Abstract: Science and Engineering Fair of Houston

3303

Understanding Rock and Sand Erosion

Mirian Rodriguez, Julian Viramontes

Charter/School of Science and Technology, Houston - MS

Category:

Environmental Engineering

In our project were gonna see the importance of beach erosion and how it affects communities and the ecosystem. Were gonna demonstrate it by using a model of a "beach" and use a rain simulation and show the deposition of the sand and how it can bank and make new sand formations which can affect the environment and cause flooding and also at the same time were gonna show how sand will work on a slope and how we can see the groves the water makes on the sand. We may also do another demonstration showing how waves/currents affect the beaches and how it can take the sand with it and it can also cause banking. Erosion affects communities like Galveston by the strong waves and currents from the Gulf of Mexico and the hurricanes that go through their affect the sea level and human activity and we will tell how sea walls are important, especially for coastal cities.

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APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3304

LSTM-Based Early Flood Warning

Category:

Environmental Engineering

James Li

Private/The Village School

Timely and accurate flood forecasting is vital for flood risk management. Traditional physics-based forecasting models, such as HEC-RAS, require significant running time, taking hours or even days to simulate a single event, particularly for unsteady 2D flow simulation. As climate change intensifies the frequency and magnitude of extreme storm events, these computational constraints significantly limit their practicality for Early Flood Warning, where lead times of several hours are critical, especially during flash flood events. To address these limitations, this research proposes a novel approach using Long Short Term Memory (LSTM) neural networks for flood forecasting. The LSTM model uses non-linear spatial and temporal relationships inherent in the hydrologic and hydraulic dynamics within a watershed, and provides accurate discharge forecasts at critical locations within seconds instead of hours or days, with early lead times of 6 to 12 hours, which are critical for response during extreme weather. The LSTM model is demonstrated for the Arroyo Colorado Watershed within the Lower Rio Grande Valley, Texas. Datasets consisted of 10 years of hourly precipitation and soil moisture data at 8 rain gauges and hourly peak discharge data at critical locations from the International Boundary and Water Commission. A 72-hour sliding window was selected for training the LSTM network. The model was tested by comparing the predicted hourly peak discharges against observed peak discharges for 2025, including the March 27 flood event. The Nash-Sutcliffe Efficiency was used to validate and determine the model's accuracy. The model resulted in a NSE value of 0.96. This indicates high accuracy of prediction. By providing flood information within seconds, the model dramatically reduces the computational time compared to traditional simulations. The LSTM flood forecasting approach offers a scalable, low-cost tool for communities to minimize the economic and human harm of floods.

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Abstract: Science and Engineering Fair of Houston

3305

From Pantry To Plastic: Transforming Starches Into Polymers

Category: Environmental Engineering

Fatima Rizvi

Private/AL-HADI SCHOOL OF ACCELERATIVE LEARNING

This experiment investigated how two different starches—corn starch and potato starch—affect the strength, hygroscopy, and opacity of sustainable bioplastics. The bioplastics were synthesized by combining the starch with water, glycerol, and acetic acid (vinegar). After shaping and drying, they were assessed using three different methods: adding weights to test strength, letting the plastic sit in water and measuring its mass for hygroscopy, and checking opacity by comparing how clearly words could be seen through it. The purpose of these assessments was to determine which starch source creates a stronger, more resistant, and more functional plastic. The overall results showed that the bioplastic made from potato starch produced a more efficient, usable, and appealing material. It was clearer, stronger, and dried faster than the bioplastic made from corn starch.

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Abstract: Science and Engineering Fair of Houston

3306

Category: Environmental Engineering

EnviroCast: A Quantum-Enhanced, Agentic Self-Recalibrating Environmental Intelligence Framework for Real-Time Air Quality Forecasting and Health Risk Analysis

Kavin Elangovan, Arnav Nemade

Houston ISD/Carnegie Vanguard HS

INTRODUCTION: Globally, air pollution is a leading environmental health risk, contributing to millions of premature deaths annually and disproportionately affecting vulnerable populations. Despite widespread monitoring of atmospheric pollutants, existing air quality forecasting systems often lack sufficient accuracy, adaptability, and real-time intelligence. AIM: To develop a computationally efficient, highly accurate, hybrid quantum-classical, multi-agent -recalibrated artificial intelligence (AI)-powered environmental intelligence framework, integrated into a real-time platform, EnviroCast, for precise multi-pollutant air quality forecasting and health risk analysis. RESEARCH METHODOLOGY: Classical recurrent models (LSTM, GRU) and handcrafted hybrid Quantum Recurrent Neural Networks (QRNNs) were evaluated using large-scale real-world datasets from 12,000+ global monitoring stations, meteorological sources, and NASA TEMPO observations, with continuous multi-agent recalibration. RESULTS: Hybrid quantum-classical models outperformed classical-only baselines, achieving >95% forecasting accuracy with improved stability and reduced prediction drift across diverse regions. EnviroCast delivered low-latency hourly 24-hour forecasts with robust scalability and generalization. CONCLUSIONS: This study demonstrates that hybrid quantum-classical, agentic AI frameworks can significantly advance environmental forecasting performance. EnviroCast establishes a new benchmark for accuracy, adaptability, and real-world deployment in environmental intelligence systems. RESEARCH APPLICATIONS: EnviroCast provides scalable, open-access infrastructure for public health guidance, urban planning, environmental research, and policy decision-making, enabling improved air quality management at a global scale.

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Abstract: Science and Engineering Fair of Houston

3307

Dust-Off: A Biomimicry-Inspired Vibrational and Surface Engineering Approach to Self-Cleaning Solar Panels

Wendi Ning

Fort Bend ISD /Clements High School

Category:

Environmental Engineering

Dust accumulation remains a costly and widespread barrier to solar efficiency.This project experiments a novel approach to improving solar panel efficiency by using mechanical and sound frequencies to generate vibrations that mitigate dust accumulation on photovoltaic (PV) panels, and seeks to answer a question: Can mechanically and acoustically generated vibrations enhance solar panel efficiency by mitigating dust accumulation and optimizing energy output? A prototype-based experimental approach with controlled and variable conditions was used. A 3650 Vibration Motor and a computer were connected to four mini solar panels tilted at 30 degrees to induce mechanical and sound frequencies. Each measurement was repeated multiple times. For mechanical vibrations, the average power output improves 9.1%, 20.3%, and 35.2% for light, moderate and heavy dust conditions, respectively, compared to the control conditions. For acoustically generated vibrations, the average power output improves 3.5%, 7.4%, and 7.8% for light, 10.6%, 17%, and 14.6% for moderate, and 9.5%, 22.6%, and 24% for heavy dust conditions for the 100Hz, 500Hz, and 1000Hz frequencies,respectively. The percentage of clean power retained decreases significantly when dust becomes heavier. T-tests and ANOVA tests show mechanical vibration is the best to improve the percent of power retained. The experimental results indicate that vibration-based dust mitigation, whether mechanical or sound frequency vibrations, consistently improves PV performance across all dust conditions. The demonstrated effectiveness suggests a promising alternative to traditional cleaning methods that are often water-intensive, labor-heavy, or expensive to deploy.

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Abstract: Science and Engineering Fair of Houston

3308

Air for All: Design and Validation of a Solar-Powered Outdoor Air Filtration System

Ojeifo Okhiria

Harmony Public Schools - South District/Harmony School of Innovation Katy

Category:

Environmental Engineering

Many urban and metropolitan areas around the world face both short and long-term air quality hazards, such as wildfire smoke and vehicle emissions, that affect heavily populated outdoor areas. The compounds released by these hazards pose a serious risk to those who breathe them in, contributing to approximately 7 million premature deaths worldwide. The aim of this project is to build and test a compact and affordable outdoor air-filtration and monitoring unit to improve air quality in common outdoor environments. The prototype uses HEPA panels, an activated carbon layer, a pull-through fan system, and an embedded controller that logs data from upstream and downstream sensor sites, allowing for comparison of air quality before and after filtration. Additionally, in areas without consistent access to electricity, the system can be equipped with solar panels to meet its energy needs, making it self-sufficient and allowing it to be deployed in many harsh environments. Performance is evaluated by ambient field trials in Houston, Texas, and key metrics are single-pass particle reduction and ozone reduction. Additionally, the system allows for modularity, serving as a valuable tool for community air quality monitoring and for proactive responses in urban areas.

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Abstract: Science and Engineering Fair of Houston

3309

Closed-Loop Capacitive Deionization for Selective Phosphate Removal from Water

Huanran Yu, Erin Hua

Katy ISD/Jordan - HS

Category:

Environmental Engineering

Excess phosphate from agricultural runoff and wastewater discharge is a major cause of freshwater eutrophication and harmful algal blooms, which degrade ecosystems and hurt drinking water quality. This project proposes and investigates a low-voltage capacitive deionization (CDI) system designed for selective phosphate removal from water using phosphate-affinitive electrodes and closed-loop feedback control to optimize energy efficiency. A CDI cartridge was constructed using a sealed flow housing, porous carbon-based electrodes, and a spacer channel that directs water between oppositely charged electrodes under an applied electric field less than or equal to 1.2 Volts. Phosphate selectivity is introduced through surface modification of the electrodes to preferentially capture phosphate relative to competing ions such as nitrate and chloride. Phosphate concentration is measured using a molybdenum-blue colorimetric assay integrated with an LED–photodiode sensor. This enables real-time effluent monitoring. A microcontroller implements closed-loop control by dynamically adjusting CDI charge–discharge cycles based on measured phosphate levels, allowing comparison with fixed open-loop operation. Experiments evaluate phosphate removal efficiency, selectivity, regeneration behavior, and energy consumption under controlled testing conditions.

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Abstract: Science and Engineering Fair of Houston

3310

AI-powered Digital Wildfire Intervention Optimizer

Category:

Environmental Engineering

Sahana Dilli babu

Houston ISD/Carnegie Vanguard HS

Wildfires cause billions of dollars in damage each year, but most wildfire modelling tools focus on predicting where fires will spread rather than where intervention would be most effective. This limitation becomes critical in regions like Houston, Texas, where wildfires are not frequent but have high impact, and dense suburban areas intersect with forests and grasslands. Tools currently used by local agencies lack the ability to prioritize locations of intervention, increasing the risks of inefficient resource allocation and catastrophic damage. This project presents an AI-powered Digital Wildfire Intervention Optimizer to shift wildfire management from prediction to optimization. Using historical wildfire data from NASA FIRMS combined with land cover, elevation, and infrastructure data, the system learns how fires spread in Houston's unique environment. The landscape is applied as a grid, and a machine learning model is trained to predict probabilities of fire spread between neighbor cells. Rather than evaluating risk alone, the model measures how much wildfire spread and potential damage can be prevented by placing a fire break at a specific location. Fire spread is repeatedly simulated while firebreaks are applied to individual grid cells, which allows the model to quantify the impact of each intervention. The model then ranks the top five firebreak locations that provide the most damage prevention under resource constraints. The final output is a firebreak map and ranked intervention list that provides clear guidance for urban planners and fire agencies. This work demonstrates how optimization driven by AI can improve wildfire mitigation in regions underrepresented in wildfire research, offering a cost-effective and practical tool for reducing future damage.

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Abstract: Science and Engineering Fair of Houston

3311

Detection of Low Concentrated Heavy Metal Ions with Machine Learning

Katherine Hu

Conroe ISD /AST: Academy of Science and Technology

Category:

Environmental Engineering

Heavy metal ions in drinking water are detrimental to human health. Even in a low concentration, they could accumulate in the human body and will eventually exceed the safety limit after a long enough time. The state-of-art fluorescence spectral sensing methods using nanomaterials such as carbon quantum dots have been applied to detect heavy metal ions in low concentrations. However, the biggest challenge of these methods is that they still have the potential limit of detection, i.e., they couldn't differentiate samples when their concentrations are below the threshold value. The purpose of this work is to apply the machine learning algorithms on existing data to enhance the sensitivity of detection of heavy metal ions.

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Abstract: Science and Engineering Fair of Houston

3312

sustAInable: Right-Sized AI for Smarter and Greener Data Center Cooling

Tavishi Sinha

Fort Bend ISD /Dulles High School

Category:

Environmental Engineering

The rapid expansion of artificial intelligence into nearly all aspects of our lives has significantly increased computational demands on datacenters, resulting in high electricity consumption and large-scale water usage for cooling systems. Existing AI-based cooling optimization models are often computationally expensive, introducing inference latency and contributing to inefficient overcooling while remaining unoptimized for their own energy usage. This project, sustAInable, investigates a hybrid predictive cooling approach that dynamically switches between small and large AI models in real time to optimize rack-level and room-level cooling. The project aims to address optimized predictive cooling by conducting experiments on a prototype and comparing electricity and water usage data. The prototype cooling controller was developed using an ESP32 microcontroller, temperature and humidity sensor (DHT22), power sensor (INA219), cooling fan, heat source, resistors, transistors and USB power meter. It simulates datacenter operating conditions. Three cooling control strategies were evaluated: a small-model controller, a large-model controller, and an adaptive controller that switches between models based on simulated workload and thermal conditions. Model performance was analyzed within the following metrics: cooling energy needs, water usage, peak temperature, and switching frequencies. Results demonstrate that adaptive model switching can preserve cooling performance while reducing computational overhead, suggesting a more energy-efficient and scalable approach for AI-driven datacenter cooling control.

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Abstract: Science and Engineering Fair of Houston

3313

Effects of UV Irradiation on the Production of Algae: New Carbon Capture Alternatives

Chloe Luo

Clear Creek ISD /Clear Lake High School

Category:

Environmental Engineering

This study investigates microalgae as a sustainable biomass and carbon-capture platform, focusing on how ultraviolet (UV) light irradiation influences algal growth under phosphorus-limited conditions. Microalgae rapidly accumulate biomass and efficiently sequester CO_2, making them promising candidates for mitigating atmospheric carbon while serving as renewable biofuel feedstock. Their photosynthetic growth can be represented by: $106\ CO_2 + 16\ NO_3^- + HPO_4^{2-} + 112\ H_2O + 18\ H^+ + \text{energy} \rightarrow (CH_2O)_{106}(NH_3)_{16}(H_3PO_4) + 138\ O_2$ While nitrogen nutrition has been widely studied, phosphorus remains comparatively under-investigated despite its critical role in cellular metabolism and energy transfer. Following an analysis of pH effects on phosphorus uptake, this study explores UV irradiation as an additional energy input to enhance algal growth efficiency. A 38-W household UV light irradiated microalgae cultures for 3 hours daily over a two-week period. Growth was compared to non-irradiated control samples under identical conditions. Irradiated cultures exhibited a 4.4 wt% increase in biomass relative to controls. Although the increase is modest, experimental conditions were intentionally conservative. Cultures were grown at relatively low temperature and supplemented only with plain water, without optimized nutrient enrichment. In addition, the household UV source provided limited irradiance compared to industrial systems or natural solar exposure. These factors suggest substantially greater growth enhancement may be achievable under optimized conditions incorporating nitrogen and phosphorus enrichment, controlled pH, elevated temperature, and higher-intensity UV exposure. These results support the feasibility of UV-assisted microalgae cultivation as part of scalable CO_2 mitigation strategies. Because natural UV radiation is strongest in equatorial regions, often within developing countries, effective global carbon capture may benefit from collaborative international deployment.

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Abstract: Science and Engineering Fair of Houston

3314

AutoFerment-Tox Biosensor

Category:

Environmental Engineering

Yue Li, Zhixuan Sun

Private/The Village School

The project will aim to develop a microchip based biological sensor based on brewer's yeast(Saccharomyces cerevisiae). The experiment will test on how the changes in population of yeast due to pollutants including heavy metals and metal salts may affect the carbon dioxide level of the environment of yeast. In turn, it will affect the acidity level of the environment due to the formation of carbonic acid in the environment of the yeast. The project aims to detect the variation through the microchip, potentially developing a less expensive way of detection of cytotoxic and harmful substances by yeast.

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Abstract: Science and Engineering Fair of Houston

3315

Ground-Level Drone to Survey Pollution in Neighborhoods Using Grid Mapping

Sam Faulk, Suraj Verma, Micah Kan

Private/ST. JOHN'S SCHOOL

Category:

Environmental Engineering

Pollutants in the air can pose many health risks, including cancer, cardiovascular diseases, and respiratory diseases, as well as reproductive, neurological, and immune system disorders. These dangers are especially prevalent to those who live in large cities or industrial centers. Despite these dangers, most information on air pollution is on a large scale and does not effectively allow for individuals to protect themselves. Although readings that can be found on the internet mention the high levels of pollution in the large area, there is no way to tell how any specific person is actually affected. This project aims to create a ground-level drone which travels throughout a neighborhood based on a mapping program while collecting data on the quality of the air. The drone then presents the data in a digestible format for the user to understand how best to protect themselves and help the pollution in the areas most pertinent to their lives. The system collects data from six distinct sensors (particulate matter, ozone, carbon dioxide, carbon monoxide, nitrogen oxides, and volatile organic compounds) and organizes the data through heat maps to inform the user on the most present pollutants in their neighborhood and the dangers posed by those pollutants. The data can then be uploaded to a database so the entire community can benefit from the results, not only the user. With easily accessible information about the small-scale dangers in the air people breathe, those individuals can work together to protect themselves and reduce the large-scale effects of pollution.

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Abstract: Science and Engineering Fair of Houston

3316

Capturing condensation: A thermally driven, hydrogel-based system for atmospheric water harvesting

Max Madof

Private/The Emery/Weiner School

Category:

Environmental Engineering

More than one quarter of the world's population lacks access to safely managed drinking water due to physical inaccessibility or contamination. The atmosphere, however, represents a vast and largely untapped reservoir of freshwater and offers a potential pathway toward scalable solutions to this global challenge. Here, I present a low-cost, thermally driven atmospheric water-harvesting (AWH) system that captures moisture directly from ambient air and converts it into liquid water. The apparatus, termed FRANK (Forced Radiative Atmospheric Night-day Kollector), consists of a transparent acrylic enclosure housing an internal, removable metal screen coated with a hydrophilic, water-based polymer (hydrogel). The hydrogel, synthesized from polyvinyl alcohol (PVA), glycerol, and calcium chloride, was designed to absorb atmospheric water vapor under cooler conditions and subsequently release it as liquid water during warmer periods. FRANK was operated over three adsorption–desorption cycles under relative humidities ranging from 38% to 93%. Analysis of system performance indicates that water yield increased with both higher relative humidity and elevated temperatures, consistent with a thermally driven adsorption–desorption mechanism. These results demonstrate that, with further optimization, scaling, and integration of effective liquid-water purification strategies, FRANK could be deployed at larger scales and contribute meaningfully to addressing global water scarcity.

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Abstract: Science and Engineering Fair of Houston

3317

Quantifying the Circular Economy: A Multi-D imensional Comparative Analysis of Seven Re cycled Waste Aggregates for Enhanced Concre te Durability, Embodied CO2 Reduction, and Maximized Non-Biodegradable Waste Diversion

Natasha Pesnell, Leah Walters

Conroe ISD /AST: Academy of Science and Technology

Category:

Environmental Engineering

The world is facing two major, closely connected problems: rising greenhouse gas emissions that drive climate change and the growing accumulation of non-biodegradable waste, especially plastics. This study explores whether common waste materials—polyester, acrylic, nylon, rubber, aluminum, plastic, and glass—can be reused as concrete aggregates to lower embodied carbon without sacrificing strength or durability. Concrete samples were made using seven recycled aggregates and a control mix, with 25%, 50%, and 75% of the fine aggregate replaced by waste material. This project builds on last year's research, which focused only on the compressive strength of polyester-modified concrete. The results show that recycled aggregates clearly affected concrete performance. Most recycled mixes were far more workable than the control, which had a slump of 20 mm. Rubber, plastic, and glass produced the highest slump values, while aluminum showed the lowest workability. Glass had the best environmental impact, and mixes with 75% replacement achieved the greatest overall carbon reduction. Durability testing showed that nylon, rubber, and plastic significantly reduced water absorption by up to 88.56% compared to the control, while polyester allowed more water penetration. The strongest mixes were those with 75% rubber and plastic, achieving compressive strengths of 4651.16 PSI and 4069.77 PSI, respectively. Overall, the findings suggest that recycled waste aggregates, especially rubber, plastic, and glass, can improve concrete performance while reducing environmental impact, supporting their use in more sustainable infrastructure.

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Abstract: Science and Engineering Fair of Houston

3318

Comparative Study of Biodegradable Plastics from Starch and Algae Sources

Daniel Ayo

Harmony Public Schools - South District/Harmony School of Innovation Katy

Category:

Environmental Engineering

Conventional plastic bags contribute significantly to environmental pollution due to their durability and resistance to natural degradation. As a result, biodegradable plastics derived from renewable sources such as algae and starch have been experimented as sustainable alternatives. This project compares algae-based biodegradable plastic bags, starch-based biodegradable plastic bags, and conventional polyethylene plastic bags to evaluate their tensile strength, decomposition rate, and environmental impact. Tensile strength was measured by applying increasing loads to standardized plastic samples until material failure occurred. Decomposition rates were assessed by burying samples in soil under controlled indoor conditions and monitoring physical changes, mass loss, and structural integrity over a 14-day period. Environmental impact was evaluated through analysis of existing scientific literature addressing material sourcing, biodegradability, and life-cycle considerations. Results indicated that both algae-based and starch-based biodegradable plastics exhibited significantly faster degradation than conventional plastic bags, while conventional plastic demonstrated the highest tensile strength. By doing this project, I attempt to connect to real-world plastic waste challenges and sustainable alternatives.

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Abstract: Science and Engineering Fair of Houston

3319

Integrated Atmospheric Filtration Dome for CO_2 Extraction Using Calcium Hydroxide and Thermoelectric Energy Conversion

Anh Nguyen, Kemli Vo

Alief ISD/Alief Taylor HS

Category:

Environmental Engineering

Rising atmospheric carbon dioxide (CO_2) levels are a major contributor to climate change, driving global temperature increases and environmental instability. Current carbon capture technologies are often energy-intensive, costly, and primarily focused on long-term storage rather than reuse. This project presents an integrated atmospheric filtration dome that captures CO_2 using calcium hydroxide and converts thermal energy into electrical energy through a thermoelectric generator (TEG). Ambient air is drawn through a chemically coated filter where CO_2 reacts to form calcium carbonate, reducing greenhouse gas concentration. Simultaneously, a temperature gradient applied across the TEG generates electrical power via the Seebeck effect. Experimental trials measured CO_2 removal efficiency and energy output under varying temperature differences. Results showed an average CO_2 removal of approximately 30% and increased electrical energy generation with larger temperature gradients, confirming effective coupling of carbon capture and energy recovery. This low-cost, small-scale system demonstrates the feasibility of integrating chemical CO_2 capture with thermoelectric energy conversion for sustainable climate mitigation applications.

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Abstract: Science and Engineering Fair of Houston

3320

Evaluating UAV-Based Litter Monitoring Performance for Environmental Assessment Across Ground Types and Illumination Conditions

Jason Zhao

Katy ISD/Tompkins - HS

Category:

Environmental Engineering

Litter accumulation in urban forest parks is a rising challenge for environmental engineering. Large geographical scope, complex ground surface types, and partial occlusion by surrounding vegetation make ground survey methods highly time-consuming and limit environmental monitoring efficiency. Unmanned Aerial Vehicles (UAVs) equipped with computer vision systems are gradually becoming a potential engineering solution for large-area litter monitoring. However, their effectiveness has not been fully validated under real forest park conditions, especially since environmental factors such as ground surface types and illumination conditions may constrain the reliability of UAV-based litter monitoring systems. This study evaluates the performance of a UAV-based litter detection system in a real urban forest park. A systematic evaluation was performed to test the effects of litter type, ground type, and illumination conditions on detection accuracy. A dataset containing 375 images was created using drone-captured imagery, and a YOLO object detection model was created based on this dataset. The impact of environmental conditions on detection accuracy was analyzed using ANOVA statistical method. The results show that litter type and environmental conditions have significant effects on detection accuracy, with certain significant interaction effects between them. From an environmental engineering perspective, this study provides insights for establishing UAV-based litter monitoring strategies. The findings could improve environmental monitoring efficiency, help litter cleanup operations, and provide decision-support for park and ecological management.

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Abstract: Science and Engineering Fair of Houston

3321

PINN-point Air Quality: Physics-Informed Neural Networks for Predictive Benzene Dispersion Mapping

Neev Pratap, Krishiv Vyas

Fort Bend ISD /Elkins High School

Category:

Environmental Engineering

Over 6 million Americans live within three miles of oil refineries, facing chronic benzene exposure that increases leukemia risk by 27%. This environmental burden falls disproportionately on low-income and minority communities, with African American and Hispanic populations experiencing 10–21% higher benzene concentrations and people in poverty facing up to 50% greater cumulative exposure. Current monitoring approaches fail to protect these vulnerable populations. High-quality sensors cost $15,000–$100,000+ each, creating coverage gaps that leave entire neighborhoods unmonitored and operate reactively, detecting benzene only after residents have already been exposed. Pure computational models, such as CFD, require perfect meteorological data and take hours to compute, making them unsuitable for rapid monitoring. This project addresses this problem by developing an integrated hybrid machine learning system that provides comprehensive predictive benzene monitoring at a feasible cost. First, a Physics-Informed Neural Network (PINN) was trained on synthetic data generated from numerically solved advection -diffusion equations, with physics-based loss terms enforcing transport dynamics and conservation laws. To account for real-world deviations from idealized simulations, a data-driven correction network was then implemented to learn systematic discrepancies between PINN outputs and sparse sensor measurements. This two-stage approach eliminates monitoring gaps by providing concentration estimates at every spatial point, while enabling proactive alerts before benzene plumes reach residential areas. This empowers environmental justice communities to take protective action before exposure occurs.

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Abstract: Science and Engineering Fair of Houston

3322

PollenPilot: An Auto-Pollinating Ground Robot

Category:

Environmental Engineering

Aaron Wu, Carson Wang

Private/ST. JOHN'S SCHOOL

Global honeybee populations have continued to decline by 40-50% in the last decade, creating a critical agricultural crisis, especially in Controlled Environment Agriculture (CEA), where natural pollination is hindered by artificial light and pathogens. Enter PollenPilot: an autonomous, convolutional neural network (CNN) integrated ground robot designed to pollinate greenhouse tomatoes. The system consists of four novel subsystems: a tread-based drivetrain with a rack-and-pinion actuator, stereoscopic computer vision, biomimetic soft robotics, and non-contact electrostatic pollination. Using a You Only Look Once (YOLOv8) CNN to classify flower bloom stages (bud, bloom, flower), PollenPilot coordinates with stereoscopic triangulation to generate real-time depth maps. To optimize the path of travel, a 3D Traveling Salesman Problem (TSP) algorithm was developed; with a custom Z-weighted Euclidean heuristic, this algorithm proficiently reduced localized travel distance by 16.6%, from 33.24 cm to 27.73 cm during cluster traversal. The current performance metrics show a drivetrain speed of 0.161 m/s and an average arm extension time of 7.33 seconds, successfully meeting industry standards of 5-8 seconds. By synthesizing four subsystems, PollenPilot ensures food security in the face of the accelerating collapse of natural pollination.

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Abstract: Science and Engineering Fair of Houston

3323

Category: Environmental Engineering

NanoSorb: Developing a Hydrophobically Functionalized Bio-Based Magnetic Nanosponge for Rapid and Recyclable Oil Spill Remediation in Aquatic Environments

Amber Zheng, Gauri Chandran

Conroe ISD /AST: Academy of Science and Technology

As industrial activity and global transportation expand, water pollution has become a critical environmental and public health concern. Oil spills, in particular, cause long-term damage to aquatic ecosystems by creating an impermeable film on water surfaces, preventing oxygen transfer. However, traditional methods of treatment are often expensive and energy-intensive, highlighting the need for a sustainable, efficient, and scalable alternative. In this study, a bio-based nanosponge was developed to explore the potential of sustainable, biodegradable materials for the removal of pollutants. First, chitosan, cellulose, and Fe3O4 nanoparticles were incorporated into an acidic solution to form a viscous gel base for the nanosponge. This solution was then poured into foil-lined Petri dishes and frozen for over 24 hours, allowing a porous internal structure to develop. After freezing, the chitosan gel-polymer structure was neutralized using NaOH to stabilize and preserve its structural integrity during the 48-hour air-drying process. The resulting sponges were then characterized and tested based on physical appearance, hydrophobicity, magnetic response, and oil absorbance capacity. The sponges exhibited irregular pores, but a mechanically usable structure. They showed magnetic attraction within approximately 4 seconds and absorbed, on average, around 5 grams of oil per gram of sponge, while effectively repelling water. This approach presents a promising solution for the targeted removal of oil from contaminated water sources, offering a sustainable and reusable method for mitigating localized water pollution, paving the way for groundbreaking solutions to advance environmental remediation efforts.

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Abstract: Science and Engineering Fair of Houston

3324

Decentralized Stormwater Micro-BMP with Removable Sand and Biochar Cartridges: Effectiveness, Hydraulics, and Maintainability

Luke Lipari

Conroe ISD /AST: Academy of Science and Technology

Category:

Environmental Engineering

This project investigated the efficacy of a small, decentralized, cartridge-based system with biochar-amended media, designed to reduce turbidity and balance pH in synthetic stormwater while maintaining reasonable hydraulic performance. Stormwater runoff often contains high turbidity and imbalanced pH levels, leading to water and soil quality decay. Decentralized filtration systems introduce a small-scale solution to this problem that can be easily implemented across urban areas to reduce pollutants before they enter local major water bodies. Multiple cartridge configurations, including biochar, sand, and zeolite media, were constructed and tested using synthetic stormwater under controlled and sustained flow conditions of 2 L/m. Filter performance was evaluated across multiple trials to assess turbidity reduction, pH neutralization, hydraulic headloss, and longevity. The filtration system met the turbidity and pH thresholds in 14 of the 15 trials run for each. Headloss achieved its target goals in all trials, and longevity testing indicated stable performance, with step growth below 15% across six consecutive measurements. These results highlighted that the system frequently performed well across multiple configurations and maintained reliability over repeated usage. Additionally, the results illustrate consistent effectiveness across multiple biochar-amended configurations. Overall, these findings successfully exhibit that a decentralized cartridge-based micro-BMP can effectively treat synthetic stormwater while maintaining hydraulic function, indicating potential for broader application in urban runoff management. The outcomes of the tests run on the interchangeable design and use of removable cartridges suggest this system could be adjusted for urban small-scale stormwater management applications.

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Abstract: Science and Engineering Fair of Houston

3325

Category:

Environmental Engineering

Utilizing Pestalotiopsis microspora to Enhance the Mitigation of Municipal Solid Waste Landfill-Derived Plastics Through Surfactant-based Hydrophilic Interactions

Adam Siddiqi

Conroe ISD /AST: Academy of Science and Technology

In recent years, the increasing accumulation of plastic waste has posed a significant environmental challenge due to polymers' resistance to natural degradation methods, overfilling MSW Landfills. Polyethylene terephthalate (PET) plastics, found in commercial packaging and consumer products, are impervious to degradation largely due to their hydrophobic nature. Fungal species Pestalotiopsis microspora has garnered attention due to its capabilities of plastic degradation through extracellular hydrolytic and oxidative enzymes. However, current enzymatic-plastic interactions remain ineffectual due to their antiparallel hydrophobic and hydrophilic natures, limiting degradation efficiency. This research aims to investigate whether Polysorbate 80 (Tween 80), a biodegradable surfactant, can enhance fungal-mediated plastic degradation by mediating plastic and fungal surface tensions. 2 PET plastic pieces, weighing 5g, were placed into petri dishes, one immersed in a 1% Polysorbate 80 solution. Then 6 cm^3 of liquid Pestalotiopsis microspora were placed onto the PET plastic surface, and measurements were taken each day over a five-day period to measure plastic degradation utilizing Monte Carlo Simulations to approximate the integral of the surface. Results revealed a 26% increase in plastic degradation in the Polysorbate 80-surfaced plastic compared to the control with only the fungi. Importantly, Polysorbate 80's presence in the experiment did not significantly alter the fungal growth or pH; in fact, the fungi utilized the degraded plastic as a source of nutrients, contributing to greater fungal growth. These findings demonstrate the potential of fungal surfactant-based approaches in bringing a promising solution to plastic degradation, contributing to applications in the research industry and landfill areas.

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Abstract: Science and Engineering Fair of Houston

3326

A Solar-Assisted Composter for Household Food Waste

Category:

Environmental Engineering

Lorena Zou

Fort Bend ISD /Clements High School

In this project I plan to complete three composts with three groups, two of which involve different add-ons, and one of which is the control group. Since this is a solar-powered thermal composter, the buckets the soon-to-be compost is placed in are located outside, so that they can be rained on and have direct sunlight to enable quicker thermal composting. The control group has all the normal components of compost: brown matter (shredded paper and cardboard) and organic matter (fruit and vegetable scraps, leaves), as well as a small but measured quantity of dirt. Likewise, the other two groups also have the same amount of brown and organic matter, but the other two groups have different commercial compost starters purchased online. The first experiment I ran for this project determined which bucket type I used: Lowe's blue 5 gallon bucket or an off-brand white 5 gallon bucket. I left them both outside on both cloudy and sunny days and noticed a clear temperature difference, with the blue bucket being consistently warmer, making it the better choice for this thermal composter. In addition, a second experiment with only brown matter inside the two differently colored buckets showed an even larger difference, so I picked the blue bucket for all three groups. Next, I filled them all with equal amounts of brown and organic matter with the same amount by weight of either a commercial compost starter or dirt from my backyard and mixed them all before placing them in the same location outside. My hypothesis is that there is not much of a difference between commercial compost starters and dirt in accelerating the thermal composting process, and I hope to prove it with the three compost groups.

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Abstract: Science and Engineering Fair of Houston

3327

Development and Performance Evaluation of Bio-Based Air Filters Using Plant Fibers and Recycled Paper.

Paulo Galindo, Dany Zabala

Alief ISD/Alief Taylor HS

Category:

Environmental Engineering

The purpose of this experiment is to test plant fibers and recycled paper as biodegradable air filter materials. We expect that these materials can capture harmful particles from the air, and then break down safely after use instead of creating long lasting waste. This experiment helps explore sustainable alternatives to traditional synthetic filters, which can release microplastics and may not capture all particulate matter, such as PM2.5 and PM10. Our hypothesis is that processed recycled paper and plant fiber based materials can provide effective particulate filtration while reducing environmental and human health impacts. To test this hypothesis, it was necessary to break down the paper and fibers as much as possible. Previous research shows that cellulose based filters and papers that are reshaped from their original form can remove fine particles more easily because of the way their pores form. Guided by these results, samples of both materials were prepared and tested to create a steady airflow and reduce the amount of PM particles in a small, controlled space. To evaluate the efficacy of each material, we used a small enclosed space and a small fan to constantly circulate particles through the filter. The results indicate that both plant fibers and recycled paper can serve as substitutes for plastic based filters. Their performance shows effective air purification can be achieved using sustainable materials that do not create residual plastic waste. This supports ongoing efforts to develop ecofriendly filtration technology and provides a starting point for improving biodegradable filter design.

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Abstract: Science and Engineering Fair of Houston

3328

Improving Coralline Algae

Isabel Sopon, Abigail Constantine

Conroe ISD /ASHP: Academy for Science and Health Prof

Category:

Environmental Engineering

This project aims to help coralline algae survive in acidic environments. The hypothesis is, "If other algae can survive in acidic environments, then genetically modifying coralline algae should help improve the survival rate." Growing different species of algae at varying pH levels, specifically 2, 5, 7, and 8, enables the isolation of cells that can survive best in acidic environments. Once the algae have finished growing, begin the DNA extraction process, followed by genetic sequencing to determine the genetic code responsible for adapting to an acidic environment. The main materials needed are test tubes, pipettes, pepsin solution, and water filters. With the pH levels of 2 and 5, those algae did not grow to their full potential. Compared to the pHs for 7 and 8, which continually grew. The hypothesis that different algae can survive in different acidic environments was supported.

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Abstract: Science and Engineering Fair of Houston

3329

Eco-Starch: Bio-Remediation for Oil Spills

Category:

Environmental Engineering

Karina DSouza

Conroe ISD /TWHS: The Woodlands High School

Oil spills cause severe ecological and economic damage, killing birds and sea turtles, harming marine mammals, disrupting fish populations, and restricting fishing and boating during long cleanup periods. Many current cleanup methods further damage vulnerable aquatic life, rely on harsh techniques, and fail to preserve spilled oil, resulting in significant waste as in 2024 approximately 10,000 tons was lost to tanker spills. Duckweed is typically harmful due to its rapid growth and oxygen depletion, but contains a microtubular structure that absorbs oil, allowing it to be repurposed for oil spill cleanup. This project builds on my prior work in converting harvested duckweed starch into an oil absorbing material and evaluates its effectiveness under freezing, sunlight, and saltwater conditions, as well as its impact on water quality and the possibility of oil reuse. To evaluate performance under freezing, sunlight, and saltwater conditions, 6 grams of material were exposed to simulated oil spills for 48 hours and then reweighed to determine oil absorption; each test was repeated three times. Saltwater conditions were modeled using a saline solution made by dissolving 9 grams of iodized salt in 1 cup of water. After absorption, a centrifuge was used to separate the oil from the material to find the percentage of oil recovered and oil clarity. Water quality was assessed using three pH strips. Results showed that freezing conditions doubled oil absorption, while sunlight and saltwater produced results consistent with the control variable. On average, the material absorbed 71% of the oil with a recovered purity of 69%, and all pH tests remained neutral, indicating environmental safety. The results suggest oil reuse would be possible with a successful under various conditions, cost-effective, quick, and environmentally safe duckweed starch-based material.

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Abstract: Science and Engineering Fair of Houston

3330

Experimental Analysis of a Floating Wave Energy Converter

Category:

Environmental Engineering

Nilgun Sari, Halid Avsar, Neva Ugur

Harmony Public Schools - South District/Harmony School of Innovation Katy

The purpose of this project was to design an efficient point absorber wave energy converter and study how changes in wave conditions and mooring setup affect electrical power output. As global energy use moves toward renewable sources, improving small scale hydrokinetic energy systems is important for supplying power to offshore sensors and coastal infrastructure. In this study, a prototype floating buoy was built using high density foam and connected to a permanent magnet DC generator. The system was tested in a controlled wave tank where wave height (H) and wave period (T) were adjusted. A power take off system converted the vertical up and down motion of the buoy into rotational motion that could generate electricity, and the electrical output was measured using a digital multimeter across a fixed load. The stiffness of the mooring system was changed by using springs with different constants to observe how this affected the buoy's natural motion and energy capture efficiency. Results showed that power output increased when the wave period matched the natural frequency of the buoy system. Under optimal conditions, with a wave height of (X) cm and a period of (Y) seconds, the prototype produced a peak voltage of (Z) mV. Further analysis showed that increasing mooring stiffness improved efficiency in short period waves but reduced performance in long period swells, leading to the conclusion that tuning the buoy system to match wave conditions is key to maximizing energy output and demonstrates the potential of small scale wave energy for sustainable offshore power.

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Abstract: Science and Engineering Fair of Houston

3331

Category: Environmental Engineering

Super Soaker: Improving Atmospheric Water Harvesting via Dual-Function Calcium Chloride and Photothermal MOF-801-Graphene Oxide Hydrogel Composites

Shaan Patel

Conroe ISD /AST: Academy of Science and Technology

2.2 billion people are facing water shortages, one of humanity's most pressing concerns. Surface and ground water is depleting, inaccessible, and heavily polluted; microplastic-heavy metal coagulation amplifies this effect. Sorption atmospheric water harvesting (SAWH) is a promising alternative with current trade-offs between performance and environmental impact. A zirconyl-based metal-organic framework-801 with a photothermal graphene oxide additive and experimental calcium chloride was developed and tested to maximize uptake, integrity, and reusability. MOF-801-GO was synthesized from zirconyl chloride octahydrate, fumaric acid, and a 5% wt graphene oxide additive using reflux-based solvothermal synthesis. MOF-801-GO was isolated by vacuum filtration and solvent exchange, then incorporated into gelatin-sodium alginate-polyvinyl alcohol hydrogels, containing 0%, 5%, 10%, and 20% $CaCl_2$ (w/w polymer). Alginate provided ionic crosslinking and PVA improved mechanical stability. Samples then underwent 2 adsorption-desorption cycles, including 28 trials. Adsorption was conducted at STP and 70-80% relative humidity in darkness for 8 hours, followed by desorption at low relative humidity and 50-60°C using a heating lamp. Adsorption metrics were quantified gravimetrically, and $CaCl_2$ concentration strongly influenced performance. The 10% $CaCl_2$ hydrogels had the most consistent water uptake of 0.65-1.06 g/g, 200% of similar research, and retained ~50% of uptake across cycles. 5% CaCl2 samples exemplified previously unreported osmotic-pressure based bubbling, contributing to high uptake, while 20% CaCl2 samples showed high apparent uptake (up to 1.29 g/g) though they still need remediated degradation. Compared to existing energy-free SAWH systems, these results demonstrate significant advancement, with a future-facing focus on scalability.

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Abstract: Science and Engineering Fair of Houston

3332

HydroMetrix: A Piezoelectric-Activated Device for Precise Heavy Metal Detection and Filtration of Wastewater Contaminants

Jose Barrios, William Li

Conroe ISD /AST: Academy of Science and Technology

Category:

Environmental Engineering

Heavy metal contaminants, such as chromium and lead, originating from industrialization, urban runoff, and mining, cause major health issues and five million annual deaths. Current filters adsorb contaminants but quickly saturate with non-target particles, resulting in recurrent and expensive replacements preventable through target-triggered filtration. Many conventional metal detection methods are either qualitative, such as paper strips, or lab-based and expensive. HydroMetrix is a digital heavy metal sensor using the piezoelectric property of a quartz crystal microbalance (QCM) to detect changes in frequency when heavy metals are present in water. By coating the QCM sensors in chitosan and sodium tripolyphosphate, the sensor is capable of real-time detection of metal ions through the frequency shift as they bind to the coated surface. Sensor performance was evaluated using copper solutions to safely test heavy metal detection. Using an oscilloscope, the QCM frequency changes were recorded using a two second rolling average to reduce environmental noise. Frequency shifts exhibited a strong linear correlation with metal concentrations, with an R squared value of 0.89. A t-test confirmed a statistically significant non-zero slope, with a p-value less than 0.05. Repeated exposure trials demonstrated consistent frequency shifts and stable sensor performance. The results prove the feasibility of using a novel, digital QCM-based sensor to detect heavy metals in water. HydroMetrix provides a low-cost and real-time method for water monitoring, helping cities identify dangerous water contamination before people suffer and supporting future development of adaptive filtration by activating mechanisms only when heavy metals are detected.

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Abstract: Science and Engineering Fair of Houston

3333

Agrabhi

Nathan Sharma, Naitik Patel, Evan Quach

Katy ISD/Cinco Ranch - HS

Category:

Environmental Engineering

Variation in soil moisture across agricultural fields reduces crop yields and leads to inefficient water management. Climate change has increased the variability of soil moisture, intensifying this problem. An autonomous drone system, built for under $1000, collects soil moisture data and generates high-resolution field maps using regression kriging. The drone integrates a custom linear-actuator-driven capacitive sensor probe, an RTK-GPS for centimeter-level spatial accuracy, and a Raspberry Pi/Pixhawk architecture for data collection and semi-autonomous navigation. We calibrated the soil sensor against the gravimetric water content of the test field soil. Custom written code collected data at landing points, controlled the actuator, and evaluated interpolation methods. Among Ordinary Kriging, Regression Kriging, and Inverse Distance Weighted Interpolation, Regression Kriging demonstrated the smallest Root-Mean-Square Error (RMSE) in Leave-One-Out-Cross-Validation (LOOCV) and reasonable Mean Error (ME) when coupled with elevation data. Field validation shows interpolated moisture values are within experimental uncertainty of ground-truth measurements. While commercial agricultural drones cost several thousand dollars, our relatively low-cost system provides high-resolution, spatially explicit moisture mapping, revealing detailed patterns of soil moisture variation and potentially supporting improved irrigation decision-making and water efficiency.

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Abstract: Science and Engineering Fair of Houston

3334

Stopping Seeds Before They Sprout: A Hormone-Based Solution for Chinese Tallow Trees.

Joslinne Ramirez-Salgado, Lindsey Lozano, Caitlin Helm

Conroe ISD /ASHP: Academy for Science and Health Prof

Category:

Environmental Engineering

The purpose of this project is to design a prototype device that holds Jasmonic (JA) & Abscisic (ABA) acid to implement a hormone-based method that decelerates the germination of the Chinese Tallow Tree. It is hypothesized that a device can be innovated that supplies a specific concentration of Jasmonic (JA) and Abscisic (ABA) acid to prevent the germination of the Triadica Sebifera during a yearly 3 month time period. (February to March) The hormonal device was built using a mini linear actuator, an RF forward reverse switch, a 3000mAh battery, and a 10mL syringe kept inside of a clear rectangular container. The actuator was connected to the syringe and controlled by a remote to push and pull the connected syringe, which would release jasmonic and abscisic acid. The device was tested through 15 trial runs to confirm that the actuator had the ability to push and pull just as it was programmed to do. It was tested to prove that the device had the potential to release hormones into the tree, and all results concluded "Yes". As this ensured 100% accuracy as the device functioned. The engineering goal was correct since the device successfully pushed and pulled the syringe to deliver jasmonic and abscisic acid. Thus, despite the device being in its embryonic stages, it could be used in the future to control the germination of Chinese Tallow Tree seeds and help manage their invasive spread across the United States. This creates a possible solution to eventually eradicate the invasive species Sapium Sebiferum, a prospect for restoration in its surrounding environment for native wildlife.

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Abstract: Science and Engineering Fair of Houston

3335

Category:

Environmental Engineering

In-Silico Screening of Metal-Organic Frameworks: Maximizing Carbon Sequestration for Downstream Algal Photosynthetic Conversion for Self-Sustaining Extraterrestrial Life Support Systems

Advika Asthana

Home School/Homeschool

Long-duration spaceflight introduces significant challenges in atmospheric management, particularly the continuous buildup of CO_2 within tightly sealed spacecraft environments. Current Environmental Control and Life Support Systems (ECLSS) for long-duration spaceflight face critical limitations in mass efficiency and resource regeneration. We present a system that integrates Metal-Organic Frameworks (MOFs) with biological carbon fixation to create a self-sustaining atmospheric cycle. The study utilizes in-silico screening and simulations via the MOFX-DB to characterize the adsorption kinetics of candidate materials, specifically MOF-210 and its amine-functionalized derivatives. Simulation results under simulated spacecraft conditions (0.5% CO2, 298 K) demonstrate that MOF-210 exhibits a superior CO2 capacity (up to 2.4 kg/g) and enhanced selectivity over atmospheric nitrogen compared to traditional zeolite-based scrubbers. By employing a computational materials science approach to optimize the capture-to-conversion interface, this research provides a validated framework for. This research presents an advancement in engineering life support systems that will be essential for long-duration space missions.

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Abstract: Science and Engineering Fair of Houston

3336

The Robotic Linear Actuator

Rodrigo Valdez

Pasadena ISD/Pasadena Memorial Early College HS

Category:

Environmental Engineering

In the agricultural life, farmers faced serious measures on growing their agricultural plants by facing these things called pests which are an invasive species who feed on the agricultural plants. Farmers have come up with solutions to solve this but one of them brings harm to the environment. By using pesticides which are chemicals that remove the pests but it has 2 downsides of using those services by using this some pests can grow immune to the usage of over excessive chemicals. The other is that these chemicals are sprayed on the fields which are just left there in the ground but when it comes to irrigate the field. Some farmers may saturate the soil over the excessive amount of water, and because of that, it causes run-off water to bring with the chemicals with it and the run-off water mainly affects nearby body's of lake which puts in risk the aquatic life. In this case if chemicals are drag into a nearby body of water this will cause Alga bloom covering the whole entire body of water, which the alga bloom covers the rays of the sun which prevents the plants underwater to produce oxygen and therefore the aquatic life would not have anything to breath under with. Because of this the Robotic Linear Actuator's main job is to monitor how much water is being watered around the soil, to prevent the saturation of the soil and prevent which at the same time it prevents run-offs, which as well prevents alga bloom.

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Abstract: Science and Engineering Fair of Houston

3337

Characterization and Fabrication of Bioplastics Mesh Bag from Waste Materials: A Sustainable Packaging Solutions

Laurelle Er

Conroe ISD /AST: Academy of Science and Technology

Category:

Environmental Engineering

Plastics are a major source of pollution, degrading into microplastics, which are harmful to human health. Bioplastics are an alternative to conventional plastic because they're made from renewable, organic sources. Biofillers are natural additives added to bioplastics to improve their thermal and mechanical properties. This project investigates whether starch-based bioplastics reinforced with waste biofillers can be a viable alternative to plastic mesh packaging. This study utilized tapioca starch with eggshells, cardboard, and pine needles incorporated as biofillers in the production of bioplastic. Ten samples with different composition and percentage of biofillers were fabricated. The results showed that two bicomposite bioplastic samples, BC3 (10% cardboard and 10% pine needles) and BC4 (10% cardboard and 5% pine needles) were capable of holding eight and six times the weight load of mandarin oranges packaged in a conventional plastic mesh bag. Both biocomposites have high tensile strength, which indicates that the biocomposites are stronger at resisting tension, and the Young's modulus measurement indicates that the materials retain some degree of flexibility. BC3 and BC4 have better water resistance compared to bioplastic made from tapioca starch alone. This experiment demonstrates that starch-based bioplastics, enhanced with cardboard and pine needles can serve as a viable alternative to plastic packaging.

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Abstract: Science and Engineering Fair of Houston

3338

Olive Pit Turf: Olive Pit Rubber Infill Replacment for Artificial Turf Crumb Rubber

Katherine McDermott, Meera Kalakkunnath

Conroe ISD /TWHS: The Woodlands High School

Category:

Environmental Engineering

Athletes and children are exposed to the crumb rubber infill in artificial turf daily, which poses extreme chemical risks. Studies have shown that if a child were to digest or was regularly contaminated by phthalate particles in infill, it could cause hormone development problems as well as chemical infections considered risky on the EPA levels. Additionally, the infill contains levels of lead, and no level of lead exposure is safe for children. Moreover, various studies on the tire crumb infill stressed the presence of carcinogens in the tire crumb, which has risks for both children and adults. This research is important because as more people begin to add artificial turf in their lawns and schools, more kids' and athletes' bodies are becoming less developed. We strive to create something that can continue to keep artificial turf's low-maintenance features while allowing for a safe environment.

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Abstract: Science and Engineering Fair of Houston

3339

A Blow of Water: A Wind-Solar Hybrid System for Runoff Water Restoration

Kaelynn Suris, Isaac Morales

Fort Bend ISD /Willowridge High School

Category:

Environmental Engineering

The goal of this project was to design a solar panel and wind turbine dual hybrid powered water pump to help irrigate dry areas without relying on electricity from the grid. The background research showed that renewable energy systems like wind and solar are commonly used in remote or drought prone regions because they are sustainable and cost efficient. We also learned about water scarcity issues from sources like the U.S. Drought Monitor and methods such as rainwater harvesting and underground pumping. To build the hybrid system, I created a small vertical axis savonius wind turbine and paired it with a solar panel to test how both could power a DC water pump. Using a fan for wind and a lamp for sunlight, I measured how much water the pump moved under different conditions. Some trials showed the wind turbine producing enough energy on its own, while others relied more on the solar panel. When both wind and sunlight were available, the pump worked faster and more consistently. These results showed that using two renewable sources increases reliability, since one can compensate when the other is weaker, making hybrid systems more efficient than using wind or solar alone. After building and testing my prototype, my results showed that solar and wind energy can successfully power a small water pump under certain wind speeds and photovoltaic energy. This supports our engineering goal of creating an ecofriendly irrigation solution. The data we collected matched what we found in my research. Hybrid systems work best in areas with consistent wind and sun can reduce dependence on traditional water pumping methods. My conclusion connects directly to my research because it proves that renewable energy can be applied to solve real-world water challenges.

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Abstract: Science and Engineering Fair of Houston

3340

Shaping Heat: How Wall Geometry Influences Thermal Efficiency

Jay Holliday

Conroe ISD /ASHP: Academy for Science and Health Prof

Category:

Environmental Engineering

The global demand for energy efficient housing is increasing as energy consumption continues to outpace energy production, placing greater strain on cooling systems in buildings. Traditional flat exterior walls contribute significantly to internal heat gain, yet alternatives that reduce heat absorption without added insulation remain underexplored. This study investigated whether exterior wall geometry alone could reduce internal temperature rise in small scale structures. Five model buildings with different wall designs were exposed to direct sunlight under controlled conditions, and internal temperature changes were measured over time and corrected for ambient temperature. One geometric design consistently demonstrated better thermal performance, showing the lowest average corrected temperature increase (5.00 °F), the smallest variability (1.52 °F), the slowest heating rate, and the fastest stabilization at a thermal plateau. Moreover, when compared to the poorest performing design, this structure reduced heat gain by 25% and outperformed a flat-wall control by 2.3%. Other designs increased heat gain, indicating that wall geometry can either enhance or degrade thermal performance depending on configuration. Furthermore, these results demonstrate that carefully designed exterior wall geometries can directly reduce internal heat gain, which suggests a practical strategy for lowering cooling demand and improving energy efficiency in residential and industrial buildings.

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Abstract: Science and Engineering Fair of Houston

3341

An Effective Solution to Adhesives

Taha Elldakli

Alief ISD/Alief Early College

Category:

Environmental Engineering

Potholes pose a serious threat to our infrastructure, often causing damage to vehicles, accidents and costly repair bills. The purpose of this project was to study a simple, low-cost short-term pothole method for making our roads safer. The objective of the project was to investigate whether common commercial adhesives could be used as a temporary pothole patch. This study tests the hypothesis that patch potholes using strong commercial adhesives will hold better to compressive forces than a road that had already been constructed (the control). The adhesives used for testing in this study were Eclectic E6000, Gorilla Glue, and Titebond Original Wood Glue. Each adhesive will be diluted to the consistency of a patch used for potholes. The time was recorded for each adhesive to achieve relative hardness. Then each patch, as well as the control road surface, were subject to non-standardized compressive forces for evaluation purposes. The usability of each patch can be watched qualitatively by observing whether the patch held under the imposed compressive forces. According to the gathered data, Eclectic E6000 displayed the quickest hardening time (rank 1), while Gorilla Glue was ranked second. The control road surface sustained the maximum (highest ranking) compression test without failure, while Gorilla Glue failed second (rank 2) completing the least tests was Eclectic E6000 (rank 3). All adhesives failed the compression tests. Therefore the hypothesis was not supported since the compression test did not yield any adhesive to outperform the control. The trade-off was clearly between time to harden vs strength. The stronger adhesive (Gorilla Glue) would prove to be a better choice when compared to the quicker curing (E6000) suggesting that the strength of the patch area will be more important for a temporary pothole patch.

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Abstract: Science and Engineering Fair of Houston

3342

Solar-Powered Water Purifier

Zoe Valdez, Juliana Guillen, Jocelyn Elias

Aldine ISD/Nimitz Ninth Grade School

Category:

Environmental Engineering

Our experiment is to test if we can make a Solar-Powered Water Purifier at a low cost that is also efficient, for areas that have limited access to clean and drinkable water. The purifier would prevent diseases by evaporating the water and separating the bacteria and metals by leaving them behind. The solar-powered water purifier would also help improve hydration, food security, and reduce dehydration rates. Our hypothesis was to test whether we can make impure water pure and clean water. Alongside the question "How much water can it purify per hour?" as well as "How does the system use solar energy to filter and purify the water?" To test whether our experiment is usable for people in need of pure clean water. For our experiment, we used a glass bowl, a glass cup, a rock, clear wrap, and contaminated water. We placed our experiment outside in direct sunlight for roughly 6 hours. Every hour or so, we would check on the experiment and switch the pure water to a different container. We redid the process until we hit the 3-gallon mark. We concluded that our solar-powered water purifier was able to purify 3 gallons of water in 6 hours.

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Abstract: Science and Engineering Fair of Houston

3343

Breathing Easier: An Olivine Air Filtration System For Atmospheric CO2 Removal

Briley Grimm

Clear Creek ISD /Clear Falls High School

Category:

Environmental Engineering

Scientific research studies show that atmospheric carbon dioxide (CO2) is rising faster than current solutions can safely remove it. Many existing carbon capture solutions depend on storing CO2 underground in tanks or geologic formations. This raises long-term safety and capacity concerns. An alternative is to copy Earth's own chemical process known as enhanced weathering. Olivine, an abundant silicate mineral, reacts with CO2 and water through natural weathering forming stable carbonate silt. This project investigates if olivine dust/sand suspended in a 5:1 distilled water to olivine slurry can be an air-filtration system that reduces CO2 in a closed system. Air enriched to be 5000 ppm of CO2 was passed through slurries containing 0 g, 57g, 114g, 170g, or 227 g of olivine. CO2 concentrations were measured repeatedly in 5-minute increments. The average CO2 value decreased from 4636.1 ppm in the control trials to 2956.6 ppm at 227 g of olivine showing clear removal of CO2 from the closed air space. Standard deviations increased with the olivine mass, which demonstrates that while the effect strengthened on average, trial measurements became more variable, likely due to agitation or mixing differences in the thicker slurry. These results support the hypothesis that increasing olivine concentration in a slurry enhances CO2 removal and shows a proof-of-concept for using olivine mineral slurries inside filtration systems in homes, businesses, and industries. In the future olivine-based air filters could replace underground CO2 storage schemes by locking carbon into safe mineral forms offering a safer approach to long-term carbon management.

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