Abstract: Science and Engineering Fair of Houston

3001

Sugar Rocket Ratios

Category:

Aerospace Engineering

David Dias, Alexandra Smith, Gilmar Mavares

Harmony Public Schools - South District/Harmony Science Academy - Beaumont

This study evaluates the thrust performance of sugar–potassium nitrate (KNO_3) solid rocket propellants by systematically varying the oxidizer-to-fuel ratio and measuring peak force with a custom cart-and-pulley spring scale. The primary goal was to optimize an efficient, low-cost sugar rocket through fuel ratio analysis and practical design choices. Five propellant mixtures (KNO_3-to-sugar: 40–60, 50–50, 60–40, 70–30, 80–20) were prepared by powdering KNO_3, dissolving and heating with sugar and water, and casting into PVC rocket shells using a 3D-printed mold to increase burning surface area. Rockets were secured to a wheeled cart equipped with a rear pulley, low-expansion rope, and a spring scale (20 N capacity) configured to half the load and allow thrust estimation by doubling the recorded tension. Each mixture was tested in duplicates, ignited by torch, and peak thrust was recorded in newtons. Data analysis focused on peak thrust as the primary performance metric, with burn time held approximately constant by equal propellant volume. Averages were computed for each fuel ratio and plotted as a bar graph to compare thrust across mixtures. Results showed a clear dependence of thrust on oxidizer proportion, with the 60–40 ratio producing the highest average force among the five tested; repeat trials improved confidence in that ranking. These findings support the role of oxidizer content in enhancing combustion completeness and thrust, while highlighting practical considerations in casting, mounting, and thermal protection for consistent measurements. Conclusions indicate that optimizing KNO_3 proportion is key to maximizing peak thrust in sugar rockets within low-cost constraints. Applications include educational demonstrations of propulsion, hands-on testbeds for solid rocket motor design and combustion chemistry, baseline data for further work on burn rate modifiers, alternative sugars, nozzle geometry, and expanded instrumentation (e.g., load cells and time-resolve

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Abstract: Science and Engineering Fair of Houston

3002

Category: Aerospace Engineering

Physics based analysis of passive spacesuit surface properties for reducing lunar regolith adhesion.

Rajveer Thukral

Houston ISD/Westside HS

Lunar dust poses a major challenge to astronaut safety and the durability of space suits during long-duration missions. The particles are irregular, jagged, and range in size from 1 to 100 micrometers, which makes them prone to adhering to the surface. Current active dust removal systems can reduce accumulation but require extra power, increasing complexity and risk for astronauts. This project investigates how passive surface traits of space suits affect lunar dust adhesion in vacuum-like conditions using deep analysis. There were three main traits that I analysed: mechanical compliance, surface energy, and surface texture. Using data from NASA research papers, technical reports, and published studies, I evaluated how these traits influence dust adhesion forces, such as the more prominent van der Waals interactions and mechanical interlocking. Comparative diagrams and tables were used to illustrate the relationships between surface properties and dust accumulation. The results suggest that optimizing surface energy and surface texture can significantly reduce dust adhesion without consuming additional energy. This passive approach could lead to space suit designs that are more durable, safer, and easier to maintain during lunar exploration. By focusing on material properties that naturally minimize dust accumulation, this study provides insights into creating systems to optimise surface traits to lower the rate of lunar dust adhesion without the use of an energy-dependent option.

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Abstract: Science and Engineering Fair of Houston

3003

Space Invaders

Category: Aerospace Engineering

Akif Budak, Abdullah Al-Anbagi

Harmony Public Schools - North District/Harmony School of Advancement

Carbon dioxide (CO_2) buildup in closed space habitats such as the International Space Station (ISS), Lunar Gateway, and future Artemis missions poses a serious risk to astronaut health, cognitive performance, and mission success. Prolonged exposure to elevated CO_2 levels can cause headaches, fatigue, impaired decision-making, and, in extreme cases, loss of consciousness or death. Current CO_2 removal systems can be complex, power-intensive, and difficult to maintain, highlighting the need for a more reliable and user-friendly solution. This project proposes a dual-component carbon capture and recycling system consisting of a wearable cartridge integrated into the astronaut's Portable Life Support System (PLSS) and a stationary processing pod located within the space habitat. The cartridge captures exhaled CO_2 using sorbent materials during astronaut activity and is later inserted into the pod, where the CO_2 is extracted and thermally converted into oxygen and carbon monoxide. The recovered oxygen is stored and reused to support crew respiration, while carbon monoxide is safely vented. Designed with strict constraints on mass, volume, power consumption, safety, and maintainability, this system reduces crew workload, provides redundancy to existing life-support systems, and improves long-term sustainability of human spaceflight. By enhancing carbon management efficiency and oxygen recovery, this design supports astronaut health, mission resilience, and future deep-space exploration.

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Abstract: Science and Engineering Fair of Houston

3004

The A360 or 797X?

Category:

Aerospace Engineering

Charles Robertson

Conroe ISD /AST: Academy of Science and Technology

Abstract The commercial aviation industry faces a gap between very large, four engine aircraft such as the Airbus A380 and smaller, more efficient twin engine widebodies such as the Boeing 777X. This project investigates whether a new ultra high capacity twin engine aircraft can bridge this gap while maintaining long range capability and acceptable aerodynamic efficiency. The research question asks whether a non blended wing body design seating approximately 475 passengers can achieve a range of 7,500 nautical miles while remaining aerodynamically viable. The aircraft, designated the 797X, was first designed using scaled technical drawings and then modeled digitally using computer aided design software. Computational fluid dynamics simulations were conducted to evaluate lift, drag, and overall aerodynamic performance. Key design parameters such as wing aspect ratio, sweep angle, dihedral, and engine placement were selected using preliminary transport aircraft design methods and compared to existing high capacity aircraft concepts. Results indicate that the 797X achieves lift and drag coefficients within expected control ranges for aircraft of its size. Induced drag and zero lift drag values were found to be comparable to similar conceptual designs, with moderate tradeoffs in transonic performance due to reduced wing sweep. Analysis shows that these tradeoffs may be offset by structural efficiency and manufacturing simplicity. In conclusion, the results suggest that the 797X represents a feasible baseline design capable of filling the market gap between current ultra large and high efficiency widebody aircraft, warranting further high fidelity aerodynamic and mission level analysis.

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Abstract: Science and Engineering Fair of Houston

Category:

Aerospace Engineering

3005

Egg-Drop

Micheal Adeolu, Shoaib Arafi, Miguel Maldonado

Harmony Public Schools - South District/Harmony Science Academy-Houston

Dropping fragile items is one of the most common ways they get damaged, especially during shipping or handling. This project looks at how to protect something as delicate as an egg when dropped from a height. The idea is to design a system that keeps the egg safe, just like packaging does for breakable goods in real life. The goal is simple: build and test a device that can cushion an egg during a 2-meter drop. To do this, we'll explore how different materials and designs absorb impact, figure out which design works best, and think about how these ideas could be used in packaging industries. The main questions are: which design protects the egg most effectively, and how do different cushioning materials change the results? The guess, or hypothesis, is that using shock-absorbing materials like foam and straws will keep the egg from breaking. To test this, we'll change two things: the materials used (foam, bubble wrap, straws, cotton) and the design style (box, parachute, suspension). What we'll measure is whether the egg stays intact, cracks, or breaks. Everything else will stay the same: the drop height (2 meters), the type of egg, the surface (concrete), and the indoor environment. The materials include four large eggs, foam padding, bubble wrap, straws, cotton balls, cardboard boxes, tape, scissors, a measuring tape, stopwatch, and a camera. Four designs will be built: one with foam inside a box, one with bubble wrap and straws, one with cotton and a parachute, and one with mixed layers. Each design will be dropped from 2 meters, tested three times, and the results recorded with photos and videos.

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Abstract: Science and Engineering Fair of Houston

3006

Lunar Regolith Electrodynamics

Category:

Aerospace Engineering

Samantha Cassady, Ivy Walker

Clear Creek ISD /Clear Lake High School

In Lunar exploration, dust is extremely hazardous: it can damage landers, spacesuits and human lungs if inhaled. Dust particles have microscopic barbs that give them their abrasive qualities making mechanical abrasion (trying to rub off the dust) equivalent to rubbing sandpaper on a surface. Studies have shown that dust particles respond to electrostatic bias. The experiment aims to utilize said bias to remove dust from space suit-like material. Initial concepts included using a capacitor to put a bias across the fabric and using static energy from a balloon or PVC pipe rubbed with wool to create a bias near the fabric. Initial capacitor trials proved unsuccessful, with no movement of the dust at all. PVC/Balloon trials proved to be more effective. The experiment involved applying dust to suit-like material, taking before photos, applying the control technique or the electric bias, and taking after photos. Using photoshop to analyze the color curve of each photo, we could determine quantitative differences in the amount of dust on the fabric before and after the trial. The bigger the difference the more effective the removal process was. The results showed control (rubbing the dust off with hands) the most successful, followed by the balloon, likely due to increased charged surface area. The hypothesis correctly assumed electrostatic bias was effective but was inaccurate in assuming the capacitor would be the most effective. Future experiments should find more scientific ways to apply static, as rubbing a balloon both difficult and time-consuming.

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Abstract: Science and Engineering Fair of Houston

3007

Flight by Design: Optimizing Foam Aircraft for Performance

Category: Aerospace Engineering

James Gonzalez

Clear Creek ISD /Clear Lake High School

This project investigated how differences in glider design impact flight stability, time aloft, and distance traveled. Two foam gliders were designed using Aery, which provided predicted stability values called Aery numbers: 155 for the first design and 135 for the second. After difficulties integrating an IMU for acceleration and rotation measurements, data collection shifted to video based timing and measured flight distance. Both gliders were launched at a consistent speed of 18.52 km/hr, and each design was tested 30 times. The higher Aery number glider (155) averaged 2.04 seconds of flight time and 30.7 feet of distance, while the lower Aery number glider (135) averaged 3.11 seconds and 55.9 feet. This demonstrated that differences in performance were not caused by velocity or launch variations, but by stability and aerodynamic efficiency. The results show that design factors such as wing area, geometry, and tail placement meaningfully affect glide performance and that more stable configurations sustain longer, more efficient flights. These findings may guide future refinements and support iterative design improvements.

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Abstract: Science and Engineering Fair of Houston

3008

Busses and Bernoulli

Category: Aerospace Engineering

Riley Santeler, Rohan Patel, Arch NIlkamhang

Conroe ISD /ASHP: Academy for Science and Health Prof

This project investigated the aerodynamic drag on school buses and how modifying the bus will reduce aerodynamic drag. Reducing the drag on buses is important because it will make the buses more fuel efficient. It is hypothesized that making the bus more aerodynamic will reduce the drag and will make the bus more fuel efficient. Two bus models were designed using Tinkercad and they were compared to a real bus. These buses were put into a wind tunnel that was made out of wood, a fan, and a smoke machine. An anemometer will then be used to test the aerodynamic drag of the three different buses. After testing the aerodynamics of the busses the results show that the second design created was the most improved with a drag coefficient of .08 the regular bus design being the least aerodynamic with a drag coefficient of 0.8. To conclude the project we discovered that a pointer design was the most streamlined. We also went with a blockier design that still took initiative in becoming more aerodynamic, which it did but nowhere near as much as the second design. Assuming the only variable that changed was the shape of the bus using the drag coefficient the fuel efficiency will increase by upwards of 10%. Which means we have accomplished our goal of increasing the fuel efficiency and reducing the drag of a school bus.

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Abstract: Science and Engineering Fair of Houston

Category: Aerospace Engineering

3009

Moondust Magnet: A Novel Bipolar Electrostatic System for Capturing Airborne Fine and Sub-micron Lunar Regolith in Habitat Airlocks

Jiaen Jiang

Home school/Jiang Family Home School - MS

Lunar regolith, consisting of abrasive and adhesive fragmented lunar rocks and dust, poses a significant challenge to current and prospective lunar operations due to its detrimental effects on astronauts' health. Airborne regolith can be influenced and manipulated through electrostatic fields, specifically through enhanced attraction or repulsion to specific objects. Systems such as Electrodynamic Shields (EDS) for protecting equipment from regolith have been developed; however, no system exists specifically designed to collect airborne sub-micron regolith dust particles that may be introduced into the habitat through airlocks. Addressing this gap, this research develops the first bipolar electrostatic capture device designed to extract these airborne particles before they infiltrate the habitat. The novel device consists of a high-voltage bipolar embedded electrode array developed and evaluated in a controlled environment with LSP-2 regolith simulant dust clouds to assess the efficiency of this device in capturing sub-micron airborne regolith. To assess device efficiency, I measured the mass of regolith simulants captured by the device and the concentrations of three forms of particulate matter (PM1.0, PM2.5, PM10) remaining in the air, with primary focus on PM2.5. The results from testing show the device removes 77.07% of airborne regolith on average, outperforming standard active pre-filters by more than 50%, and further reducing the PM2.5 concentration by 60 μg/m^3 within 100 seconds, achieving a clearance rate approximately 4x faster than state-of-the-art mechanical pre-filters. This device functions as a high-capacity pre-filter for HEPA systems, significantly reducing the influx of lunar regolith in habitats, reducing risk for regolith-induced health complications and extending the operational lifespan of HEPA filtration systems.

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Abstract: Science and Engineering Fair of Houston

3010

Category:

Aerospace Engineering

Analysis of synergetic usage of biomimetic features in reducing propeller noise with minimal efficiency loss

Aarush Bhavanam

Cypress Fairbanks ISD/Bridgeland - HS

The objective of this research is to evaluate the synergistic effects of leading-edge tubercles and trailing-edge serrations on the acoustic and aerodynamic performance of small-scale drone propellers. Standard propellers generate significant high-frequency tonal noise that limits their application in urban environments and reduces overall efficiency. This project utilizes a bionic approach by combining features from the humpback whale flipper and the barn owl wing to reduce noise while keeping thrust output the same. Four propeller designs were modeled using a NACA 4412 aerofoil: a control model, a trailing-edge serrated model, a leading-edge tubercle model, and a synergistic model combining both features. The study employed SimScale CFD with a Transient k-omega SST turbulence model to predict thrust, torque, and lift-to-drag coefficients at 10,000 RPM. Physical prototypes were 3D-printed in high-strength PLA and tested on a custom-built stand equipped with a 5kg load cell. Acoustic data was captured using a Dayton Audio iMM-6C microphone and analyzed through Room EQ Wizard (REW). Physical testing revealed a 15–20% thrust gain for the tubercle model and a ~5% increase for the synergistic design at 12,000 RPM. However, these gains were accompanied by an increase in current draw, suggesting that the bionic geometries increase the torque coefficient. Future research will focus on optimizing the Power Loading (thrust/watt) to ensure that the acoustic benefits do not come at the expense of battery longevity.

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Abstract: Science and Engineering Fair of Houston

3011

Aircraft Efficiency: Magnus Effect Edition

Category:

Aerospace Engineering

Joshua Erdem

Clear Creek ISD /Clear Creek High School

The aviation industry invests hundreds of millions of dollars in new aircraft designs that typically yield only marginal efficiency improvements of approximately 3% over previous models. This study investigated whether RC aircraft utilizing the Magnus Effect—wherein rotating cylinders generate lift through aerodynamic pressure differentials—could offer a cost-effective alternative to conventional fixed-wing designs. An RC aircraft was constructed using rotating cylinders instead of traditional wings, and systematic flight tests were conducted to compare performance metrics, including lift generation, power consumption, flight stability, and overall efficiency. Data was collected using onboard sensors and precision measurement instruments across multiple test flights with various cylinder configurations. Results demonstrated that Magnus Effect wings were significantly inferior to traditional fixed-wing designs in nearly all performance categories, including lift efficiency, power requirements, and flight stability. While the Magnus Effect aircraft achieved sustained flight, it required substantially greater energy input and exhibited reduced controllability compared to conventional designs. This study concludes that, at the RC aircraft scale, Magnus Effect technology does not provide efficiency advantages over traditional wing designs. The findings suggest that while the Magnus Effect represents an innovative approach to lift generation, practical limitations, including increased mechanical complexity, power demands, and reduced aerodynamic efficiency, make it unsuitable as a replacement for conventional wings in current aviation applications. Future research could explore hybrid designs or specific use cases where Magnus Effect principles might offer targeted advantages.

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Abstract: Science and Engineering Fair of Houston

3012

Category:

Aerospace Engineering

GreenOrbit: Tracking the Carbon Cost of Human Space Travel, Powered by Green AI

Jedidiah Obomanu

Spring Branch ISD/Stratford - HS

With the progression of space travel and the upcoming introduction of commercial human space tourism, ensuring that the wellness of our environment is not neglected is paramount. How can we combat the environmental threat of growing human space travel? By designing a satellite equipped with eco-friendly hardware and Green AI software, GreenOrbit is a Cube-sat able to detect harmful chemicals released from spacecraft and track its carbon cost on the environment. This project involves designing and building a biodegradable CubeSat prototype equipped with environmental sensors and a green AI processing system to measure and analyze emissions related to space travel. GreenOrbit introduces an energy-efficient and eco-friendly way to combat the negative environmental effects of space travel.

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APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3013

Category: Aerospace Engineering

AeroHive: A Novel Honeycomb Electrohydrodynamic Thruster Array with Vectorized Propulsion

Cayson Wang

Conroe ISD /AST: Academy of Science and Technology

Electrohydrodynamic (EHD) propulsion, also known as ionic wind, is capable of producing thrust with no moving components. Using emitter and collector electrodes, EHD thrusters ionize and accelerate air molecules through a corona discharge. EHD propulsion provides many benefits, including low noise output, minimal maintenance, and zero carbon emissions. Currently, EHD's largest challenge is the low thrust produced, hindering its widespread use. This project aimed to address this challenge of low thrust by designing, building, and testing a novel EHD thruster: AeroHive. By using a honeycomb shaped collector with needle emitters, AeroHive's design minimized wasted space while demonstrating structural integrity. AeroHive's components were designed and 3D printed, and a conventional thruster was created using the same process to serve as a comparison. After electroplating collectors, the thrusters were then tested, and the input current, thrust, wind speed, operational voltage, and operational current were recorded. AeroHive produced roughly twice the thrust density as the conventional thruster despite having half the electrode volume. By modifying AeroHive's electrode connections, thrust vectorization was achieved. Additionally, numerical simulations via Finite Element Method confirmed the results of the honeycomb and conventional thrusters and optimized airflow and thrust. Overall, AeroHive offers enhanced performance, optimized geometry, and novel features with potential applications for silent, electrically driven propulsion systems and electric component cooling.

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Abstract: Science and Engineering Fair of Houston

3014

Testing Possible Aerospace Architecture Structure Products

Category:

Aerospace Engineering

Rafaela Rossetto de Souza Castilhos

Conroe ISD /AST: Academy of Science and Technology

This project consisted on the starting of studying the principle of in-situ resource utilization. Because humans intend to colonize Mars, it is essential to consider the materials that will be used to construct the habitats. Building a Martian colonization using Earth materials would be economically catastrophic, so it is necessary to find materials that shall inhabit the possible protection for future habitats. This study made a prototype for an insulative paint used as shielding against UV radiation and heat temperatures for future Martian habitats. Volcanic Basalt rocks were used to simulate Martian volcanic rocks. Rocks were grinded to micro particles by professional grinders into two groups of 23 microns and the other of 131 microns; groups were mixed with a silicate solution for binding and paste creation. An experiment was conducted to test the two pastes against UV radiation and heat temperatures using a vacuum chamber. Results concluded that a microparticle paste of 131 microns contributed significantly better in temperature tests while both pastes transmitted the same results in the ultraviolet radiation trials. In conclusion, this experiment supported the principle of in-situ resource utilization, and proved that volcanic basalt rocks, when mixed with a silicate solution, can provide surface shielding against UV radiation and temperatures.

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Abstract: Science and Engineering Fair of Houston

3015

Drone-Mounted Piezoelectric Transducers for Damage Detection in Shingle-Based Roofing Structures

Adam Al Ghazawi, Xianze Meng

Conroe ISD /AST: Academy of Science and Technology

Category:

Aerospace Engineering

Shingle-based roofs often develop damage hidden to the human eye, like tiny cracks, delamination, or punctures, which cannot be detected through traditional drone imaging techniques alone. Most current drone inspections rely on visual analysis that only identifies surface-level issues, leaving the deeper structural problems unnoticed until they become severe. This project aims to improve such traditional techniques by designing a drone with a mounted tapping and scanning system using piezoelectric sensors to collect vibration data as it moves along the roof. For experimentation, a downscaled roof model was built using plywood and asphalt shingles, with four types of damage introduced: impact dents, punctures, delamination, and scratches. An undamaged roof model was used as a baseline. The drone performed repeated tapping and scanning runs while an Arduino Microcontroller recorded the voltage patterns, which were plotted to compare the vibration signals from the undamaged against the damaged shingles. A digital map was then created using a mapping library in Python to mark the location and severity of the detected damage. Results showed clear differences in the vibration responses. Control shingles had the highest average (~1280). Scratches were a bit lower (~1070), dented shingles even lower (~910), and delaminated shingles the lowest (~490), showing significant structural weakening. The punctured shingles displayed values similar to the control, making them harder to detect. These results demonstrate that drone-mounted piezoelectric tap testing can detect roof damage, providing a safer and more informative method other than visual inspections.

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Abstract: Science and Engineering Fair of Houston

3016

Ionic propelled cargo aircraft

Category:

Aerospace Engineering

Antonio Ortiz

Clear Creek ISD /Clear Brook High School

In this project I will be engineering and testing the extent to which an aircraft can be created using Ionic-Propulsion with the intentions of cargo/transport implications. This is important because the use of this technology isn't fully fleshed out and especially in Earth's atmosphere. The first and only aircraft made was by MIT and it was only meant/ able to move its own weight; my engineering goals however are to make something for that purpose. With the innate low force of Ionic propulsion as the most significant con, it has an extraordinary efficiency and can its implication into aerospace has great potential. My methods brainstorming and planning different concepts, then prototyping components of the aircraft with a vision to put them together, then test the full creation and review its aspects. My conclusion for my first full prototype is that the propulsion is very satisfactory, with it the only issue being human error and a misalignment in one of the thrusters. Additionally, the weight and durability is also satisfactory since it uses very light materials, with the heaviest of the materials weighing under 80 grams. However, the prototype has some defects such as small lack of aerodynamics, and more prominently a lack of lift from helium. I think this is because the internal components often disrupt airflow, and because of my limited tools preventing me from both gauging how much helium I put in a balloon, and the amount of helium I have. Further concepts and prototypes can be expected in the future with the same goal in mind.

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Abstract: Science and Engineering Fair of Houston

3017

Aerodynamics of the B2 stealth bomber

Category:

Aerospace Engineering

Adan Velazquez, Amaya Ayala

Charter/SST - Champions College Prep - HS

The four forces of flight lift, weight, thrust, and drag are essential in understanding how aircraft fly. Lift is the upward force that counters weight (gravity), thrust is the forward force produced by engines to overcome drag (resistance), and drag slows the aircraft down. Aerodynamics is the study of how air interacts with moving objects, and it plays a crucial role in aircraft design. The B-2 Spirit bomber, known for its advanced stealth capabilities, uses a flying-wing design to minimize drag and reduce its radar signature. Its smooth, triangular shape helps it achieve both aerodynamic efficiency and stealth, allowing it to fly undetected while carrying out long-range bombing missions.

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Abstract: Science and Engineering Fair of Houston

3018

From Single-Use to Repeatable: A Reusable Hybrid Rocket Engine for Accessible, High-Fidelity Propulsion Experimentation

Category:

Aerospace Engineering

Asa Gangjee, Suman Muppavarapu

Private/ST. JOHN'S SCHOOL

Repeatable experimentation is essential to propulsion science, yet most hybrid rocket engines are inherently single-use, limiting systematic study and placing rigorous experimentation beyond the reach of low-resource research environments. Although hybrid propulsion systems offer intrinsic safety, storability, and throttleability advantages, their reliance on sacrificial combustion chambers and nozzles makes controlled iteration costly, wasteful, and impractical for statistically meaningful testing. As a result, hybrid propulsion research has remained fragmented and difficult to reproduce outside well-funded laboratories. This project presents the design and experimental validation of a reusable, modular hybrid rocket engine specifically optimized as a research platform rather than a single-use performance device. The engine employs paraffin wax as the solid fuel and nitrous oxide as both oxidizer and working fluid for internal thermal management, enabling repeated firings without permanent structural degradation. By preserving critical hardware across test cycles, the system shifts hybrid propulsion experimentation from a consumable model to a repeatable, high-fidelity experimental framework. The engine architecture prioritizes experimental control and accessibility. Key components, including the injector, fuel grain, and nozzle, are mechanically modular and can be exchanged independently in minutes, minimizing uncontrolled geometric variation between tests. This modularity enables rapid iteration, back-to-back firing sequences, and controlled parametric studies within a single test campaign. The reusable design reduces the per kNs cost to that of LOX/Methane liquids, lowering the financial and environmental barriers to sustained propulsion research. The resulting platform expands access to high-quality hybrid rocket research and supports more rigorous, reproducible investigation of hybrid combustion phenomena across educational and commercial ventures.

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APPROVED 2026 sefh SCIENTIFIC REVIEW COMMITTEE

Abstract: Science and Engineering Fair of Houston

3019

Category:

Aerospace Engineering

Effect of Micro-Slats on Airfoil Lift and Stall Behavior

Krish Bahl

Fort Bend ISD /Elkins High School

Unmanned Aerial Vehicles (UAVs) operating in low-Reynolds number regimes often suffer from premature laminar flow separation, resulting in sudden aerodynamic stall and reduced payload efficiency. This study investigated passive leading-edge micro-slats as a weight-efficient solution to address these hazards without the complexity of active mechanical systems. The research centered on the premise that a curved slat geometry, optimized to utilize the Coanda Effect, would re-energize the boundary layer by injecting high-momentum fluid into the slot gap. A "Digital Twin" methodology integrated stochastic computational modeling with physical validation. Phase I utilized a custom Python optimization algorithm executing 2,000 iterations to isolate a "Global Maxima" configuration at a 22-degree deflection angle and 2.5% chord gap. Phase II involved constructing a suction-type wind tunnel with honeycomb flow straighteners to isolate laminar flow for physical testing. Lift forces were quantified using a digital balance on a custom-fabricated NACA 2412 airfoil. Results confirmed the curved slat yielded a 14.8% increase in peak lift force compared to the baseline. Furthermore, the slat extended the critical stall angle from 12 to 16 degrees and introduced a "Soft Stall" characteristic, which serves as a gentle lift-curve plateau eliminating the violent collapse observed in standard profiles. These findings demonstrate that passive curved micro-slats provide a robust, cost-effective solution for enhancing the aerodynamic reliability of autonomous flight systems.

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Abstract: Science and Engineering Fair of Houston

3020

Category: Aerospace Engineering

Experimental Analysis of Scale Effects on Structural and Aerodynamic Performance

Gregorio Souza Gomes

Conroe ISD /AST: Academy of Science and Technology

When designing new prototypes, scale models are often the best option for testing as they are cost effective, time efficient, lightweight, and easily modifiable. Scale models allow for testing and modifications to be done to the prototype design without the need for an actual prototype. In the aerospace industry, this is especially important. When developing new technologies such as rockets, fighter jets, or regular airplanes, it would take too much time and money to rebuild each prototype in full size for every modification. Instead scale models are used where a prototype is made in a much smaller size. However, this presents a slight issue, which, if unaccounted for, may become a major issue, especially in aerospace; Scale models do not accurately display the aerodynamic properties of their full sized counterparts. For example, if an airplane is being modeled in half the size, its lift and drag coefficients will not be exactly half of what the coefficients of the prototype would be. This project aims to explore these scale effects and find what exactly the model would display compared to the prototype. Given this, a 'scale effect coefficient' would be calculated and applied to several other scenarios, removing the risk and addressing this issue.

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Abstract: Science and Engineering Fair of Houston

3021

A Green Breath in Space

Category:

Aerospace Engineering

Gissel Cardenas

Harmony Public Schools - North District/Harmony School of Advancement

The duration of space exploration missions is often limited by insufficient oxygen levels inside spacecraft for crew members aboard. This project explored the potential use of a plug-and-play algae sponge system designed to address this limitation for spacecraft such as the International Space Station, Artemis missions, and the Lunar Gateway. The research examined how a plug-and-play algae sponge system could perform under mission constraints including mass, volume, and energy to increase oxygen levels while producing biomass suitable for biofuel to support spacecraft. Data collected throughout the project was based on existing research from experiments and trials conducted by science and engineering professionals. Using previous and current spacecraft construction data, constraints regarding engineering systems such as size, energy requirements, maintenance needs, and scalability in spacecraft environments were taken into account. The results communicate that algae-based systems can effectively remove carbon dioxide and generate oxygen while producing biomass that could be converted into biofuel. Although challenges regarding efficiency, system integration, and long-term stability remain, the findings suggest that modular algae systems represent an attainable life-support technology designed to operate next to existing environmental control systems. The project concludes that a modular algae sponge system could increase air quality in space habitats if made simple for crew to rely on and use. Using LED lights to complete photosynthesis and the humidity that the astronauts produce, the algae becomes self-sustainable. Overall, this research emphasizes the potential of self-regulating systems in future missions and evaluates central areas for further engineering development..

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Abstract: Science and Engineering Fair of Houston

3022

Category: Aerospace Engineering

Computational Optimization of Airfoil Geometries via Genetic Algorithms and XFOIL for Multidimensional Aerodynamic Performance Enhancement

Stein Mei

Conroe ISD /AST: Academy of Science and Technology

Airfoils play a major role in the aerospace industry from maximizing efficiency to conserving resources. The importance of these components are the key to many fields. Airfoil optimization is usually the most common way to create better airfoil. Unfortunately modern methods used to create the optimized airfoils prove to be extremely costly and time consuming. Engineers use high fidelity CFD evaluation, while these results are extremely accurate and detailed the resources and energy used for this optimization are massive. I used a closed python genetic algorithm that encases XFOIL. XFOIL is a program used to evaluate airfoils and give out coefficients after simulation. Although not quite as effective as CFD evaluation, its efficiency and limited resource use make up for the marginal errors. The genetic algorithm combines airfoils together to create an offspring. In a sense it's similar to a punnet square of two parents. By combining coordinates of parent airfoils, offspring are projected to carry some of the traits of the parents in order to improve efficiency.

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