Abstract: Science and Engineering Fair of Houston

3284

Magnetic Transmission

Nahaar Mirza, Aidan Ahmed, Musa Abbas

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

Traditional mechanical transmissions rely on direct contact between gears, leading to friction, wear, lubrication requirements, and frequent maintenance. This project explores the feasibility of a fixed-ratio magnetic gear transmission as a low-maintenance alternative to conventional gear systems. The prototype transfers torque using magnetic fields rather than physical contact, reducing mechanical wear. The system implements a 3:1 gear ratio, using four large permanent magnets on the input rotor, eight steel screws as a stationary flux modulation ring, and twelve smaller permanent magnets on the output rotor. The prototype is currently hand-driven, allowing controlled observation of magnetic coupling behavior without electrical or thermal interference. Performance is evaluated by measuring input and output rotational speeds, observing slip under increasing manual load, and assessing alignment sensitivity and smoothness of operation. Testing also examines how air gap distance influences torque transfer and rotational stability. This early-stage investigation demonstrates that a magnetic transmission can achieve consistent speed reduction and smooth torque transfer without mechanical contact. The results provide foundational insight into magnetic gear behavior and identify key limitations, such as torque capacity and alignment sensitivity, that must be addressed before scaling the system to motor-driven or automotive applications.

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☐ Vertebrate animals   ☐ microorganisms   ☐ rDNA   ☐ tissue

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[X] yes   ☐ no

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[X] yes   ☐ no

Abstract: Science and Engineering Fair of Houston

3285

The Art of Sling

Jackson Husted, Hunter Felker

Charter/SST - Champions College Prep - HS

Our project is about testing what measurements and measurement ratios are best for a sling trebuchet. We tested different pivot placements on a trebuchet design to try to both predict and observe how the changes affect the trebuchet's shooting distance.

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Abstract: Science and Engineering Fair of Houston

3286

An Alternative Suspension System Design that Maintains the Aerodynamic Performance of a Formula One Car

Matthew Xu

Conroe ISD /AST: Academy of Science and Technology

The current suspension systems used in Formula One can lead to stability issues and disruptions in aerodynamic flow. These suspension systems can also result in varying ride heights, which may damage the car or disrupt smooth airflow. Can an alternative suspension system design lead to a more sustainable and stable aerodynamic package for F1 cars? The goal was to explore alternative designs that could improve these aspects and enhance overall performance. For the experiment, the kingpin, the Push Rod, and the Double Wishbone suspensions were tested on their effects on stability and aerodynamic flow using a model F1 Car. I 3D designed and printed the Push Rod and the Double Wishbone in PLA material. Stability was measured by the duration the model car traveled in a straight line, while the aerodynamic performance was tested by measuring the wave amplitude of a piece of paper when air was blown from the front of the model. The Kingpin and the Push Rod had similar test results in stability and aerodynamics, while the Double Wishbone had a significant difference. The Kingpin led to the highest overall results; however, this is due to the superior quality and precision of the plastic mold used. The 3D printed Push Rod was less precise and more fragile. Based on previous research, the conclusion is that the Push Rod is the best suspension design for achieving stability and maintaining smooth aerodynamic flow.

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Abstract: Science and Engineering Fair of Houston

3287

The Invisible Wind that Matters: Visualizing Ground Effect in Drone Flight

Simone K

Fort Bend ISD /Clements High School

Category:

Engineering Mechanics

This study utilized simple and low-cost visualization methods to study drone downwash and turbulence by observing airflow patterns at different drone hover altitudes and propeller speeds. The hypothesis was that decreasing the drone's height above ground and increasing the throttle/propeller speed would increase the plume width and turbulence due to stronger turbulence. Airflow patterns of the drone visualized using liquid-based generated smoke at different ground levels and propeller speeds will be recorded with slow-motion videos and analyzed by measuring the plume width and observing turbulence intensity. A 3.5" prop diameter drone was used in this study. It was placed at heights of 25 in, 48 in, and 72 in from the ground. The other controlled variable was rotor speed, ranging from 4000 to 14000 rpm with increments of 2000 rpm. When the drone was placed at 25 in, the width of the plume increased with rotor speed from 4 to 6 ft. However, above 8000 rpm, the high speeds created extreme turbulence, making it hard to observe the plume width. At 48 inches, the plume width increased with rotor speed and then stabilized at around 5.5 ft. At 72 inches, there was no defined plume or ground effect observed, even at high rpm; only diffused turbulence was noticed. Results demonstrated that the ground effect experienced is dependent on drone height and throttle. Excessive throttle use near the ground creates unstable and risky conditions due to extreme turbulence. On the other hand, mid-height operating presents clean airflow and allows for more predictable behavior. These findings suggest safer takeoff/landing height, payload drops or pickup height and provide better guidance on propeller guards and drone algorithms design.

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Abstract: Science and Engineering Fair of Houston

3288

Smart Adaptive Vibration Energy Harvester for Real-Time Resonance Optimization

Salma Khalifa

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

Category:

Engineering Mechanics

This project focuses on developing a smart adaptive vibration energy harvester designed to improve the efficiency of converting mechanical vibrations into electrical energy. Traditional vibration harvesters only operate efficiently at one fixed resonance frequency, which limits their performance in real environments where vibration frequencies constantly change. This project aims to solve that limitation by creating a self-adjusting system that detects the incoming vibration frequency and automatically retunes the harvester for maximum power output. The device uses a piezoelectric element, an adjustable mass–spring structure, and a microcontroller-based feedback system. An accelerometer measures the vibration frequency, and the microcontroller analyzes the data and activates a tuning mechanism that shifts the system's resonance. Multiple tests are performed at different vibration frequencies to compare the power output of the adaptive design versus a traditional fixed-frequency harvester. The results are expected to show that the adaptive harvester will produce significantly higher electrical output under variable-frequency conditions, demonstrating the advantages of real-time resonance optimization. This innovation could help power low-energy devices such as wireless sensors in industrial machinery, transportation systems, and remote locations without requiring batteries or frequent maintenance. This work represents a complete, independent engineering project conducted over one year and does not involve human or animal subjects.

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Abstract: Science and Engineering Fair of Houston

3289

ExoMano: A Mechanically-Actuated Hand Orthosis for the Restoration of Functional Grip in Arthritic Patients and Improved Quality of Life

Felix Everhard

Conroe ISD /AST: Academy of Science and Technology

Category:

Engineering Mechanics

Arthritis is a common condition in adults, especially the elderly, that can occur due to a wide variety of factors including wear on a joint's cartilage, the immune system attacking the lining of the joint capsule, and genetics. This causes joint pain and stiffness, which worsens with age. Of all the kinds of arthritis there are, most people have osteoarthritis. The third most common kind of osteoarthritis is hand osteoarthritis, meaning that a substantial amount of people from all over the world suffer from this condition. In order to combat this, orthoses have been created to assist the hand in movements which would otherwise be difficult. However, these hand orthoses are typically very expensive and sometimes unreliable, causing them to be an uncommon solution. This project aimed to create a more affordable hand orthosis than what is commercially available in order to mitigate arthritis. An orthosis glove was developed using stepper motors to pull rings connected by strings. This is a common approach used by many hand orthoses as it does not add much mass or surface area around the fingers and allows the electronics to be stored near a stronger area of the body such as the waist. Currently, the project costs $45, or $75 including the battery. This project is a prototype, meaning there are improvements that could be made to make the hand stronger and cheaper further solidifying it as a more affordable alternative to commercially available hand orthoses.

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Abstract: Science and Engineering Fair of Houston

3290

Designing A Prosthetic Arm for Disabled Violinists

Akhil Rajarathnam

Clear Creek ISD /Clear Springs High School

Category:

Engineering Mechanics

Wrist movement is imperative for violin players to properly use the bow. This severely inhibits amputees who are unable to use the full length of the bow, impacting the sound quality, and volume of the violin. This project is aimed to construct a prototype to restore wrist motion to align the bow correctly. The prosthetic has a 3D printed wrist and bow holder that attached to the arm. Using a sprocket chain system, the wrist is always aligned with the shoulder's rotation, angling the bow correctly. With a pin slot mechanism, the players shoulder angle can be changed, allowing them to use the bow on every string. To determine the effectiveness of the prototype, it was attached to a mock prosthetic arm and tested to see how much of the bow could be used when playing the violin. The results showed that with this prosthetic, users will be able to use the entirety of the bow consistently. One identified issue is that the prosthetics design somewhat inhibited some shoulder movement. Despite this minor limitation, this concept shows significant promise and could be a feasible, low-cost, and accessible solution.

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Abstract: Science and Engineering Fair of Houston

3291

Rediscovering GEVs: A Novel Ground Effect Vehicle Design and Intelligent Control System For Efficient Air Transportation

Rafael d'Souza

Private/ST. JOHN'S SCHOOL

Category:

Engineering Mechanics

Ground Effect is an aerodynamic phenomenon affecting bodies that use wings to generate lift. It causes a massive reduction in induced drag while flying at low levels, increasing the lift-to-drag ratio of an aircraft immensely, thereby increasing efficiency. Leveraging the Ground Effect has the potential to realize significant savings in fuel consumption and carbon dioxide emissions in the commercial aviation industry. One major issue with Ground Effect is its logarithmic increase in aerodynamic efficiency with proximity to the ground. To gain the maximum benefit, a craft must fly very close to the surface. Proximity to the ground introduces challenges such as obstacle avoidance and flight instability due to turbulence or wind gusts. These challenges have confined past designs to operating over water, and in ideal weather conditions. These challenges have also hindered the commercialization of Ground Effect vehicles (GEVs), despite their potential to significantly reduce fuel costs and carry more payload compared to similar sized conventional aircraft. My engineering goal in this project is to design and build a prototype aircraft that implements variable-geometry wings capable of adjusting the anhedral angle of the outboard wing segments, thereby increasing or decreasing the aircraft's overall effective anhedral angle. These variable geometry anhedral wings will allow the aircraft to seamlessly move in and out of the Ground Effect, thereby overcoming traditional limitations of GEVs. I have completed conceptual design of the aircraft, conducted design validation using CFD simulations in ANSYS Fluent, developed a detailed Fusion 360 CAD model, and have begun fabrication of the test vehicle. My next step is to conduct flight tests of this novel design.

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Abstract: Science and Engineering Fair of Houston

3292

UndrForce: Refining the Rear Spoiler Design of an AMG GT3 to Increase Cornering Speed with Maximum Downforce via Aerodynamics

Aryan Khandelwal

Conroe ISD /AST: Academy of Science and Technology

Category:

Engineering Mechanics

High performance GT3 cars, such as the Mercedes AMG GT3 configuration, rely heavily on aerodynamic downforce to maximize traction in the tight corners of a race track. While an increased-downforce setup may be beneficial towards cornering speeds, it heavily compromises the lap times of sectors heavily composed of straight lines. The primary objective of this project was to determine which rear spoiler design parameters - specifically angle of attack, chord length, and the endplate configuration - help a car to balance speed and downforce without inducing excessive drag or flow separation. To complete the project objective, a Computational Fluid Dynamics (CFD) simulation was conducted with numerous rear spoiler designs tested through their CAD models. A large range of rear wings were tested due to the variability in endplate and spoiler designs. Taking inspiration from the RB17 hyper car, a model was designed with the rear wing wrapping around the sides towards the back of the car. This inspired modifications in some of the designs tested. During the testing, Downforce and drag coefficients were extracted for each design and compared to the baseline model. Results stayed parallel with real-world studies where an increase in angle of attack would be followed by increased downforce. Optimizing the endplate height significantly enhanced downforce generation by approximately 7%. The final iteration of the design produced a measurable increase in rear downforce with air flowing towards the sides, allowing for stability in corners. This study demonstrates how targeted aerodynamics can yield meaningful performance gains through rear spoiler optimization.

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Abstract: Science and Engineering Fair of Houston

3293

Optimizing the Strike: A Calculus-Based Analysis of Bowling Mechanic

Kenneth Baloy

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

Category:

Engineering Mechanics

This mini bowling lane demonstrates the core physics concepts that govern a real bowling ball's motion from release to pin impact. The wax paper simulates the oiled front portion of a lane where friction is low and the ball skids. The bare wood simulates the dry backend where friction increases, enabling the skid-to-roll transition and hook motion. Pin collisions demonstrate momentum transfer and the importance of entry angle. Combined with video analysis of real bowling footage, this project provides both qualitative demonstration and quantitative data supporting the conclusion that bowling's difficulty stems from the extreme sensitivity of the ball's trajectory to initial release conditions.

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Abstract: Science and Engineering Fair of Houston

3294

Testing the Properties of Linear Superposition

Corbin Throckmorton

Conroe ISD /ACES: Academy for Careers in Engineering and Scien

Category:

Engineering Mechanics

I wanted to answer the question of how different levels of forces acting on a body affect linear superposition, and constructive and deconstructive interferences. To test this, I filled a troth with water and measured the waves produced when different weights are dropped on both sides. The data found from this shows that forces combine to produce the amplitude of the constructive and deconstructive interferences, and that larger forces produce larger constructive and deconstructive interferences. The data also aligns with the most widespread notion of how linear superposition occurs, with the constructive and deconstructive interferences cancelling out the two forces over time.

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Abstract: Science and Engineering Fair of Houston

3295

Earthquake Resistant Tower

Jefferso n Alvarez, Mohammed Al Abdulaali

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

This project presents the design and construction of an earthquake-resistant tower built from lightweight balsa wood, with a focus on the use of X bracing to enhance structural stability. The primary objective was to investigate how geometric reinforcement strategies can improve resilience against lateral forces generated during seismic activity. The tower was carefully assembled with symmetrical framing and cross braced joints, ensuring efficient load distribution and minimizing torsional stress. Testing under simulated earthquake conditions demonstrated that the X bracing system significantly increased the tower's ability to withstand vibrations, preventing collapse and reducing structural deformation. The results emphasize the importance of bracing geometry, material efficiency, and energy dissipation mechanisms in earthquake resistant design. This project illustrates how accessible materials like balsa wood can be used to model real world engineering solutions, offering valuable insights into disaster resilient construction practices.

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Abstract: Science and Engineering Fair of Houston

3296

weighted boxing hand wrap

Manuel Huerta

Pasadena ISD/Pasadena Memorial High School

Category:

Engineering Mechanics

This project was about finding a cheaper way to do resisted training for boxing without buying expensive equipment like $300 weighted gloves. I box, and I felt there had to be a simpler option that still worked. The question I looked at was whether boxing hand wraps could be modified to add weight while still being usable and not affecting form or comfort. I predicted that adding weight near the Velcro end of the hand wraps would create resistance but still allow the wraps to function normally. I also believed that if the weight was kept compact and secured, it would not shift around or make the wraps feel bulky. I chose weights that were heavy enough to feel but not so heavy that they would interfere with punching technique. For this project, I bought 180 cm boxing hand wraps and measured the Velcro locking section to decide where weight could be placed. I used old clothing cut into smaller pieces to create pockets inside the wraps. I measured each pocket multiple times, usually at least three times, to make sure the sizes were consistent. I created three different pocket sizes: 2.5 × 5.5 inches, 2 × 1 inches, and 2.5 × 1 inches. I then built three prototypes weighing approximately 8 oz, 6 oz, and 2.5 oz using 6 mm steel balls. At this stage, the project is focused on construction rather than testing. All three prototypes were successfully made. This project shows that it is possible to create a lower-cost option for resisted boxing training by carefully controlling weight and pocket size. Further testing will help determine which design works best.

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Abstract: Science and Engineering Fair of Houston

3297

Devising a Visual and Auditory Alignment System for Accurate Telescope Collimation and Rotational Precision

Eric He, James Heffner

Conroe ISD /AST: Academy of Science and Technology

In order to produce accurate imaging results, both the orientation and optics of a telescope must be correctly aligned with the target. However, aligning and collimating telescopes requires great precision, and many astronomers with visual or auditory impairments are excluded from accurately doing so. Their disabilities often result in inaccurate data and subpar imaging quality. In this paper, a novel device is outlined that may assist disabled astronomers who wish to generate more accurate images. In our proposed device, a Raspberry Pi read information from a gyroscope, magnetometer, star database, and camera, converting the angular difference between the devices' readings and the target's heading into directions that were planned to be made palpable via a touchscreen and speaker, intended to culminate in the user successfully aligning the telescope with the target object. Simultaneously, the Raspberry Pi analyzed the camera's images of the telescope's focuser lens and calculated which collimation knobs needed to be turned so that the telescope mirrors were aligned. At the end of this paper, we document our experiments with the new device - including commentary on why our system's perceived altitude values and collimation attempts were close to accurate, as well as why the opposite held true for our system's perceived azimuth values, which were noticeably inaccurate - and discuss how our data can be included in future research over the status of disabled astronomers, the nature of their roadblocks, and methods that can help resolve their issues with even greater accuracy and reliability than what is outlined here.

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Abstract: Science and Engineering Fair of Houston

3298

T.A.C

Jasiel Escamilla

Pasadena ISD/Pasadena Memorial High School

The procedure was sort of decisive. I landed on two main ideas, but settled on using a magnet-based system to create a counteracting force for tremors, but then found that idea to be a bit to ambitious, especially considering the amount of knowledge and resources I had. Additionally, I also wanted to create a 2-in-1 project where I was going to attempt to create a device that both assisted those with Parkinson's and those with Arthritis, after having found a link between them. Eventually, I settled on the gyroscopic solution, utilizing a gyroscope to create rotational motion, and in turn creating that counteracting force to stabilize tremors. First landing on the use of two motors, then one, and then having the gyroscope by itself to help visualize the process of collecting the data and then translating it into the speed the gyroscope required to counteract that force of the tremor. Most data, basically the tracking done through the accelerometer, for the device was collected through the Arduino app using the code to show how position shifted and so on.

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5. My display board includes non-published photographs/visual depictions of humans (other than myself):

[X] yes   [ ] no

6. I/We hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.

[X] yes   [ ] no

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Abstract: Science and Engineering Fair of Houston

3299

A Novel Unmanned Surface Recharge and Data Transfer Station for Autonomous Unmanned Vehicles

Ziyad Gilani, Elias Zhang, Saira Merchant

Private/ST. JOHN'S SCHOOL

Category:

Engineering Mechanics

Autonomous underwater vehicles (AUVs) are widely used for marine research, inspection, and environmental monitoring, but their mission duration is limited by battery capacity and the need for crewed retrieval for recharging and data transfer. Current industry solutions include docking stations which utilize expensive, inefficient wireless charging technology and often lack the capacity for data transfer. This project aims to demonstrate a wired connection solution to create a more cost effective autonomous docking and recharge system. The wired connection mechanism allows an AUV to slot into place during docking and allows for watertight connection through a novel double seal process. A five-thruster, torpedo-shaped AUV and a surface-based docking station was constructed from off-the-shelf components and 3D-printed parts to test the charging mechanism's design. The docking station employs a dual-pontoon structure with a funnel-guided docking interface to allow for positional error during autonomous docking. Key engineering challenges addressed include waterproofing, structural design, and navigation. Watertight epoxy endcaps were developed and tested through repeated submersion trials, leading to reliable sealing using TPU molds and epoxy endcaps. Computer vision navigation using a camera and onboard Raspberry Pi allows the AUV to detect and track high-visibility markers on the USV, enabling surface localization and navigation. Water and navigation testing of the integrated system is ongoing. This novel charging system has the potential to enable longer, more cost effective environmental monitoring and marine research, where reducing operational cost and human involvement is essential.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- [ ] Human participants
- [ ] potentially hazardous biological agents
- [ ] Vertebrate animals
- [ ] microorganisms
- [ ] rDNA
- [ ] tissue

2. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only.

- [X] yes
- [ ] no

3. I/We worked or used equipment in a regulated research institution or industrial setting.

- [ ] yes
- [X] no

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- [ ] no

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Abstract: Science and Engineering Fair of Houston

3300

Smart Car

Maximus Rosas, Juan Franco, Valeria Santos

Harmony Public Schools - South District/Harmony School Of innovation- Houston

The purpose of this project is to design and evaluate a smart car system that enhances safety, efficiency, and user experience through intelligent automation. The project explores how sensor integration, real time data processing, and machine learning can support autonomous decision making in a vehicle environment. The methods used include the development of a prototype equipped with ultrasonic sensors, cameras, and onboard computing. Algorithms for obstacle detection, lane recognition, and adaptive speed control were implemented and tested in controlled scenarios. Data was collected during multiple trial runs to assess system accuracy and responsiveness. The key findings show that the smart car prototype can reliably detect obstacles, maintain lane position, and adjust speed based on surrounding conditions. The system demonstrated consistent performance across varied test environments and responded effectively to unexpected changes. The significance of this project lies in its contribution to safer and more efficient transportation. By demonstrating the feasibility of low cost intelligent vehicle systems, the project supports ongoing efforts to reduce accidents, improve traffic flow, and advance the development of autonomous mobility technologies.

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Abstract: Science and Engineering Fair of Houston

3301

Modifications to improve cooling efficiency of Natural Convection

Amiesha Umbarkar

Conroe ISD /AST: Academy of Science and Technology

Category:

Engineering Mechanics

Devices that require an abundance of computation experience an increase in energy consumption and the generation of heat. To combat this heat, we invest in forced and natural convection. While forced convection uses more energy with an external cooling system, natural convection only uses air as its medium, making it more sustainable. Unfortunately, heat transfer of natural convection is inefficient compared to forced convection. In my project, I studied how geometric aspects of the fins of a heatsink affect the overall cooling. Based on Ahmadi's concept, I created different simulations on SimScale, a simulation program, testing different CAD models to study the effects of fin height, spacing, orientation and heatsink material. The results exhibited different impacts each factor had on the paramount factor, the heat flux. Height was the most influential, as results show height can increase heat flux, but too much height can restrict airflow, diminishing all the beneficial factors. Closer spacing increases the surface area, while farther spacing can allow better airflow. The downwards tilt 30° had the worst impact, as it restricts airflow and results in a warmer base compared to the other tests. The upwards tilt 30° provided more heat removal, while the flat fins resulted in the coolest base. Material heat flux values had the least variation. After conducting ANOVA tests, height and material tested to be significant to the performance of heat sinks, while the others showed correlation within the heat flux values, but were found insignificant.

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