Abstract: Science and Engineering Fair of Houston

1273

Goodnight, Lights!

Val(erie) Gualberto
Conroe ISD /McCullough Junior High

Category

Environmental Engineering

"Goodnight, Lights!" is a experiment to bring awareness to the excessive use of artificial light. This experiment hopes to relay concrete evidence that the visibility to drive at night whilst also being able to spectate stars is possible. Natural wildlife and its environment is being effected by streetlights and even the human race is as well. This experiment including changing the hue of a strip of LED lights that represent "streetlights" and attraction light whilst periodically taking photos of the outcome on how well you could see a photo of stars on the ceiling. The closer the photo was panned in, the less the visibility was and how ineffective that hue was. Teal/blue variety of light worked best and red variety performed worse. Each change was at 400k.

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Abstract: Science and Engineering Fair of Houston

1274

Modeling Climate Change Effects on Yellowstone's Ecosystem with a Programmable Multi-Agent Simulation

Neil Pawar
Conroe ISD /McCullough Junior High

Category

Environmental Engineering

As Yellowstone National Park grows hotter, drier, and experiences much less snowfall than it has in previous years due to climate change, it is clear something needs to be done. Using a programmable multi-agent system could help with testing possible solutions for adapting to this change in the environment. With this software, I built a model that matches the GYE (Greater Yellowstone Ecosystem) and added environmental factors essential to testing these possible solutions. After building the model, I recorded the results and built graphs to organize the data. After making observations based on the data, I made a conclusion based on my hypothesis or engineering goal. While programmable MAS software is capable of such experiments and acts as a good placeholder for more advanced software, naturally-occurring oscillations could make it unclear of how much change is due to global warming and climate change and how much of it is just decadal oscillations (natural changes in the weather that usually occur every decade).

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Abstract: Science and Engineering Fair of Houston

1275

Designing an earthquake resistant structure

Karim Kanash
Arhan Jain
Arhan Seth
Tomball ISD /Northpointe Int

Category

Environmental Engineering

Every single year 60,000 people die because of earthquakes destroying buildings. In this project me (Karim Kanash), Arhan Jain, and Arhan Seth hope to learn about earthquake resistant structures and the best method for them. We compared different methods of earthquake reenforced structures and settled on a combination of base isolation, tune mass damper, and reenforced walls. for our project we created a simulated earthquake to test the different types of structures, and unsurprisingly ours was the best. in conclusion we can say that earthquakes still kill a lot of people but that doesn't mean that the numbers can't decrease.

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Abstract: Science and Engineering Fair of Houston

1276

Wind Power!

Mason Ard
Clear Creek ISD /Brookside Intermediate School

Category

Environmental Engineering

Abstract Wind Power! The purpose of this project was to test the effect of wind turbine blade design on the amount of power the wind turbine will produce. A hypothesis was made, If the wind turbine blade gets wider and tilted, then the wind turbine will generate more electricity than the normal wind turbine design. To evaluate this, the following designs were made, two blade design, three blade design, four blade. The two blades produced the least amount of electricity, the three blades produced an intermediate amount of electricity, and four blade design produced the most. Then, a 4-blade wide design and a 4-blade thin blade design were made. The thin design produced no electricity, and the wide blade produced the most out of all designs. This overall shows that the more blades a wind turbine has, the more power it will produce; as well as the wider the blades are, the more power they will produce.

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Abstract: Science and Engineering Fair of Houston

1277

Oil Clean up Boat

Isabella Barrios
Conroe ISD /Irons Junior High

Category

Environmental Engineering

The objective of this science project is to find a boat that will clean up gasoline from the water in crowded coastal cities.The findings of this project will help improve the cleaning process for water, which will improve the water quality.The hypothesis stated that if a boat is tested to clean up gasoline from the water at different speeds, then when the boat goes slower it will clean up more gasoline than if it goes fast.In order to test the hypothesis a boat with oil socks on the sides was placed in a kids pool and driven at two different speeds,then the added mass to the oil sock was measured with a scale and recorded.The data showed that the slower a boat goes the more oil the boat could absorb.This study shows that a public transportation boat will absorb more gasoline that a private boat.

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Abstract: Science and Engineering Fair of Houston

1278

Hot Angles

Abigail Reichert
Clear Creek ISD /Seabrook Intermediate School

Category

Environmental Engineering

What is the effect of wall angles on a building's ability to keep out heat? The year 2023 has been the hottest counted ever and is getting worse daily. If different wall angles are tested, then the 60-degree angle will work the best to keep out the heat. The experiment was testing the buildings insulated from the top and bottom. The thermocouple was taped to both sides of the building. The heat lamp was placed one foot away from the building. The heat lamp was turned on. The timer was set for 15 minutes and record the temperature and repeat till 45 minutes. The heat lamp was turned off for 20 minutes and do the experiment again. The purpose of this experiment was to find which angles buildings let the least heat in over 45 minutes. In the experiment, there were five buildings tested. The 60-degree building had 1.99°C average. The flat building had 15.04° C average and was the worst building. The angle with the least effect on the was the 111 degrees with 7.92°C average. The 60-degree building worked the best with a high average of 1.99°C. This would be useful to architects to build 60-degree buildings. The results showed that the 60-degree building worked the best, so the hypothesis was correct.

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Abstract: Science and Engineering Fair of Houston

1279

The relationship between the amount of materials in a water filter and the pH level of the filtered water

Eduardo Meraz
Houston ISD /BCM Biotech Academy at Rusk - MS

Category

Environmental Engineering

This project could help with the way water filtration devices are built.Clean water is important, and with my project, I can find a way to achieve a more efficient form of water filtration.This could be important to know what materials are more filtering efficient.That way we could know what amount of materials is best to achieve the most neutral pH level. For the procedure,1. Cut the middle of the bottle(s) with scissors or a razor blade 2.Tie the rubber band to tightly grasp the paper coffee filter around the bottle top.The rubber band does not count towards material total as it is not part of the filter system 3.Flip and place the bottle over its bottom half 4.Add all the materials in this order starting from the bottom (may vary): Gauze pads Cotton balls Activated charcoal (Coarse) sand Pebbles Marble chips Add your materials into the top half of the bottles(for this experiment you need to have different amounts) 5.Then pour 2 handfuls of dirt and a pinch of baking soda to the water filled container and add it to the filters.Use pH strips to identify the dirty water's pH beforehand.Test the pH of the water by dipping the tip of the pH strip for at least 2 seconds and then wait around 15 seconds to see the results.Match color of strip to color of pH 6.Once the filtering is done, use the pH strip to measure the pH of the filtered water 7.The result should show that the water is more neutral(near pH 7) 8.Repeat, but this time replace the dirty water with acidic water by adding lime juice from 1 whole lime and 5% acidic vinegar(30mL) 9.Test the pH of the water.Match color of strip to color of pH 10.Document results in graph or chart. When I poured the water in the filters for both trials I observed that the more materials in a filter, the faster the water would be filtered. I also noticed that the more materials, the cleaner the water looked. The data also shows that the first filter was not very efficient. The other 2 filters did better, though the 3rd filter seemed to work a little less then the 2nd filter. The 2nd filter seemed to be the best overall, reaching a more neutral pH than the other filters, which was the main goal.The 1st filter did little to no

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Abstract: Science and Engineering Fair of Houston

1280

Water Purification

Hailey Henderson
SST - Champions College Prep - MS

Category

Environmental Engineering

The purpose of this experiment was to raise awareness of unsafe water around the world, and to show people how to purify water. What I did was i built my system by placing each material in the water bottle, then I poured the dirty water in the bottle. The result was that the dirty water turned clean when it exited the water bottle. I concluded that a water filtration system can actually clean dirty water.

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Abstract: Science and Engineering Fair of Houston

1281

What type of activated carbon is best to filter water?

Shanvitha Challarapu
Conroe ISD /York Junior High

Category

Environmental Engineering

Clean water is super important for daily life, and activated carbon is commonly used in filters to get rid of impurities and odors from water. So, picking the right activated carbon for a home filter is really important, and this experiment will help figure it out. Start by pouring a cup of tap water into a plastic cup. Stack 4 coffee filters and secure them with a rubber band to create the filter. In another cup, dissolve 4 grams of powdered activated carbon in a cup of tap water. Pour this mixture through the filter and measure the ppm. Then, do the same thing with granular activated carbon. The results show that powdered activated carbon turned the water from deep red to clear, while the granular activated carbon only made it a bit lighter and slightly lowered the ppm. Both types took a long time to filter the water, but the powdered form was clearly better at cleaning and removing impurities, as shown in the table and graph. In conclusion, powdered activated carbon does the best job at filtering water. This was because powdered activated carbon has a smaller size and larger surface area, making it better at absorbing impurities.

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Abstract: Science and Engineering Fair of Houston

1282

Analyzing the Efficacy of P. chrysogenum in the Biodegradation of Synthetic Plastic

Varun Iyer
Conroe ISD /McCullough Junior High

Category

Environmental Engineering

According to the United Nations Environmental Program (UNEP), the world produces 430 million tonnes of plastic waste each year. Single-use plastics take between 10 and 1000 years to break down. They have inundated marine, terrestrial, air, and human biological systems. This study explores the efficacy of Penicillium chrysogenum in biodegrading LDPE and benchmarks its efficiency against other plastics, such as polypropylene (PP) and polyethylene terephthalate (PET). LDPE, PP, and PET samples of the same size were placed in fungal culture for a ten day period on a potato dextrose agar substrate. Visible deformities on the plastics' surface were monitored to review the degradation process. The fungus' impact on degradation was also tested through contact angle measurements to determine surface properties changes. The hypothesis that Penicillium chrysogenum would cause visible degradation in LDPE faster than in PP and PET proved to be correct. LDPE showed visible evidence of degradation faster than the other plastics; however, PP and PET showed signs of dense fungal growth faster during experimentation. The decline in the Contact Angle Measure (CAM), a quantitative indicator of surface hydrophilicity, suggested that as the plastics were broken down, their surfaces became more porous and water-attracting. Fungal enzymes began degrading the plastic by making it porous. This study has significant applications in the domain waste management as a safe, cost-effective, sustainable, scalable and impactful way to arrest the problem of plastic pollution.

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Abstract: Science and Engineering Fair of Houston

1283

Sticking to a Greener World: Finding a Suitable Replacement for Plastic Lollipop Sticks

Aria Allen
Spring Branch ISD

Category

Environmental Engineering

The purpose of this experiment is to find what ratio of ingredients is needed to produce a suitable bioplastic lollipop stick in order to reduce the world's plastic pollution issue. I investigated the ingredients to produce a suitable bioplastic stick by designing a set of experiments with different ratios of cornstarch, water, vinegar, glycerin, and cotton balls. After combining the ingredients and cooking them on a stove, they were poured to dry in stick molds. Once fully dried, I measured the hardness of the stick by using a Shore A Durometer. These bioplastic sticks were also tested for hydrophobicity by submerging them in water and meltability by placing them in an oven at 320°F. After testing 18 different ingredient ratios 10 times each, which resulted in 180 total sticks, the hardness range was 1-85.5, compared to paper and plastic reference sticks, which measured at 106.5 and 102.5 respectively. The sticks were also tested for hydrophobicity. The range of how much water each stick absorbed in relation to their weight was 9.47%-28.18%, compared to paper and plastic reference sticks, which had absorption of 85.31% and 0% respectively. During the meltability test, the plastic reference sticks melted, unlike the bioplastic and paper sticks. Through this testing, I was able to find a suitable replacement lollipop stick. Future study is required to optimize the manufacturing process.

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Abstract: Science and Engineering Fair of Houston

1284

Cooking with the Sun

Gracyn Goynes
Weis Middle School

Category

Environmental Engineering

First, take the pizza box and line the inside of the lid with aluminum foil. Second, put black paper on the bottom of the pizza box. Wrap plastic wrap around the pizza box (not including the top flap. Place the marshmallows inside pizza box. Set the stopwatch, and measure with thermometer how long it takes to fully cook. (around 122 degrees.) Put your solar oven outside 3 different times with differing climates. Lastly, compare how long it took to cook during each different climate. Determine which climate is best for solar cooking. Pizza box clock/stopwatch marshmallows, plastic wrap, aluminum foil, black paper, glue scissors thermometer. First take the pizza box and line the inside of the lid with aluminum foil second, put black paper on the bottom of the pizza box 3rd wrap plastic wrap around the pizza box not including the top flap fourth place the marshmallows inside the pizza box 5th set the stopwatch and measured with thermometer how long it takes to fully cook then then put your solar oven outside three different times with different climates lastly, compare how long it took to cook during each different climate determine which climate is best for solar cooking. The independent variable is the climate the controlled variable is the solar oven and the marshmallows inside. my hypothesis is that when is sunny outside the marshmallows will cook faster. I believe this because when it is cloudy, the sun is blocked. The energy from the sun is what the solar oven uses to cook. if we use solar power to cook more often, could it help the environment with climate change with all the gases being released and affecting the climate I think maybe the solar powered oven could help the problem. The reason I chose to do this experiment is to learn about cooking with solar power cooking with solar power is not harmful to the environment and it cost-efficient. It can be very useful in case of an emergency. In conclusion when it was sunny outside the solar oven cook the marshmallow faster. well, I would add to this research in the future is how to make the solar of more energy, efficient and Accessible To everyone around the

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Abstract: Science and Engineering Fair of Houston

1285

BANANA PADS!? Part 2

Prudence Thomasson
sable clift
Central Middle School

Category

Environmental Engineering

This is a continuation project from when we were in the 6th grade. Then, we had a great theory of how this would work, but since then we have decided to create and test our hypothesis. We are testing to see if the trunk/stalk of a banana tree can be dried out and compressed to absorb water which is acting as a substitute for blood in the project. we will cut the tree down, cut the trunk into 148g pieces and put them into the oven to dry out, after that we will then blend the dried piece(s) up and compress them into small pads/blocks, we will then measure the weight and ad water to see if it will absorb the water.

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Abstract: Science and Engineering Fair of Houston

1286
shifting shadows

Jaycee caton
Central Middle School

Category

Environmental Engineering

Concrete cracking is causing damage and using the tax money to fix, in neighborhoods, major roads, side walks, and even in parking lots. The purpose of this study is to persuade treasures to plant more trees. The data is explaining that in the morning it is cool but as the hours progress the concrete gets hotter. The two hottest temperatures for asphalt are 125.7, and are 111.7 for concrete. This test is also meant to save money for better purposes such as educational purposes, local businesses, and food and homes for the weak. I found that concrete was cooler in the shade and hotter in the sun. Concrete cracks because of the direct heat from the sun, direct heat can cause this and it is called thermal expansion. Thermal expansion happens when concrete gets intensely hot and expands under the heat then as it cools down it contrasts which causes cracks.

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Abstract: Science and Engineering Fair of Houston

1287

Water Filtration

Lylah Gealow
Twin Creeks - MS

Category

Environmental Engineering

Clean water is a concern for the entire world. I was interested in investigating which areas of the world needed clean water. I found that Mexico City was very challenged in it's water sources. I decided to try to investigate what water filter would filter water the best. I did this for a survival reason as well. I wanted to know what would work best.

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Abstract: Science and Engineering Fair of Houston

1288

Possibilities of Nanotechnology

Isabel Sopon
Sacred Heart Catholic School - MS

Category

Environmental Engineering

The problem is that oil spills are affecting marine ecosystems and the surrounding environment. The hypothesis is "If ferrofluid and magnets are an efficient method to remove oil or gasoline from freshwater than saltwater environments because the salinity of the saltwater can cause weaker magnetic fields." Nanotechnology is allowing better ways to clean oil spills by innovatively using this technology. Ferrofluid and strong magnets can help with separating magnetized oil and gasoline particles from contaminated water. The experiment was conducted to test the efficiency of ferrofluid in fresh and saltwater conditions imitating the cleaning of oil and gasoline spills in the ocean. To create a real-life scenario of fresh and saltwater environments the water was prepared in flasks to represent each environment. Magnets were swiped through Petri dishes containing fresh or saltwater; oil or gasoline, and different amounts of ferrofluid. The hypothesis of this experiment was supported when it came to the gasoline trials but data was inconclusive in the motor oil trials. The efficiency of the ferrofluid was inconsistent when comparing its efficiency between gasoline and oil. As a future appreciation of the real world fuel and oil spills are causing many environmental issues. Ferrofluid may offer advantages such as cost efficiency and little interruption to the ecosystem. This technique may have the potential to handle a wide range of spill types and spill conditions. By testing different amounts of ferrofluid with the same amounts of oil it can determine how much is needed in the real world.

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Abstract: Science and Engineering Fair of Houston

1289

Which shingles are the best for internal house temperature

Olivia Sauceda
Clear Creek ISD /Brookside Intermediate School

Category

Environmental Engineering

The purpose of this project was to determine which shingle keeps the house internal temperature the coolest, Asphalt Shingles, Solar Reflective Shingles, or Metal Shingles? A roof plays a critical role in helping protect homeowners from the elements. Homeowners haven't given much thought about what their roof is made of. A roof can cost them more money than they know to cool off their homes. When the weather is hot, the roof is the hottest place in the house, and it could be over 50 degrees hotter than the temperature outside. To gather data, three identical sized scaled houses were built and placed outside exposed to the sun. Each house was built with a different kind of shingles, but all of them were built with the same materials, measurements and had a thermometer inside each of them to measure the internal house temperature. According to the data gathered during the experiment, metal shingles were more efficient in keeping the house internal temperature cool by 5 degrees Celsius in comparison to the other two shingles. Results showed that metal shingles for the 5 days of trial had a temperature of 19°C, 33°C, 32°C, 33°C, and 27°C which revealed the coolest out of all of them. In conclusion, my hypothesis was proven to be right. If a homeowner wants to keep their house cool during hot weather, the most efficient way to do so is to use Metal shingles for the roof.

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Abstract: Science and Engineering Fair of Houston

1290

Biodegradable Fishing Hook

Miranda Martinez
Aldine ISD /Hambrick MS

Category

Environmental Engineering

Fishing hooks contribute tons of environmental damage to the sea, so as a result a biodegradable fishing hook would help reduce these problems! The fishing hook is made up out of sugar fed bacteria that then is fermented to make the PHA filament, which is then mixed with PLA filament to make it strong. To test if my hook is strong enough to pierce through fishes, I tested it on a Tilapia fish which has tough scales and rough teeth, so I'll be able to see if the average fish is able to be hooked onto the fish. The hook is able to hold 15 pounds and can pierce through the fish's scales and mouth. At the end of the day, what I'm hoping for is that if my biodegradable fish hook gets well received, it's able to reduce marine pollution by providing an environmentally friendly option.

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Abstract: Science and Engineering Fair of Houston

1291

Utilizing Food Wastes For Sustainable Biodegradable Plastic Development

Avery Wong
Claire Wang
Julia Zhao
Fort Bend ISD /Sartartia Middle School

Category

Environmental Engineering

Pollution and global warming are issues that constantly threaten our environment, with one of the leading causes being the production and use of plastic. Although the use of plastic poses many issues, the manufacturing and production of many consumer goods relies on the characteristics of this synthetic material. In consequence, the impact of plastic pollution grows more evident daily. Thus, many scientists and researchers have found that creating an eco-friendly alternative to plastics would negate this issue. This study explores the possibilities of creating potato biodegradable plastic, specifically from potato waste, glycerin, and vinegar as a cheaper and less harmful alternative to conventional plastics. We created prototypes of our biodegradable plastic through combining the components of our plastic and cooking the mixture to induce gelatinization, then cooling and dehydrating our samples. Through our observations, we would repeat our experiments but change certain aspects of it in hopes of creating a better, stronger plastic. Our final samples showed satisfactory qualities, such as durability, structural integrity, insolubility, and flexibility. This allowed our biodegradable plastic to potentially be used in many products instead of regular plastic. Our biodegradable potato plastic offers a low-cost alternative to current plastics while also retaining similar properties. This solution could be beneficial for regions with less resources or economic stability, and could later have potential in the packaging or other industries.

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Abstract: Science and Engineering Fair of Houston

1292

Sail Away From Pollution

zoe dellosso
payton varela
Central Middle School

Category

Environmental Engineering

We chose this project because we were interested in learning more about possible pollution from bottom paint and how it could affect our local waters. Bottom paint is used to prevent barnacles and other marine organisms from growing on the boats and often contains the heavy metal copper. We wondered if the paint can wash off the boats over time leaving behind heavy metals. The heavy metals we tested for were copper, mercury, iron, and lead. We decided to test water in 3 different places for heavy metals. To test the water, we got a heavy metal test strips. We put the strips into the water for about 2 seconds then shook off extra water. After that, we let it sit for about 30 seconds, then looked at the testing strips to compare the color to the provided result chart.

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Abstract: Science and Engineering Fair of Houston

1293

The MNP Smart Bin

Parth Shah
Neil Mehta
Martin Bate
Harmony Public Schools - Houston North District /Harmony School of Excellence-Houston

Category

Environmental Engineering

The purpose of the project is to eventually use this to assist the population in helping them throw away waste in the correct place. What we did was we cut out all the cardboard pieces and connected them together to make the frame of the separator. We also made sure to cut a cardboard piece on the side that we will later use to connect to the servo. We connected all the wires to the servo motor and coded it. We coded it first using microbit, but then later realized we needed to use an arduino instead. After that, we connected the servo motor to the extra piece of cardboard we cut out on the side. Next, we coded the sensors that will detect if it is trash or recyclable. And then we connected all the wires, motors, and sensors to the cardboard frame to make our finished product. Finally, we tested it out to ensure it worked, which included a lot of trial and error, since the sensors don't always detect the correct things.

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Abstract: Science and Engineering Fair of Houston

3253

CyanoHUB: A Data-Driven Harmful Algal Bloom Prediction & Control System Utilizing Nanobubble Technology

Tavishi Sinha
Fort Bend ISD /Dulles High School

Category

Environmental Engineering

Freshwater cyanobacterial harmful algal bloom (CyanoHAB) incidents have increased globally as a result of global warming and eutrophication of waterbodies from anthropogenic nutrient sources. CyanoHABs pose threats to human and pet health, harm aquatic ecosystems, and lead to fish kills and billions in economic losses. Currently, there is a lack of cost-effective and environmentally-friendly prediction models for CyanoHABs and preemptive treatments to prevent the onset of CyanoHABs. This project aimed to address this problem by developing an integrated system utilizing remote sensing and local water dataset modeling alongside nanobubble technology to predict and mitigate CyanoHABs efficiently. First, a dissolved nutrient prediction model was trained and tested. To accomplish this, a Deep Belief Network (DBN) was implemented with TensorFlow using Keras, where Restricted Boltzmann Machines (RBMs) were manually stacked for pretraining and fine-tuning the network using supervised training. Next, a Random Forest algorithm was trained and tested in order to build a cyanobacteria prediction model. These two prediction models together make up the prediction section of the project. Then, two sets of experiments with a nanobubble (NB) generator were run to draw relationships between algae/nutrient concentration and NB treatment time. This data was then fed into a regression model to accurately predict nutrient treatment time and CyanoHAB treatment time. Finally, a drone-mounted NB treatment device that combines the prediction and mitigation modeling alongside NB technology was designed and tested.

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Abstract: Science and Engineering Fair of Houston

3254

Can a Dehumidifier Cool a House and Save Electricity Cost?

Allan Patrolia
Clear Creek ISD /Clear Falls High School

Category

Environmental Engineering

My project involved using a dehumidifier in a residential home to reduce the assumed temperature (feels like temperature); concurrently, elevating the temperature setting on the air conditioner. During this process, I measured the electrical consumption of the house with and without the dehumidifier. The goal was to determine if the dehumidifier, working together with the air conditioner could create a similar or same assumed temperature as the air conditioner alone, while lowering energy consumption. I installed an electrical monitoring system to my family home to measure how much electricity was used. The electrical monitoring system could isolate the output of the air conditioner and the dehumidifier. The outcome of the experiment did not show positive results for using a home dehumidifier. Living in a high humidity area, the cost of running the dehumidifier (with higher outside temperature and humidity) is greater than the savings of running the air condition one degree Celsius warmer. During the second round of the experiment, the outside temperature was cooler with lower humidity. This showed savings in electrical usage; but this was because the AC unit was not running as much. The AC kicked on less frequent because of the outside temperature, not because of the dehumidifier lowering humidity inside.

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Abstract: Science and Engineering Fair of Houston

3255

Affordable Automatic Air Purifier for the Developing World

Maximilian Werner
Cinco Ranch - HS

Category

Environmental Engineering

Many developing nations struggle to maintain healthy air quality due to inadequate government regulation and lack of proper sanitation, impeding on the health of individuals. Particulate matter such as PM10, PM2.5, and TVOC, usually formed from pollutants, impose a great deal of health risks that are not only carcinogenic but also impede the lives of people on a daily basis. While there are many devices that do an excellent job at controlling air currently in internal spaces, allowing a healthier environment for lower income individuals, they remain as an expensive commodity and are mostly attainable to people that live in developed nations. The product that I have made has shown to decrease TVOC and PM particulates from the air while still retaining modern features of expensive air purifiers. To conduct a study on how well the device performs, I added heat to a stick of wood until it started smoking and covered it with a container, simulating air pollution. Using the TVOC detection circuit that I have made, I measured the control TVOC levels (being at around 75-120um/m3). The TVOC detection circut was then submerged into the container and measured around 4300-4900um/m3. The air filtration system was then put under the container and started. After 15min, the TVOC levels were back to around 20-75um/m3, after multiple trials. Based on the results, it is proven that a successful method of air filtration can be used to improve the air quality of lower income individuals.

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Abstract: Science and Engineering Fair of Houston

3256

Flood Risk Simulation Using HEC-RAS 2D and AI ML Flood Inundation Forecasting

James Li
The Village School

Category

Environmental Engineering

Flooding is the most frequent and costliest natural disaster in the United States, with damages escalating due to climate change. Flooding risk mapping and early flood warning (EFW) are critical for flood disaster mitigation. This study demonstrated the use of the U.S. Army Corps of Engineers' HEC-RAS 2D program for flood risk simulation in a 25-square-mile area within the Fort Bend County's Sugar Land region and the Brazos River Watershed and the use an AI Machine Learning Neural Network model for EFW based on data derived from HEC-RAS 2D modeling. For RAS 2D modeling, LiDAR data, land cover data, soil data, NexRAD rainfall data, stream gauge data, and NOAA Atlas 14 rainfall data were collected and processed. A 2D computational mesh was developed. Hydrologic and hydraulic input parameters and data layers were prepared. The Hurricane Harvey flood event was used for model validation. Twenty-one (21) scenarios were run to compute flood inundation depths for storm events (10-, 25-, 50-, 100-, 200, 500-, and 1000-yr) and upstream Brazos River stream hydrographs. The AI modeling includes construction of an AI Neural Network model, and training of the model wit computed data from HEC-RAS modeling. The input layers of the model include daily rainfall data and Brazos River inflows. The output layer represents flood inundation depths at specific locations. While the RAS 2D model accurately identified flood-prone areas and calculated flood depths, the AI-based EFW model achieved comparable accuracy and significantly cut computation running time.

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Abstract: Science and Engineering Fair of Houston

3257

Cooling the Concrete Jungle: Investigating whether widespread implementation of evaporative cooling in urban areas is a feasible and advantageous approach to mitigate the Urban Heat Island Effect.

Jiaen Jiang
Jiang Family Home School , MS

Category

Environmental Engineering

As temperatures climb, Heat islands continue to increase severely with each passing year. Heat islands cause numerous problems, including increased energy consumption, poorer water quality, and negative impacts on human health. Many urban areas struggle to manage their temperatures effectively due to heat-absorbing surfaces, such as asphalt, a lack of greenery, and gas emissions. In recent years, evaporative cooling has emerged as a potentially efficient and energy-saving approach to lower temperatures in urban areas and mitigate high energy usage in cities.This study aims to assess if widespread adoption of evaporative cooling can realistically and effectively mitigate the Urban Heat Island effect in urban settings. After performing over 3,000 simulations to examine the potential effects, advantages, and costs associated with this approach for both general urban areas and specifically for Houston, it has been determined that large-scale implementation of evaporative cooling is feasible and advantageous in addressing the Urban Heat Island effect. By applying this strategy, cities can achieve a significant reduction in air temperatures, typically ranging from 6°F to 9°F within the first hour. In hotter conditions, cooling effects are even more significant, with average decreases between 10°F and 18°F. Implementing this strategy in urban environments could lead to lower electricity usage, healthier aquatic ecosystems, and improved public health, contributing to a more secure living environment. This approach, when combined with other strategies such as cool pavements and green infrastructure, could help pave the way for cooler urban futures.

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Abstract: Science and Engineering Fair of Houston

3258

Eco-Friendly Packaging Materials

Jenann Mahmud
Harmony South District

Category

Environmental Engineering

People have a high reliance on single-use plastics which contribute to environmental pollution, degradation. This calls for a need to develop sustainable alternatives. Despite advances in biodegradable materials, many fail to meet industry standards for durability, water resistance, and cost effectiveness; this limits their widespread adoption. This project aims to create an eco-friendly packaging material using biopolymers such as cornstarch, cellulose, chitosan, and agar. The experimental process involves formulating different material compositions, casting them into molds, and conducting a series of performance tests. These tests include measuring tensile strength, flexibility, biodegradability, and water resistance. The materials will be enhanced with glycerin for flexibility. Comparative analysis will evaluate its performance against conventional plastics. Thermal stability and resistance to UV degradation will be evaluated to assess real world applicability. The hypothesis was: Biopolymer based materials will demonstrate equal tensile strength, flexibility, biodegradability, and water resistance than plastics while significantly reducing environmental impact. The experiment demonstrated that biopolymer based materials have significant potential to be more environmentally friendly than s. When enhanced with glycerin these materials showed improved flexibility and biodegradability compared to conventional plastics. However the process showed that there are limitations in tensile strength, water resistance, and thermal stability. Furthermore, the project's environmental footprint was calculated by examining resource usage and energy consumption during material preparation. This research will contribute to the advancements for reducing plastic waste scalable. The findings could pave the way for the development of cost effective biodegradable alternatives that align with global sustainability goals and industry demands.

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Abstract: Science and Engineering Fair of Houston

3259

Alternative Plastic Durability

Riya Dabi
Clear Creek ISD /Clear Lake High School

Category

Environmental Engineering

Abstract Background Info and Research Overview With rising ecological concerns, experts have begun to evaluate the effectiveness of innovative ideas that serve as replacements for plastic, one of the greatest environmental harms today. Cellulose-based alternatives have since emerged, gaining appeal due to their natural abundance and variety of applications. Although mostly used as single-use plastic replacements, there is a possibility for them to replace plastics completely. To better durability, strong fabric such as scrap denim can be incorporated. Purpose and Hypothesis Statement The experiment aimed to determine the effectiveness of a sustainable cellulose-denim material in remaining durable as opposed to ordinarily used plastic. It was predicted that the sustainable material would prove to be more durable than the plastic. Procedure Overview The sustainable material was made by combining a 3% solution of carboxymethyl cellulose, dry pulp and water, microcrystalline cellulose, cornstarch, vinegar, and glycerol before being dried overnight and lined with denim. Plastic material of the same size was cut. Each material was secured between two surfaces before having a one-pound mass dropped from one foot, two feet, and three feet above the material, three times each. Damage to the material was marked as an unsuccessful trial. Data & Sources of Error Summary The sustainable material only sustained damage in two of the nine trials, while the plastic sustained damage in five trials. Although the hypothesis was correct, improper temperatures may have caused error when mixing and drying, inaccurate measurements, and limited layers of material under lining. Conclusion & Importance Due to the success of the sustainable material in withstanding damage from the dropped mass in most the trials, it was determined as the most durable material. This discovery allows for the understanding that if improved, cellulose-denim material can be used as an effective plastic alternative.

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Abstract: Science and Engineering Fair of Houston

3260

Harnessing Shewanella oneidensis in Microbial Fuel Cells (MFCs) for Wastewater Treatment and Sustainable Electricity Generation

Amber Zheng
Gauri Chandran
Conroe ISD /AST: Academy of Science and Technology

Category

Environmental Engineering

As the global population and industrialization expand, wastewater contamination has become a critical environmental and public health challenge. However, traditional methods of treating wastewater are often energy-intensive and costly, highlighting the need for a sustainable, efficient, and scalable alternative. In this experiment, a dual-chamber microbial fuel cell (MFC) was created to explore the potential of using Shewanella oneidensis, a bacterium known for its ability to transfer electrons to external surfaces, to treat wastewater while simultaneously producing renewable energy. The MFC was constructed with an anode chamber containing a wastewater solution and a cathode chamber filled with a saline electrolyte. A salt bridge connected both chambers to facilitate ion transfer, and copper wires were connected to electrodes placed in each chamber to monitor electricity output. Over a 20-day period, the electricity generation was measured, demonstrating consistent output through bacteria metabolism. Additionally, the quality and cleanliness of the wastewater solution were tested for turbidity, pH, nitrate, and phosphate levels before and after the period. The results showed a decrease in pollutant levels and an improvement in water quality. Furthermore, the concentration of pollutants in the water and odor were also noticeably reduced. The use of Shewanella oneidensis in microbial fuel cells presents a promising solution to address clean water and renewable energy challenges, especially in areas lacking direct access. This versatile and accessible approach offers a sustainable alternative to conventional water filtration systems, paving the way for groundbreaking solutions to enhance environmental sustainability.

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Abstract: Science and Engineering Fair of Houston

3261

Ocean Waves to Power: Investigating Wave Energy Converter Performance and Efficiencies

Jessica Luo
Mayti Jha
The Village School

Category

Environmental Engineering

Fossil fuel energy sources produced 40.9 billion metric tons of carbon dioxide emissions during 2023, resulting in the hottest year on record (NASA n,d). These power sources, however, are predicted to be depleted by 2052 (Kuo 2023). Alternative energy research focuses largely on wind and solar power. However, many other sources of power are overlooked, such as wave energy converters that harness the immense energy potential of the ocean. However, there are still many obstacles when it comes to effectively converting waves into electricity including the relatively high cost and difficult maintenance. In this project, we design and build a small-scale wave energy converter prototype. At the core of this prototype is a standard electrical induction motor. By attaching a resistance load to the motor, voltage and current measurements are taken and used to evaluate the prototype's power output. To test the prototype in a manner consistent with an ocean wave, a physical mechanism or technique is designed aiming to emulate the cyclical loading of a wave. This physical mechanism will allow for loading of the prototype under different conditions. The maximum power output will be computed through the wave power equation, allowing for a rough calculation of the prototype's efficiency. The results will be evaluated against alternative energy sources. NASA. (n.d.). Emissions from fossil fuels continue to rise. NASA. https://earthobservatory.nasa.gov/images/152519/emissions-from-fossil-fuels-continue-to-rise Kuo, G. (2023, August 25). When fossil fuels run out, what then?. MAHB. https://mahb.stanford.edu/library-item/fossil-fuels-run/

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Abstract: Science and Engineering Fair of Houston

3262

From pollution to purification: A novel method for softening water through direct air capture

Max Madof
EMERY WEINER JEWISH SCHOOL

Category

Environmental Engineering

Human-induced climate change remains one of the most urgent modern challenges. Although the phenomenon is driven largely by the release of carbon dioxide (CO2), the most destructive greenhouse gas, over 35 billion metric tons are emitted annually into the atmosphere. To address this issue, various mitigation technologies have been developed, including carbon capture, utilization, and storage (CCUS). A prominent example of CCUS is direct air capture (DAC), a method that removes CO2 directly from the air. However, much like other CCUS techniques, DAC often produces byproducts that are underutilized. Here, in response to these challenges, I developed a low-cost, solar-powered method using a sodium hydroxide (NaOH) system to directly sequester CO2 from the air. I further addressed global water scarcity by repurposing the byproducts to soften hard water, a critical step in removing arsenic from contaminated water. My approach utilized an aquarium pump to bubble air through a high-molarity NaOH solution, resulting in the formation of sodium carbonate (Na2CO3), a highly effective water-softening agent. The synthesis of Na2CO3 was monitored through Arduino-based sensors, which simultaneously recorded a decrease in atmospheric CO2 and an increase in aqueous pH. After collecting over 135,000 data points, I confirmed the formation of Na2CO3 through an acid test. Using Henry's law, I then analyzed the time series to estimate the concentration of sequestered CO2. My results are significant in that they demonstrate how captured CO2 can be repurposed to address critical issues in underdeveloped communities, paving the way for other scalable pollution-to-purification solutions.

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Abstract: Science and Engineering Fair of Houston

3263

A Novel Bioremediation Strategy for Plastic Waste: Genetic Engineering of E. coli to Optimize PETase Production Using Plasmid Vectors

Yash Bhoda
Conroe ISD /TWHS: The Woodlands High School

Category

Environmental Engineering

The burgeoning crisis of plastic pollution necessitates groundbreaking solutions, prompting the development of a novel, genetically modified E. coli strain expressing the PETase gene, which catalyzes the efficient breakdown of polyethylene terephthalate (PET), a pervasive and environmentally detrimental plastic. The PETase gene produce a enzyme that catalyzes that hydrolsis of the PET into its two foundational monomres- terephatlic acid and ethlyene gylco. Leveraging cutting-edge plasmid-based genetic modification techniques, the PETase gene was integrated into the E. coli genome, yielding a strain capable of degrading PET with significantly enhanced efficacy. Comparative plastic degradation tests conducted on a 1cmÂ³ PET sample revealed a substantial disparity in degradation rates, with the genetically modified E. coli strain degrading PET at a rate of 7.14mg/day, whereas the unmodified E. coli strain degraded PET at a negligible rate of 0.15mg/day. The genetic modification was rigorously validated through gravimetric analysis, spectroscopic examination, and visual enzyme activity observations, collectively demonstrating a marked reduction in plastic mass and disintegration of the polymer structure. This pioneering breakthrough presents a cost-effective, sustainable, and environmentally benign approach to managing plastic waste, offering a promising strategy for mitigating plastic pollution in landfills and oceans. Future research directions include optimizing the degradation process, scaling it for broader environmental applications, and exploring potential synergies with other biodegradation methods, underscoring the vast potential of this innovative method to restore ecosystems and address the pressing issue of plastic pollution.

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Abstract: Science and Engineering Fair of Houston

3264

2021 Texas Storm Simulation Analysis

Carson Wang
ST. JOHN'S SCHOOL

Category

Environmental Engineering

In February 2021, Winter Storm Uri hit Texas for four long days, leaving people in big cities like Houston isolated in their homes without electricity. During this catastrophe, about ten million Texans were affected, with no power to heat their homes in the midst of a freezing winter. This experiment attempts to simulate electricity demand of consumers in the Houston area under different extreme weather conditions in order to better predict and prepare for future weather disasters. This is crucial because better predictions for electricity demand can allow the government to create more adequate plans to allocate enough electrical supply for the demand. Using the data collected in this experiment, possible plans of action were created to consider. Thus, to answer the research question, we plan to create an algorithm predicting the electrical demand under different weather conditions, where we can use the collected data to look into solutions. Currently, we are still in the process of creating the algorithm.

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Abstract: Science and Engineering Fair of Houston

3265

Bags for a better tomorrow

Solana Muehr
Averi Pigg
Conroe ISD /ASHP: Academy for Science and Health Prof

Category

Environmental Engineering

Microplastics are polluting our oceans and sea life and intoxicating our resources. One of the biggest causes of microplastic are plastic grocery bags. Plastic bags are affordable making it a steal for companies and grocery stores. The problem is the plastic bags are not being disposed of properly, which means they stay in the environment and instead of breaking down they break up into microplastics. Even with some companies and grocery stores offering discounts for the use of eco-friendly/reusable bags, people still use plastic bags when shopping because of the convenience. With 500 trillion plastic bags being used every year, only 10% of them are being recycled and another 10% of all plastic bags ending up in the ocean, the problem is evident. With biodegradable and eco-friendly bags, we can lessen the amount of plastic bags that end up in the ocean by at least 7% which means that 350 billion plastic bags won't end up in the ocean. After completing the research the results proved that HEB high-density polyethylene plastic bags were the most durable, a close second by one pound was the Gelatin-Agar bags. After testing the cost-effectiveness if materials were bought in bulk to see if the cost to make the eco-friendly bags could compete with the HEB high-density polyethylene, the results proved it would not only be cost effective but could also be cheaper.

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Abstract: Science and Engineering Fair of Houston

3266

Optimized Direct-Air Carbon Capture Using Electrolytic Cell Equipped With Ion Exchange Membrane

Boning Dai
Vivian Qin
THE JOHN COOPER SCHOOL - HS

Category

Environmental Engineering

CO2 capture has recently been a popular topic of research to alleviate the effects of global warming. The traditional method is to pump the CO2 emissions into depleted wells. However, a recent approach to removing CO2 from the atmosphere is to mineralise it in the form of CaCO3 or MgCO3 through electrolysis. These ions are naturally abundant in seawater. In this project, CO2 is mineralised from the atmosphere, with the energy for electrolysis coming from green solar power. In our setup, an ion-exchange membrane separates two chambers in order to prevent the buildup of scale by normalising the rate of reaction to avoid spikes in concentration. The electrolytic process generates hydroxyl ions, which react with CO2 in the form of carbonic acid to create carbonate ions which are then mineralised by the ions present in the water. It was found that adding 0.20g of NaOH and 0.60g NaCl resulted in the most optimal CO2 to catalyst yield ratio, with 0.27g CO2 captured. In addition, the two chamber system was successful in preventing build-up of CO3 on the electrode. With this new method, the space required for storage is decreased, and renewable energy, naturally available near the ocean, is utilised.

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Abstract: Science and Engineering Fair of Houston

3267

How to improve recycling rates through AI

Yeeun Kim
The Village School

Category

Environmental Engineering

This research explores the application of AI-powered machine learning models to improve recycling practices in the US. Motivated by the observed inefficiencies in waste separation and recycling, particularly in comparison to countries like Korea, this study aims to leverage AI to enhance recycling accuracy and efficiency. The hypothesis posits that AI models can identify recyclable materials with at least 10% higher accuracy and faster speed than human labor. The dataset used consists of photographs of six distinct classes of recyclable materials (cardboard, glass, metal, paper, plastic, trash), allowing the models to train to classify materials based on their visual characteristics. Three deep learning models are employed for identification of recyclables: VGG16, DenseNet121, and EfficientNet_b0. The models yielded varying test accuracies: VGG16 reached 89.43%, DenseNet121 achieved 91.74%, and EfficientNet_b0 reached 87.14%. Given the superior accuracy, the DenseNet121 model was selected for further analysis. When data augmentation was applied to the DenseNet121 model, it produced reasonable accuracy, highlighting the potential of AI in automating recycling processes. The relatively high accuracy suggests that AI could significantly reduce human error in waste sorting, where approximately one in four items are miscategorized. Future research will focus on utilizing more real-world data and implementing AI systems in schools, local communities and waste management companies to promote better recycling practices.

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Abstract: Science and Engineering Fair of Houston

3268

Removing Pharmaceutical and Personal Care Products Through Electrostatic Precipitation

Logan Clark
Ashutosh Sahu
Conroe ISD /AST: Academy of Science and Technology

Category

Environmental Engineering

In recent decades, the prevalence of pharmaceuticals and personal care products in wastewater has significantly increased due to a lack of efficient, cost-effective treatment methods. Pollutants like bisphenol A and ibuprofen persist in wastewater at rates of 76% and 54%. This experiment aimed to create a feasible, energy-efficient device at a minimal cost that removes ibuprofen during wastewater treatment. The specific PPCP tested in this study, ibuprofen, was chosen due to its high proportions in wastewater (603 µg/mL). This system uses a modified electrostatic precipitator with alternating charges to separate ibuprofen from water by neutralizing deprotonated molecules and attracting them to metal plates. The system operates as a scaled model with a 250 mL capacity and a voltage of 12.4 volts. Across five trials per sample base, the system achieved average removal efficiencies of 42.7% for Sample Alpha, 54.9% for Sample Beta, and 64.5% for Sample Charlie, yielding an overall efficiency rate of 54.1%. This performance demonstrates greater efficacy in removing ibuprofen from wastewater compared to activated carbon, while offering enhanced cost-effectiveness and practicality, emphasizing its potential as a viable alternative in wastewater treatment applications. Furthermore, this project has significant applications, with the potential to prevent 5,800 metric tons of ibuprofen from entering water systems annually. Its adaptability allows implementation as both primary and secondary treatment, demonstrating the effectiveness of electrostatic precipitation in removing PPCPs, including ibuprofen, from wastewater.

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Abstract: Science and Engineering Fair of Houston

3269

Designing an Energy Efficient Zeolite for Pressure Swing Adsorption of CO2

John Lezama
Tomball ISD /Tomball HS

Category

Environmental Engineering

Anthropogenic CO2 emissions are the main factor behind rising global temperatures due to the greenhouse effect. Post combustion capture, the process of removing CO2 from factory flue gas and storing it underground, has the potential to slow down and even decrease global temperatures. Existing carbon capture technology is hindered by high costs. The goal of this project is to look for ways to reduce the energy consumption of carbon capture, which would reduce its costs and encourage wider implementation. In this project, zeolites, microporous aluminosilicate crystalline materials that can contain alkali and alkaline earth metals, were the chosen adsorbents to be studied due to their high thermal and structural stability which is necessary to withstand harsh flue gas. Zeolites can be characterized by their framework, silicon to aluminum atom ratio, and cations. Each of these characteristics are alterable and affect the zeolite's performance during CO2 adsorption. Adsorption is the process of molecules sticking onto the surface of a solid, and is a method of carbon capture. The performance of adsorption can be quantified by capacity, selectivity, and operating pressures and temperatures. Capacity is the amount of CO2 molecules that can be adsorbed while selectivity is the ratio of the amount of CO2 trapped compared to other gasses like N2 and CH4 in flue gas. Grand Canonical Monte Carlo simulations were used to simulate CO2 adsorption on zeolites. Zeolite were uploaded from the international zeolite database. Their silicon aluminum ratios were altered and inaccessible sites via diffusion were blocked. Adsorption isotherms were graphed for each temperature for each zeolite configuration. Zeolite 13X possess the FAU framework and zeolite 5A the LTA framework. These zeolites are the industry standard of CO2 adsorption. The simulations agreed these zeolites have optimal performance, but new zeolite configurations are still being simulated to see if better solutions exists.

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Abstract: Science and Engineering Fair of Houston

3270

Reindeer moss as an angle-adaptive acoustic noise control strategy

Anurag Anandprasad
Chamika Udugamasooriya
Cinco Ranch - HS

Category

Environmental Engineering

This project attempts to target reindeer moss as an angle-adaptive acoustic noise control strategy to confront issues regarding noise pollution, which has proven to increase cardiovascular risks and disrupt circadian rhythms at levels past 55db. Current static synthetic noise-absorbing materials are non-biodegradable and fail to adapt to noisy environments. Leveraging the porous microstructure of moss, which has displayed more absorption efficiency for mid-to-high frequencies, this research aims to develop a sustainable, angularly-adaptive solution. A prototype system was constructed using a Raspberry_Pi4, Model B, Nema-17 stepper motor, DRV8825 driver, preserved reindeer moss, and planks/panels. Angular shifts/transformations of the panels were implemented to optimize sound absorption by exploiting frequency-dependent incident angles. Data collection utilized Fourier Transform, a mathematical model, powered by Python libraries (NumPy, sounddevice, time, RPi.GPIO, collections, Matplotlib) to measure frequency, amplitude, and sound attenuation under controlled field conditions to autonomously adjust the panel's angle in response to its environment. Preliminary results demonstrate increased level of sound absorption performance at certain angle configurations; statistical comparisons of decibels with standard acoustic materials also validate the efficiency of angular reindeer moss panels in reducing noise pollution. Overall, after real-time testing with the addition of autonomous motorization/adaptability, results concluded the motorized panel performed an increase of sound dampening by 20-30% compared to static flat panels, and 5-10% compared to static angle panels. This approach has significant potential for real-world applications (studios, hospitals, and urban zones) by providing an eco-friendly, cost-effective, low-maintenance alternative to synthetic materials while addressing sustainability/health challenges.

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Abstract: Science and Engineering Fair of Houston

3271

Restoring Texas Soil the Lone Star Way: A Comparative Study of Native and Non-Native in Degraded Areas

Jesua Trejo
Victor Aguilar
Aldine ISD /Blanson CTE HS

Category

Environmental Engineering

Soil degradation poses a critical challenge in Texas, diminishing agricultural productivity, biodiversity, and increasing erosion risk. This study explores bioremediation as a solution, focusing on native and non-native plant species' effectiveness in restoring degraded soils by examining impacts on key soil health indicators—pH, nitrogen, phosphorus, and potassium levels. We selected the Texas Bluebonnet (Lupinus texensis), a nitrogen-fixing native plant well-suited to Texas' climate, and the California Poppy (Eschscholzia californica), a non-native, non-nitrogen-fixing species, to compare their roles in soil rehabilitation. Using 32 planters divided into control and experimental groups with both degraded and fertile soils, each group was seeded with either bluebonnets or poppies, with regular measurements of soil pH and nutrients taken over one month. We hypothesized that the Texas Bluebonnet would outperform the California Poppy in enhancing soil nutrients and improving overall soil fertility due to its nitrogen-fixing capacity and native adaptability. Furthermore, we investigated whether native plants like the bluebonnet contribute more to long-term soil health and structural stability. Preliminary results indicate significant improvements in nitrogen and potassium levels in soils with Texas Bluebonnets, supporting the potential of native species in bioremediation and sustainable land management. This study highlights a promising framework for soil restoration strategies in Texas, advocating for native flora as a cost-effective, ecologically sound approach to combat soil degradation. The findings may inform broader soil rehabilitation efforts in arid regions worldwide, using native plants to bolster agriculture, promote biodiversity, and reduce environmental degradation.

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Abstract: Science and Engineering Fair of Houston

3272

Automated Waste Categorization: Using Computer Vision and Mechatronic Sorting Mechanisms

Stephanie Shen
Spring Branch ISD /Spring Branch Academic Institute

Category

Environmental Engineering

Efficient waste management is a prominent global challenge given that manual sorting methods are labor-intensive and prone to error, while industrial solutions are expensive for small-scale applications. This project aims to develop an affordable, automated waste sorting system using accessible technologies like Raspberry Pi and open-source machine learning (ML) models. By combining computer vision and a servo-based mechanical sorting mechanism, the system will classify waste items into four categories—plastic, paper, metal, and organic—all within a targeted classification accuracy of at least 80%, all within a budget of $200. The prototype uses a Raspberry Pi 4 as the processing unit, paired with a camera module to capture images of waste items. The pre-trained MobileNetV2 serves as a computationally efficient image recognition backbone and a continuous rotation servo motor directs waste items into designated bins based on the model's predictions. This project includes testing the system by using both collected images and existing waste image datasets, where images are processed at 224x224 pixels. The system efficiency will be assessed by analyzing response time (from image capture to sorting) and the classification accuracy to identify patterns in misclassifications or any mechanical inconsistencies in the system. Ultimately, this research demonstrates the potential for new technologies to address environmental challenges through automated waste sorting solutions, especially for small-scale applications where existing systems are impractical and costly. The project's methodology and results contribute to understanding how open-source ML models and affordable hardware can be effectively combined together for environmental engineering applications.

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Abstract: Science and Engineering Fair of Houston

3273

Water Quality Machine Learning

Aarush Gupta
Krithik Nallamothu
Houston ISD /Carnegie Vanguard HS

Category

Environmental Engineering

This project aims to predict future dissolved oxygen (DO) levels in rivers, streams, or lakes using a Random Forest model. Dissolved oxygen is a key indicator of water quality, directly affecting aquatic life. By gathering historical water quality data, including temperature, pH, turbidity, nutrient levels, and flow rates, the model forecasts DO levels under varying conditions. The data is preprocessed, and the Random Forest algorithm is used to make predictions. Model performance is evaluated with metrics like Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE). The insights help inform interventions to preserve water quality and ecosystem health.

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Abstract: Science and Engineering Fair of Houston

3274

Analyzing Mass-Dependent Efficiency in Gravity-Powered Energy Storage Systems :Utilizing Gravity Powered Batteries As a Way To Address Practical Sustainable Energy Solutions in Renewable Energy Challenges

Anh Nguyen
Cody Ung

Category

Environmental Engineering

The present study investigates how the relationship between weight and potential energy storage of a gravity-powered energy storage system affects its performance. This brings up a tremendous challenge that renewable energy technology faces today, wherein the effect of mass on energy amounts conversion and how it is stored is being looked at. The hypothesis proposed that a greater mass of plates must continually improve the stored potential energy up to a point without a corresponding drop in system efficiency. Researchers did an experimental design where they weighed subjects ranging from 5 up to 27 kilograms under constant variables (height, time interval, and configuration of the system) with an experimental condition. They tested these three main approaches: potential energy storage, kinetic energy generation, and total system efficiency. With very accurate measurements, most potential energies were found at heights up to about 529.7 joules from 98.1 joules, indicating that there is a direct correlation between mass as weight increases or with increased energy storage capacity.The results indicate that efficiencies averaged around 76%, with just slight variations as one moves toward the upper weights. Their experiment proved to bring important insights into the mechanisms for gravitational potential energy while demonstrating clearly the potential of scalability and exposing the precise mechanical limitations which are predominant at maximum mass.Therefore, the research provides information based on evidence from empirical observations to the scientific understanding of mechanical storage and conversion of energy. Besides that, the research shows complicated relationships between weight and energy performance, which is promisingly paving the way for further innovations in renewable energy storage. Advanced materials, optimized mechanical interfaces, and innovative friction-reduction strategies for system improvement will be possible innovations.

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Abstract: Science and Engineering Fair of Houston

3275

PowerCast: A Novel Machine Learning Framework for Predicting Power Outages and Their Durations

Sai Gangu
Mahith Gottipati
Fort Bend ISD /Dulles High School

Category

Environmental Engineering

Power outages disrupt modern infrastructure and significantly impact economies and societies, underscoring the need for accurate predictive tools. This research introduces PowerCast, a machine learning framework designed to forecast the occurrence and duration of power outages using historical outage data, environmental factors, and grid characteristics. By employing advanced regression and classification models, along with robust feature engineering techniques, PowerCast captures temporal, spatial, and weather-dependent patterns that influence outages. The framework is evaluated on real-world datasets using metrics such as accuracy, precision, and mean absolute error, demonstrating high predictive performance. The findings suggest that PowerCast can serve as a valuable decision-support tool for utility companies and policymakers, enabling proactive measures to enhance grid resilience and mitigate the impacts of power interruptions.

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Abstract: Science and Engineering Fair of Houston

3277

Firehouse to Filter

Adalise Caballero
Alief ISD

Category

Environmental Engineering

In the United States, while the majority of the population has access to treated tap water, concerns about water safety persist. A survey by the Environmental Working Group found that over 50% of Americans believe their tap water is unsafe, and 40% avoid drinking it. I identified water deficiencies in public water dispensers from four differing fire stations across Houston and tested several variables in the water to determine its purity. The concentrations of hydrogen sulfide, iron, copper, total chlorine, nitrate, and sulfate distinguish the varying levels of purity among the water samples. I provided a simple solution to the negative water samples by displaying what the use of a simple DIY water filter can have on the water. My hypothesis states that if all four water samples are of subpar drinking quality then the water filtration system will increase its drinkability. Through several trials and tests of multiple samples I determined that station two had the worst water quality before and after filtration while the other stations had the best water quality after filtration. The results of my experiment support my hypothesis by showing a decrease in each negative variable following the use of the DIY filter.

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Abstract: Science and Engineering Fair of Houston

3278

An Improved Freeze Plug System for Molten Salt Reactors

Parnika Hangal
Conroe ISD /AST: Academy of Science and Technology

Category

Environmental Engineering

Nuclear energy is the leading type of renewable energy currently due to its abundance of available fuel and the largest capacity factor of any renewable fuel methods discovered so far. The molten salt reactor is a promising advancement in this field that increases efficiency and removes certain safety concerns. However, this reactor has its own complications, which is why this experiment was focused on finding the simplest way to reduce the risk involved with using molten salt reactors: freeze plugs. The engineering goal of this project was to design a freeze plug that would result in a final concentrated salt water solution with a lower final temperature and total time taken to move through the system. A reactor model, proportional to real MSFR blueprints, was constructed along with 3 freeze plugs of different designs: stepped, spiral, and solid. Each freeze plug was filled with frozen salt ice and tested against boiling saltwater multiple times in order to observe how the final time and temperature of the "molten salt" was affected by the different design. It was observed that the spiral freeze plug resulted in the lowest final temperature of 12.3 degrees Celsius and total time of 1 hour taken to melt. This led to the conclusion that the spiral freeze plug design is the most optimal freeze plug to use in a molten safety reactor and can potentially move forward the widespread adoption of MSRs. These results highlight the significance of simple and efficient designs to further MSR safety.

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Abstract: Science and Engineering Fair of Houston

3279

Mitigating The Effects Of Fast Fashion And Concrete on Greenhouse Gas

Natasha Pesnell
Conroe ISD /AST: Academy of Science and Technology

Category

Environmental Engineering

Fast fashion's reliance on synthetic materials like polyester contributes significantly to environmental pollution. This study explored the potential of recycling textile waste by incorporating polyester fibers into concrete, aiming to enhance its mechanical properties. Concrete blocks were produced with varying amounts of polyester fibers, and their compressive strength was evaluated using a hammer rebound test. While initial results showed positive effects on strength, meaning the hypothesis was supported, the overall trend was inconclusive, due to the absent use of a Schmidt Hammer. Further research is crucial to optimize fiber content and investigate other mechanical properties for a comprehensive assessment of this recycling approach. Future studies should consider alternative fibers, such as acrylic, nylon, recycled glass, hemp seeds, or flax seeds, and evaluate the long-term durability of polyester-infused concrete under different environmental conditions. By utilizing a more robust testing method, such as the Schmidt hammer, to accurately determine PSI values, a more comprehensive understanding of the material's performances can be achieved. This research has the potential to not only mitigate the environmental impact of the fashion industry but also contribute to the development of more sustainable and resilient infrastructure. The results of infusing polyester fibers in concrete structures reduces the volume of the cement mixture necessary to produce the same product, while also increasing the window range these structures have before needing to be replaced. This means that this project is an ideal candidate for eco-conscious infrastructure development by reducing the production of greenhouse gas from concrete while also finding an effective way of recycling textile waste from the fashion industry.

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Abstract: Science and Engineering Fair of Houston

3280

Biomass for Renewable Energy: Exploring Different PH Environments to Optimize Phosphorus Fertilizer Nutrition Efficiency for Algae Growth

Chloe Luo
Clear Creek ISD /Clear Lake High School

Category

Environmental Engineering

Greenhouse gases, particularly carbon dioxide (CO_2), play a central role in global warming by trapping heat in the Earth's atmosphere. CO_2 accounts for approximately 79.4% of total greenhouse gas emissions, with fossil fuel combustion being the primary human source. The increasing rate of CO_2 emissions poses significant risks to future generations, making it crucial to explore potential solutions for carbon capture. Algae, known for their ability to absorb CO_2, may offer a viable solution if cultivated on an industrial scale under optimal conditions. This study aimed to determine how different phosphorus fertilizer pH levels influence algae biomass growth, with the hypothesis that more acidic fertilizers would promote the highest growth. The experiment tested four different fertilizers at varying pH levels (acidic to basic) to examine their effects on algae growth, focusing on the biomass yield as a potential indicator of CO_2 absorption efficiency. To measure biomass, wet algae were calibrated by weighing and drying them under controlled conditions, followed by adding 5g of each fertilizer to eight separate 500mL beakers. Each beaker contained 100g of wet algae, which were exposed to the fertilizers for two weeks outdoors. After this period, dry algae weights were measured and compared. Results showed that the pH 6 fertilizer increased algae biomass by 48.8%, while the pH 10 fertilizer increased it by 44.5%. These findings suggest that slightly acidic fertilizers promote the highest algae growth. This experiment is important for advancing carbon capture technologies and addressing climate change by optimizing algae cultivation for CO_2 sequestration.

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Abstract: Science and Engineering Fair of Houston

3281

SpiraWave: A Novel Alternative System of Buoy Based Wave Energy Generation

Jessica Bird
Conroe ISD /AST: Academy of Science and Technology

Category

Environmental Engineering

With the opportunity to mitigate climate change quickly fading, it is crucial that clean, yet effective, methods of energy production to replace the non-renewable energy sources currently relied upon. If properly utilized, wave energy has the potential to provide over half of the United State's annual energy consumption, making it a valuable resource. The project addressed this problem through the creation of the "SpiraWave", an alternative method of generating electricity through waves that focuses on torsional motion. The system works as follows: the rotation from the pump in turn rotates a shaft which, with the aid of O-rings, bearings, and couplings, directly rotates a motor that then generates electricity as displayed by an Arduino LCD Display. The project was completed through innovation with CAD designing, 3D printing, mechanical construction, Arduino electronics, and Arduino code. It was then tested through consistent physical vertical movement to simulate waves at 3 different intervals and the power output was measured. From the data collected, it is evident that the "SpiraWave" has the potential to make a significant real world impact when scaled up.

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Abstract: Science and Engineering Fair of Houston

3282

Autonomous Modular Waste Disposal System with Beach Application

Connor McCain
Edwin Rodriguez
Benjamin Adachi
ST. JOHN'S SCHOOL

Category

Environmental Engineering

In 2023, the International Coastal Cleanup reported volunteers removed over 2.5 million pieces of waste from coastlines. Through strenuous labor, volunteers removed trash; however, were unable to remove smaller plastics hidden by sediment and organic matter, which leached into the ecosystem. To combat this, the team designed a modular autonomous robot capable of navigating and surviving beach terrain while efficiently separating plastics from the sediment. The team tested various methods of trash separation, such as a sieve mechanism and centrifuge, and then implemented it in a two-part mechanism. One part of the bot contains electronic systems for autonomous navigation, batteries, and the drive system. The other contains the trash separation mechanism and storage. To ensure proper navigation and obstacle avoidance, the team uses a GNSS dead-reckoning system and internal IMU to determine the location and pathing of the bot on the beach. The team combined this with LIDAR and a camera running a custom neural network on a Jetson Nano to allow pathing changes in real-time to avoid obstacles and move towards trash. To help with pathing, the team created a wave machine capable of simulating the distribution of plastic on a beach under given conditions. A camera above the simulated beach identifies brightly colored plastics and develops the most efficient path. The path developed is implemented when the bot is run on the beach. The bot will increase the amount of waste removed from beaches while reducing the reliance on strenuous labor and volunteers to clean our beaches.

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Abstract: Science and Engineering Fair of Houston

3283

Testing the Adsorption Capabilities of Oil-Treated Hair

Emilio Pena
Conroe ISD /AST: Academy of Science and Technology

Category

Environmental Engineering

In the United States, approximately 400,000 barber stores collect one pound of hair every day. Currently, most of the hair is sent straight to landfills. However, hair can serve as a solution to very real problems: oil spills. Hair is a natural adsorbent of oil, meaning oil is 'trapped' on the surface area of the hair. Additionally, oil tends to clump up with oil. It was hypothesized oil's tendency to bunch together would outweigh the loss of surface area, resulting in less motor oil passing through. To test the hypothesis, untreated and (motor oil) treated hair adsorption was measured using pet and human hair. To collect results, sixteen containers were set up with dripping devices filled with the experiment's hair on top of the containers. Then, after pouring 75 milliliters into each dripping device, the motor oil passed through was measured for each trial. Following the tests, several two-sample t-tests were conducted to validate the significance of the results. The results were proven (with 95% confidence) to show a decrease in efficiency (for both types of hair) when treated. Interestingly, the final t-test showed that untreated pet hair was significantly more efficient than untreated human hair. Although the results showed a significant increase in efficiency when using pet hair, oil response teams often use human hair instead of the more efficient pet hair. This project's results can be a solution to all sorts of oil-related problems while also changing the type of hair used for these situations.

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