainable development and future food security in developing countries.

Digital for Development

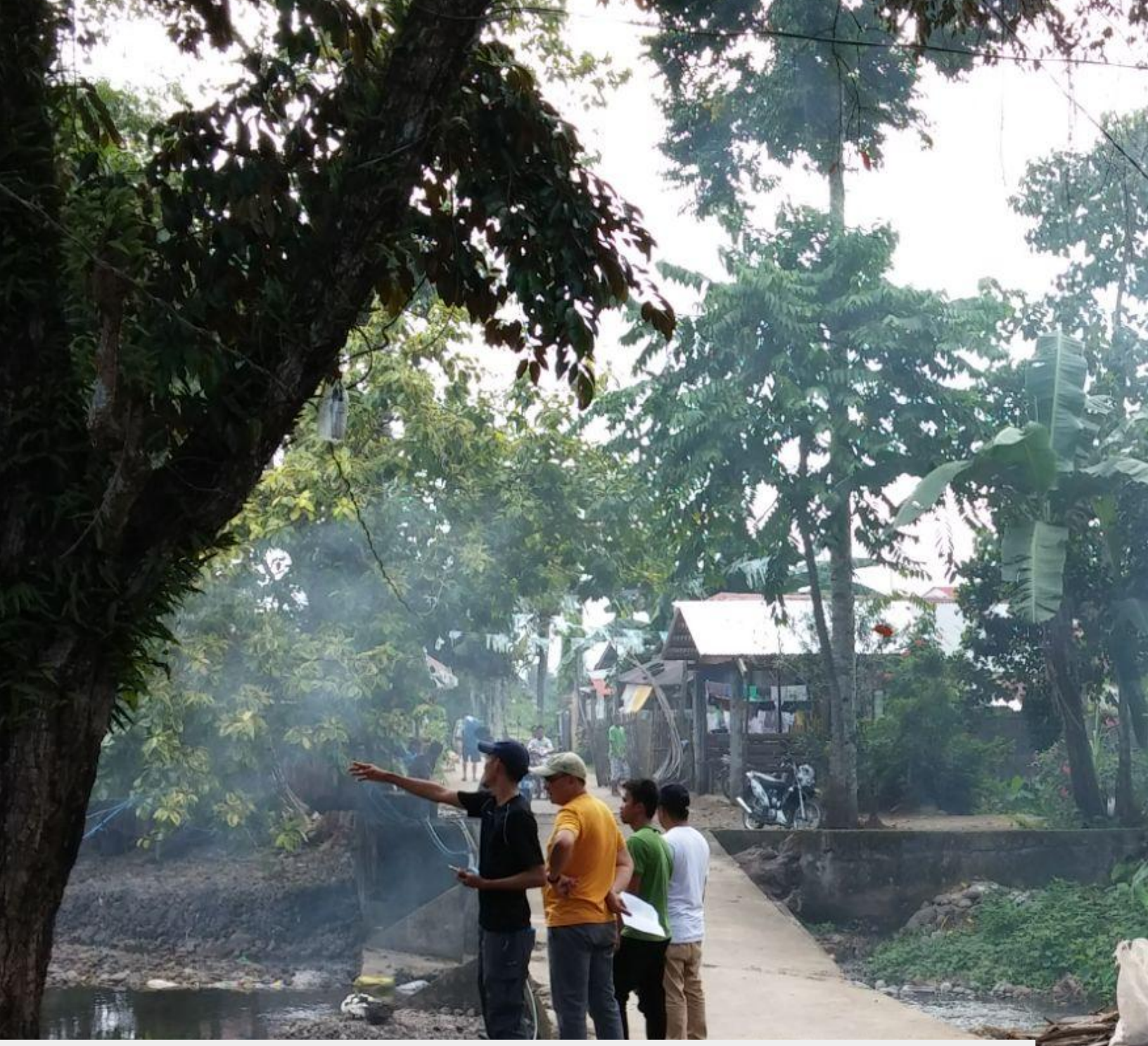
3rd Place

Aditya Radhakrishnan

India

Positively Identifying Species Using CNNs and Hypernetworks to Aid Wildlife Conservation Efforts

Abstract: Positively identifying endangered species has been a global challenge in wildlife conservation efforts. Traditional methods such as morphological means of identification require expert knowledge. Modern biotechnological tools require extensive infrastructure and capital resources. Convolutional Neural Networks have shown immense promise in classifying images. As a first step towards creating a solution, CNNs were trained to identify images of species and of their artifacts, like footprints or feces. However, CNNs have a severe limitation - they require several images for training. These images are unavailable for countless endangered species that play vital roles in ecosystems. Very few images, often only one, have ever been taken of these species. To overcome this problem, a new approach has been proposed, using a hypernetwork. The hypernetwork takes a single image of a common species as an input and outputs another neural network – a classifier. During training, backpropagation is performed on the classifier and gradients are computed and squared. These are used as the loss for the hypernetwork, with which it is trained. This is repeated for several images and several species. After training, an image of a rare species can be given to the hypernetwork to generate a classifier that can identify other images of that species. In one test of the method, dog breeds were considered. The mean accuracy of the classifiers produced by the hypernetwork was 90%. The test results showed that this solution can be used to identify endangered species. When put alongside traditional CNNs in an app, it can be effective in curbing poaching and trafficking, monitoring wildlife populations, and analyzing diversity. It can also be used offline in remote areas.



Humanitarian Assistance

PHOTO COURTESY OF USAID

Humanitarian Assistance

1st Place

Samantha Davis & Alicia Kuhlmann

USA

A Continued Study of a More Realistic Solution to Refugee Housing Using the Isoperimetric Honeycomb Conjecture

Abstract: Over 1.5 million people live in refugee camps around the world. Wind storms of over 80 miles per hour rip current refugee tents apart, destroying what little refugees have left. Regarding our irregular polyhedron, this year our objective was to transform our design into a final product. After testing in a wind tunnel and using aerodynamics calculations we found the wind resistance of our structure to be over 174.67 miles per hour. We designed inexpensive, waterproof connectors to securely hold the structure together. To make these, we calculated each dihedral angle of our structure by using multivariable calculus and Euclidean geometry. We used three-dimensional vectors to calculate the cartesian point of each vertex then drew normal vectors from each vertex using the cross product. The point of intersections of these normal vectors was then inserted into an inverse cosine function thus giving us the dihedral angles. Our final 5-6 person structure is waterproof and fire resistant lasts 20 years, and costs $96, which is 400-500 dollars cheaper than anything comparable on the market today. Our house follows the laws of special right triangles and therefore can be as small as a 1-2 person house or as big as a temporary hospital or school. Our efficient design, combined with the wind resistance of the structure, can help millions of refugees and has applications to help others such as military personnel or victims of natural disasters.

Humanitarian Assistance

2nd Place

Jetsada Sittikhankaew, Namphung Panya, & Phirachat Kochanil

Thailand

Coating Highland Rice Seeds with Local Spondisas pinnata Gum Can Reduce Seedling Mortality Caused by Water Deficit During Rain Delay

Abstract: Seedling mortality from water deficit during rain delay period is a major problem of highland rice farming. The objective of this project is to investigate a method to protect the rice seeds from damage by water deficit during rain delay. We observed that the local Spondias pinnata gum, Bombax ceiba gum and Afzelia xylocarpa gum, normally left to rot, were swollen when soaked in rain. We thought that they should be able to provide moisture to rice seed if the seeds are covered by the gum, We, thus, studied the water absorbency and water retention of the gums compared with guar gum and polyacrylate. We found that Spondias gum showed higher water absorbency and water retention than the other gum and similar to polyacrylate but degrades in nature faster than polyacrylate. We coated 3 cultivars of rice seeds with these gums and found that rice seeds coated with local gum could reduce the penetration of bugs and fungi. The coated seeds showed 1.9 times higher water imbibition than uncoated seeds. Spondias gum coating resulted in higher germination percentage and survival rate than others. When water was withdrawn for 72 hours, the seeds coated with Spondias gum were still able to germinate and grow while the uncoated seeds were not. Coating the seeds can reduce water usage for germination and growth around 30- 40%. Our finding introduces a method using local material to prolong seed germination during rain delay and reduce water usage for their growth

Humanitarian Assistance

3rd Place

Pooja Jain & Neel Jain

USA

SkyHound: A Low-Cost 3D Printed Autonomous Wi-Fi Tracking Search Drone to Locate Missing Victims of Natural Disasters

Abstract: In 2018, Indonesia was hit with one of the deadliest earthquakes in its history, measured at a magnitude of 7.5. More than 1,000 died and as many as 5,000 remain missing. Current victim tracking technology focuses on biosignatures, such breath/heartbeat patterns or brute force search and rescue, but remain inaccessible to civilians due to high-costs and involving specialized, bulky, technology. With the growing desperation to find victims alive, there's a demand for emergency rescuers to efficiently obtain information on victims as soon as possible. Studies by Pew Research published in 2018 indicate that 77% of the US population own smartphones and 94% of them frequently carry it with them, with 82% of them rarely turning them off. With these statistics, we believe the most efficient way to find victims is through the tracking of civilian smartphones with a mobile system. The solution is SkyHound: a search and rescue 3D printed drone equipped with a Raspberry Pi, Wi-Fi Tracker and GPS to locate smartphones and their owners. This project locates victims by scanning an area for Wi-Fi probing requests and then stores essential, identifying information about the smartphones into a master list on an external USB. Afterward, the list is uploaded to Google Earth, producing a map plotted with exact locations of devices, and with them, survivors. The 3D printed drone, designed with cost-effective materials for easy part replacement, is optimized with the proper weight specifications to efficiently bear the weight of the technology. This meshes together to create a portable, cost-effective, easy to operate, search-and-rescue system that can maximize the number of lives found in a period of time allowing search and rescue authorities to pinpoint survivors as soon as possible.