CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Sophia A. Brodish

Project Number

S0301

Project Title

Spinal Curvature Treatment: The Utilization of Resorbable Anterior Spinal Fusion Systems to Combat Spinal Deformities

Abstract

Objectives/Goals

Considering the variety of spinal deformity treatments, many patients agree that after surgery their mobility is significantly reduced. The utilization of resorbable materials for anterior spinal fusion systems, patients will experience the success of spinal deformity treatment and retain their prior mobility. If the systems are used on vertebrae with larger anterior width, then the spinal plate curvatures and screw trajectories will be at larger angles. Plate curvature and screw trajectory (in degrees) observations can be seen because the spinal plates varied based on the sine curvature shape of the spinal cord and increased downward from the Cervical Cord to the Coccyx. This is shown because the largest vertebra (L5) with a 2.18-inch width had the largest angles and second largest screw trajectory. The smallest vertebrae were the C4 and T4 vertebrae that had the same width of 1.08-inches; however, the C4 had the smallest plate angles and screw trajectories ranging from 76.95-95.13 degrees. The research and data provided insight to see how anterior spinal fusion systems would be required to be shaped in ways that correlate with the spinal cord in order for improved mobility.

Methods/Materials

Sahand University provided a CAD cadaver of a spinal cord specimen and was imported into Creo to retain measurements for the design of the spinal cages. Creo was used to create the spinal cages along with Desmos to view spinal curvature and Geogebra to look at different angles within the systems. The models were imported into a MakerBot (3D Printer Software) and printed with plastic filament.

Results

An increase in angles of spinal curvature can be seen from the C1 to the L5. The screw trajectory data did not show a specific trend for the plates; however, the maximum angle was 115.34 degrees and the minimum was 67.36 degrees. The data favored that the higher the width of the spinal vertebrae, the larger the screw trajectory and plate angle.

Conclusions/Discussion

The hypothesis, if the spinal implant systems are used on vertebrae with larger anterior width, then the spinal plate curvatures and screw trajectories will be at larger angles, was accepted. Many of the vertebrae with larger widths were in the Lumbar cord, which had the largest plate angles; however, they did have a few lower screw trajectories. The vertebrae with the smallest widths were mainly in the Cervical Cord which had the lowest plate angles.

Summary Statement

By viewing different anterior spinal fusion systems in correlation with the spinal cord, spinal cages were designed via the use of 3D modelling and printed using a 3D printer in order to show variation within each systems' curvature.

Help Received

Sahand University of Technology- Provided CAD Cadaver & Dr. Bret Sullivan- Local Chiropractor

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Mariko L. Costantini

Project Number
S0302

Project Title
Does Wood Type Affect the Tone of an Acoustic Guitar?

Abstract

Objectives/Goals
The goal of this experiment is to discover if the wood type of an acoustic guitar will affect its tone.

Methods/Materials
This project involved five varying types of wood, guitar tuning keys and bridge, strings, and varying power tools.

Results
It was concluded that the wood type did not have a significant effect regarding the volume. However, it had a large impact on the sustain. For example, particle board had very low sustain compared to the other woods which is why it would not be used to make a guitar.

Conclusions/Discussion
Based on the data collected, the tone of an acoustic guitar is based on the type of wood it is made out of. While I was unable to hit the strings with the exact same amount of force every time throughout the hundreds of trials, it was indicated that the sustain varied based on the wood type. Thus it can be concluded that the tone of an acoustic guitar, in terms of sustain, is affected by its wood type.

Summary Statement
I showed through trials in terms of sustain and volume that the tone of an acoustic guitar is affected by wood type.

Help Received
None. I designed and constructed the project myself.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Kyle J. Ettinger

Project Number

S0303

Project Title

Drone Disabling Technology V2.0: High Power Net Launcher and Automated Firing

Abstract

Objectives/Goals

Currently there are no effective means of disabling drones that pose a threat to public safety, security, privacy, aviation or property. My goal is to create a drone mounted net launcher that is capable of disabling an unwanted drone semi autonomously. A pilot flies the drone to intercept the unwanted drone and activates the launch system. When the unwanted drone gets within range, a sensor on board launches the net, disabling and capturing the unwanted drone.

Methods/Materials

Having developed a drone mounted net launcher which operated at 0.76 MPa and launched a net of 2m^2 last year, I realized that the ability to launch a much larger net is needed. Also, the difficulty in flying a drone while simultaneously trying to line the net launcher up and trigger it is quite difficult, making automatic firing crucial.

To launch a much larger net with air and keep component size down, I decided to increase pressure to 6.9 MPa. My design is based off a pressure piloted valve and combines the valve and tank in the same body. I designed parts and made drawings in CAD. I did extensive Finite Element Analysis as well as handbook calculations using Factors of Safety greater than that required by ASME Boiler and Pressure Vessel Code. I fabricated each component using a mill, a lathe and a 3D printer. I hydrostatic tested the net launcher to 3 times the operating pressure.

After testing ultrasonic sensors, I settled on Lidar for detecting a flying drone. I interfaced the Lidar sensor to an Arduino micro controller that triggers the launcher when a drone is in the programmable capture zone.

Initial testing of the valve resulted in only low pressure operation. I changed the valve actuation travel distance by machining two more shafts which resulted in full pressure operation and ran steady state Computational Fluid Dynamics to gain insight into the results.

Results

A drone mounted net launcher was successfully tested that can launch a net of 18.5 m^2 for a distance of 7 m or a net of 5.3m^2 for a distance of 11 m. The integrated Lidar sensor works reliably to detect and fire at an unwanted drone. A net tether prevents the captured drone from falling to the ground.

Conclusions/Discussion

The use of a drone mounted net launcher with automated firing and a net tether is an attractive option for disabling and capturing unwanted drones and carrying them to a safe location.

Summary Statement

I designed, built and successfully tested a drone mounted net launcher capable of automatically firing a net of 18.5m^2 at an unwanted drone, disabling and transporting it.

Help Received

My dad approved the safety of the design and supervised machining and testing.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Enrique B. Gamboa

Project Number
S0304

Project Title
Assistive Robotic Mechanism 2

Abstract

Objectives/Goals
The reason why I chose to construct a wearable robotic arm that allows people to lift heavy objects they can't normally pick up.

Methods/Materials
4 feet long aluminum stick to make the frame of the arm, drill to drill holes in the aluminum sticks, Velcro to attach the arm to the user, servo motor to provide movement for the arm, a ball bearing to make the arm move, switch to control the arms movement, and screws to build the arm.

Results
I was able to achieve my first goal which was to make the robotic arm under a budget of 35 dollars and In total I invested around 15 dollars in aluminum sticks bolts and screws. This takes me to my second goal which was to make my arm have a wight under 6.2 pounds. I achieved this goal because the arm weight a total of about 2 pounds. I was not able to achieve my third goal which was to try the robotic arm on someone with muscular disabilities. I did not achieve this goal because I was still not satisfied with the end result so that the next time I visit him it works 100% of the time. In addition I was not able to achieve my last goal witch was to be able to lift objects 10 pounds and above. I did not achieved this goal because it was only able to lift up about 4 pound at about 90 degree difference from the arms original state.

Conclusions/Discussion
In conclusion my problem was correct because I was able to construct a robotic arm capable of lifting heavy objects people they can't normally lift and achieved this by completing 4 goals in mind. I was able to achieve my first goal which was to make the robotic arm under a budget of 35 dollars and In total I invested around 28 dollars in aluminum sticks, pipes and air values. This takes me to my second goal which was to make my arm have a wight under 6.2 pounds. I achieved this goal because the arm weight a total of 3 pounds. I was also able to achieve my third goal which was to try the robotic arm on someone with muscular disabilities. I achieved this goal by trying out the arm and a nice and friendly man that has muscular disabilities.

Summary Statement
I built a robotic arm that helps people with muscular disabilities.

Help Received
I would like to thank Eva and Enrique for buying the aluminum sticks and driving me to Homedepot and Mr.Orantes for helping me check my writing.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Paul R. Gauvreau

Project Number

S0305

Project Title

Novel Methods of Augmenting Plant Pollination

Abstract

Objectives/Goals

The objective of this experiment is to provide artificial mechanisms by which one can augment plant pollination. This was done by spurring the release of pollen and providing a mechanism to transfer it from one plant to the next. More specifically, I created a mechanical system that can mimic specific bee behaviors that cause pollen to be released and assist the transfer of pollen from one plant to another. No one has created a device that has the ability to autonomously augment plant pollination. More specifically this experiment is a vital step towards a mechanical system that can autonomously pollination all types of plants.

Methods/Materials

There are three parts to this experiment, the first and most important part of this experiment is the pollination through vibration, I have developed a bee like device that clips to the stalk of plant and vibrates for a couple minutes every day, mimicking frequencies generated when bees beat their wings. Over time this causes the flowers on the plants to release pollen, which in return, self pollinates the flower, causing a tomato bud to form.

The second two parts of the experiments are extensions of the original concept enabled by the utilization of autonomous drones. The first was the use of autonomous drones to cross pollinate plants. This was carried out by pods from one plant to another: the pods are vibrating motors enclosed in a 3d printed housing, and covered in horsehair or filament. The second extension is the novel modulation of motor rotational speed to produce thrust changing at a frequency of 200hz. This was completed by using an Arduino to change the speed 400 times a second. This resulted in a downwards thrust that mimics vibrations created by bees. More specifically this is intended to augment pollination of all plants by causing higher amounts of pollen to be released.

Conclusions/Discussion

In conclusion, using the beelike devices, autonomous drones, and thrust of 200hz, I can augment the pollination process. Compared a control with an absence of bees, the bee like device increase pollination on average by almost 2,000%, the automated drone provide a mechanism to cross pollinate plants, and the thrust of 200hz allows for a large scale implementation and automation of the pollination through vibration.

Summary Statement

The use of mechanical devices to pollinate plants

Help Received

no one

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Sasha Jaffarove

Project Number
S0306

Project Title
Cave Mapper

Abstract

Objectives/Goals
The Cave Mapper is designed to make a map of a cave, room or any enclosed space. This years project was about making the fourth version of the cave mapper which is the transition phase from a sedentary Cave Mapper to the quadricopter (drone) version. The goal of this years project was to make it lighter and more compact so it would be easier to attach it to a quadricopter.

Methods/Materials
Raspberry Pi 3rd generation, Lidar 3rd generation, rechargeable battery, 2 micro servos, micro usb cable, 3D printed box, 3D printed servo attachments, Lidar cable, motorhat. I 3D printed my own parts because the material is quite lightweight, as well as being able to edit and change the design in only a couple hours.

Results
I managed to make my project way lighter and much more compact. I made it lighter using 3D printed materials and smaller plastic servos instead of the previously large and bulky ones. To make it more compact I carefully compartmentalized everything to fit nice and tight without damaging any equipment. Now this way I will be able to attach it easily to the quadricopter without having to worry about space and weight. An issue, that I could not find the source of, was that the servos were vibrating and less accurate which means I was unable to create a map. So I realistically will not be able to move on to the quadricopter step without finding out the solution to this problem.

Conclusions/Discussion
With this cave mapping technology it becomes easier to map deeper areas where there is a lack of oxygen. This is why it has to be automated. Not only this but for steeper areas a cave mapper on wheels will have many constraints of where it can and cannot go. With a drone it will be able to have a larger radius of movement. I accomplished to make the project more compact and lighter however couldn't produce an accurate map because of the over vibrating of the servos.

Summary Statement
My project is based on a device I built which designed to create a 3D map of a cave.

Help Received
This year I wasn't working with any mentors because I already had the knowlege from previous years of working on this project to accomplish what I had in mind

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Benjamin K. King

Project Number

S0307

Project Title

Magic the Gathering Card Sorter

Abstract

Objectives/Goals

Magic The Gathering Players need a quick, time efficient way to sort their cards, otherwise the cards pile up all around the house making a huge mess. The objectives are to provide a method of sorting Magic cards that is time efficient, is cheap, is accurate in the way that it sorts the cards, doesn#t take up more than two square feet, and can run off batteries or some other man-made fuel.

Methods/Materials

I programmed a NXT robot, using NXT software which I didn't modify, and obtained online. My materials were a NXT kit, however the only reason I used the kit was monetary. I couldn't buy an actual robot with the resources I had, so I used a NXT robot which I had previously owned.

Results

my prototype is successful. It fulfills my objective by being relatively cheap, (especially compared to Magic Cards) is time efficient, it can even run overnight, it runs off rechargeable batteries, is extremely accurate, and is fourteen inches by eleven inches. I only have one issue with my project. It cannot sort many cards at the same time. However, this is only a small issue, and with more time can be easily adjusted. Therefore, I personally judge my project and prototype a success by my standards.

Conclusions/Discussion

Unfortunately, my project doesn't expand our knowledge on any subject at all. However, I have proven that it is possible to make a Magic The Gathering Sorter, which may be sold as a product.

Summary Statement

My project is a automated Magic the Gathering card sorter, which sorts Magic Cards based on approximate value.

Help Received

My teacher, Ms. Barry, provided me with motivation to complete a project like this.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Jacob S. Kisow

Project Number
S0308

Project Title
Versatility of 3D Printed Exoskeleton Hand

Abstract

Objectives/Goals
The purpose of my project is to prove the usefulness and versatility of 3D printing in the world of prosthetics and overall medical usefulness of 3D printing. This project in particular is designed to help patients with various neuromuscular diseases gain extra strength to help perform everyday tasks that may be difficult for them.

Methods/Materials
PROCEDURES:
Model exoskeleton prototype in CAD software
Print prototype using 3D printing
Assemble and test prototype
Redesign any components necessary.
MATERIALS:
CAD Software & computer
3D Printer & filament
Solenoid
Battery Box
Wiring
Microswitch
Velcro

Results
My experiment was somewhat successful in that it proved 3D printing can be a budget-minded option for quick, personalized medical needs.

Conclusions/Discussion
Overall, my project was a great proof-of-concept. The project was easily affordable coming in at under $30, however, the motors did not reach the necessary power to have a significant effect on one's hand strength. In the future, I would worry less about a budget and more about a strong assistant.

Summary Statement
My project is about showing the versitility of 3D printing in the medical field, my project specifically is designed to give strength to patients with neuromuscular diseases.

Help Received
None. All prototypes were designed, printed, assembled, and tested in my bedroom and garage.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Benjamin T. Kolland

Project Number

S0309

Project Title

Drag-n-Fly: Optimization of Drag Coefficient Calculations from Rocket Altimeter Data

Abstract

Objectives/Goals

Flight simulations help optimize model rocket design. The TARC competition requires flying a model rocket repeatedly to a specific altitude, but the results can be inconsistent without an accurate drag coefficient (Cd). The solution: Use altimeter data to compare and optimize Cd calculations from peak altitude, peak velocity, and a curve fit using coast-down acceleration data from motor burnout to peak altitude. The hypothesis was that curve fitting the acceleration data would be optimal, as more data points per flight (60) are recorded rather than a single point peak altitude or velocity reading.

Methods/Materials

A Jolly Logic AltimeterThree recorded barometric pressure, altitude, and 3-axis acceleration data for each flight. Data analysis used RockSim (a rocketry-specific simulation program), Excel, and MATLAB. For altitude and velocity Cd, data was entered into the simulation with conditions set to match the actual flight, then the Cd was iterated and backsolved until the simulation matched the actual flight. Coast-down acceleration data was analyzed in MATLAB using linear regression to solve for Cd.

Results

Data was collected from 36 TARC flights in 2016 and 2017. Altitude backsolving using RockSim provided the most accurate Cd, but induced bias: the simulation was adjusted to match the flight altitude recorded. Velocity provided the least accurate Cd, varying from altitude Cd by 1.1% to 45.5%. Acceleration Cd values differed by 0.6% to 8.2% for all but one rocket (Pink=16.1%). The standard deviations for altitude and acceleration data were very low (<0.05), vs. high (0.13 to 0.6) using velocity. Statistical analysis showed that the medians for altitude Cd and acceleration Cd were statistically the same for all rockets except Pink. Wind tunnel tests were conducted to provide another cross-reference point.

Conclusions/Discussion

This project successfully determined model rocket drag coefficients from altitude, velocity, and acceleration. Altitude and acceleration methods yielded more accurate and consistent results than velocity. The hypothesis was partially disproved because the altitude Cd from backsolving results in the most accurate Rocksim predictions; however it may not reflect the actual Cd as well as the acceleration Cd. Observed Cd from recent wind tunnel testing supported the viability of both methods. Acceleration data is especially useful for planned integration into an altimeter.

Summary Statement

To correctly predict and optimize model rocket performance, this project analyzed altimeter/accelerometer flight data comparing three methods of determining the drag coefficient.

Help Received

Supervised rocketry testing (D. Raimondi, J. Dougherty, J. Friedland). L. Stephenson Haskins & G. Wahlstrand for data analysis. J. Beans for altimeter expertise. D. Cornelius for flight error analysis. N. Mourtos & G. Manzanares for wind tunnel access & support. 2016 & 2017 AFE Rocketry TARC teams.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Elizabeth Kravtchenko

Project Number
S0310

Project Title
Crank It Up! Finding the Optimal Crank Arm Length

Abstract

Objectives/Goals
The purpose of this project was (a) to find out if using longer crank arms on my bicycle would allow me to ride faster and (b) to develop a computer-based system, model, and analysis to determine an optimal crank arm length. My hypothesis was: if I extend the crank arms on my bicycle by 1.5%, then I will increase my peak power output by 35% and achieve much higher speed.

Methods/Materials
In my research and analysis, I used mathematical and computer modeling to describe the physics of cycling and calculate pedaling force. In my experimental method, I completed three cycling tests with different crank arm lengths and generated large data sets. My independent variable was crank arm length. My dependent variables were power, pedaling force and cadence, wheel speed, and heart rate. I used the following materials and equipment: road bicycle, stationary rollers, 170/172.5/175 mm crank arm sets, crank arm RPM (cadence) meter, rear wheel RPM (speed) meter, rear wheel hub power meter, heart rate monitor, cycling computer, personal computer, online .fit to .csv file converter, and Excel modeling software. In my data analysis and visualization, I used numerical methods and statistics to compare my test results, and data slicing and dicing techniques to gain valuable insights.

Results
I noticed virtually no effect of the crank arm length on the speed vs. power efficiency. However, with the 172.5 mm crank arms, I was able to balance my neuromuscular and cardiovascular performance and output a lot more power and achieve much higher speed than with the other crank arms! By adjusting crank arm length, and measuring power, cadence, and heart rate, one may identify his/her neuromuscular and cardiovascular "bottlenecks" and find his/her optimal crank arm length. At this optimal length, both pedaling force and heart rate achieve their max simultaneously, producing the highest power output and speed.

Conclusions/Discussion
My hypothesis was correct! I was able to output 37.5% more power and achieve much higher speed with the 1.5% longer (optimal) crank arms. I have also developed a sophisticated computer-based system and a practical novel method to determine an optimal crank arm length based on power, cadence, and heart rate measurements. I am considering filing a patent for this. My innovative system and method may help other people to find their optimal crank arm length!

Summary Statement
In my project about cycling, I developed an innovative computer-based system and method to determine an optimal crank arm length based on power, cadence, and heart rate measurements to produce the highest power output and speed.

Help Received
Dmitriy Badeka (cycling coach) helped me to install the crank sets and connect the sensors. Tatiana Seletskaia (physics teacher), Bob Dubrow (mentor), and Vladimir Kravtchenko (mentor) reviewed my project and provided feedback and guidance.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Alexandra P. Kuo

Project Number
S0311

Project Title
Game, Set, Match: An Electronic Shoe for Playing Tennis

Abstract

Objectives/Goals
My objective was to see if I could create a Peltier tile cooling device that would reduce the temperature within a tennis shoe under simulated heat conditions compared to control.

Methods/Materials
My methods were as follows:
- mathematically calculating the heat load my Peltier system might be expected to cool,
- testing the energy requirements and cooling performance of a Peltier tile,
- integrating into a tennis shoe a Peltier tile and a DC energy source,
- engineering a system for dissipating the heat the Peltier tile generates,
- testing the performance of my experimental model with different batteries against a control, and
- creating a digital model of the thermodynamics within my experimental model.

Results
- The energy requirements of the Peltier tile I planned to use for cooling fit my calculations for heat emanating from the tennis court, but not from the foot itself.
- In all tests with AAA batteries and 9-volt batteries, the experimental shoe cooled down 4°F-5°F while the control shoe cooled down 2°F-3°F
- Despite two design and experimental testing failures, my final cooling system design tested with 9-volt and AAA batteries simulating the heat in a tennis shoe performed modestly better than control so my hypothesis is correct.

Conclusions/Discussion
- In my review of the literature, I did not find that anyone else had ever tried to use a Peltier tile to cool a shoe.
- My experimental testing did conform to my mathematically calculated heat loads with respect to having a modest cooling effect.
- The digital model created will facilitate further experimental testing by better quantifying each phenomenon occurring.
- A Peltier cooling system for shoes should be considered in applications where comfort and safety in hot conditions is necessary such as boots of soldiers in a desert or firefighter boots

Summary Statement
I built a Peltier tile cooling system that functioned to cool a tennis shoe without any moving parts.

Help Received
I wish to thank Matt Ondriezek for assisting with the construction and testing of my experimental and digital models. I wish to thank David Eldon for helping me to research the feasibility of my project. I wish to thank Martin Teachworth for providing suggestions on the direction of this project.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Alexandria C. Malilay

Project Number

S0312

Project Title

Assessing Antifouling Activity of Heteractis magnifica

Abstract

Objectives/Goals

A major problem for marine industries is biofouling, the accumulation of undesirable organisms on immersed artificial surfaces. Antifouling is used to inhibit biofouling, but many antifouling coatings with metallic properties cause harm to non-target species. To prevent harm to non-target species, natural bioactive metabolites can be used in antifouling coatings. This research project focused on the sea anemone Heteractis magnifica due to past research that indicated the presence of natural antifouling agents.

Methods/Materials

The crude extract was prepared by homogenizing the body of H. magnifica. The homogenate was immersed in acetone, ethanol, and methanol; they were then centrifuged and evaporated to dryness. For the larval barnacle assay, 10 larvae were added by micropipette to 6 replicates of 2 mL test solution. CuSO4 solution was the positive control, wells with aged seawater and DMSO served as negative control, and aged sea water was the control. The plates were incubated for 24 h. The procedure was repeated with methanol, ethanol, and acetone extracts.

To analyze the antifouling activity against E. coli biofilm, a 96-well multi-well plate was filled with varying volumes of acetone crude extract. Another multi-well plate was prepared with LB; 1 µL of the growth culture from the first plate was transferred to the second plate. Supernatants were removed and wells were washed using PBS and stained with 0.4% crystal violet. A microplate reader was used to analyze the plate spectrophotometrically.

Results

The percentage of settlement and death was calculated for the acetone, ethanol, and methanol crude extract. The acetone was the most effective in inhibiting cyprid settlement and had the highest average death rate of 70%.The death rate of the cyprids for the acetone crude extract is similar to CuSO4, indicating that there are powerful antifouling agents present in the acetone crude extract.

Biofilm formation was impaired in the presence of the crude extract. The absorbance decreased by about 1 nm in the presence of different crude extract concentrations.

Conclusions/Discussion

The outcome shows potential to provide an alternate antifouling agent to coatings containing copper. The inhibitory activity of the H. magnifica extract against larval barnacle culture and biofilm formation represents an opportunity to discover active anti-macrofouling and anti-microfouling agents.

Summary Statement

The presence of alternative antifouling agents in the sea anemone, Heteractis magnifica, was confirmed through multiple assays.

Help Received

I designed the methods based on academic papers I read. My lab supervisor, Dr. Malhotra, helped me understand HPLC. Dr. Daniel Rittschof and Beatriz Orihuela of Duke University provided barnacle larvae and aged sea water. Dr. Jie Li of Scripps Institution of Oceanography was my mentor.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Yuriy D. Manuylov

Project Number
S0313

Project Title
The Effect of Ignition Timing on Emission Gasses

Abstract

Objectives/Goals
My objective was to alter the ignition timing angle to see how it affects the amount of emission gasses. The purpose of this is to see how it affects the environment.

Methods/Materials
I used a hand held Snap-On gas analyzer. I inserted it into the exhaust pipe. I heated up the engine to 190 degrees Fahrenheit. I physically moved the distributor clockwise or counterclockwise in order to advance or retard the spark. I did measurements of carbon dioxide, nitrogen oxides, and hydrocarbons. The angle varied between 40 degrees before top dead center and 20 degrees after top dead center.

Results
The least amount of pollution's found at between 10 degrees before top dead and 5 degrees after top dead center. Beyond 5 degrees of top dead center the engine would not run.

Conclusions/Discussion
Ignition timing has a direct effect on emission gasses. There is an optimum time at which pollution is least. A tune-up would reduce the emission from a standard engine out of adjustment. Therefore, this project result should recommend to the average driver that they should get a tune up before an emission (smog test).

Summary Statement
I altered the ignition angle on an engine to see its effect on pollution and found it does make a difference.

Help Received
Mr. Phillip Torres, Mr. Jeffery Adkins; experiment was done at the school auto shop.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Callie M. McCaffery

Project Number
S0314

Project Title
The Shape of Strength: Geometric Shape Impact on Truss Design

Abstract

Objectives/Goals
My goal is to understand how different geometric shapes affect the strength of a truss.

Specific Test: Does a truss composed of right triangles support more, less, or an equal amount of weight than a truss composed of equilateral triangles?

My hypothesis is that a truss made up of equilateral triangles will hold more weight than a truss made up of right triangles.

Methods/Materials
After experimenting with prototypes made out of Legos and discovering what went wrong with them, I built two styles of trusses out of bass wood that have equal lengths of horizontal members; one set of trusses was made up of equilateral triangles and the other set was made up of right triangles. I then added weights to the center of each truss and found the amount of weight that caused the truss to fail or break. I supported my data with free body diagrams and mathematical calculations.

Results
The equilateral triangle trusses held more weight than the right triangle trusses: The equilateral triangle trusses started to noticeably bow and bend at an average of 28 pounds, and broke at an average of 36 pounds. The right triangle trusses started to noticeably bow and bend at an average of 22 pounds, and failed at an average of 28 pounds.

Conclusions/Discussion
My data showed that my hypothesis was correct; the equilateral trusses held more weight.

I wanted to validate this mathematically if possible, so I drew free body diagrams applying Newton's Third Law, along with trigonometry to find which members of each truss had the most force applied to them. The member that had the most force applied to it was the breaking point of the truss. By looking at the different calculated mathematical highs, I verified my hypothesis showing that the equilateral triangle trusses better distributed the force than the right triangle trusses.

In addition to some trigonometry and physics, I discovered a number of various applications of truss construction concepts.

Summary Statement
Determined how changing the shape of a truss (specifically equilateral vs right triangle construction) affects the deflection or strength of the truss.

Help Received
I designed the prototypes and planned the experimental set up. My father helped me with construction of the set up and verified the calculations. My mother helped me with data collection.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Aren M. Melkonian

Project Number
S0315

Project Title
A Research Study: Forming an Effective Countermeasure against Tsunamis

Abstract

Objectives/Goals
Tsunamis have been deadly forces for thousands of years, and with new and advanced nuclear power plants, they have been fueled causing devastating aftermaths. My objective was to build an efficient and reliable method to assist in redirecting the energy of tsunamis and high tidal waves. Based on my research I assumed by creating a concave seawall, that is located 10.668 meters deep and 3 kilometers outland it would more effectively stop a tsunami.

Methods/Materials
To build my concave seawall, I needed several materials, five varying sizes of plexiglass, acrylic cement, access to a 3D printer able to print larger then 25.4 cm by 25.4 cm by 25.4 cm, access to CNC laser cutter, two large sheets of steel, 3 adjustable rope locks, 5 pulleys and 7 carabiners. My first step would be the assembly of all my parts. After assembling the pulley system, I would place the pulley system into the tank, then carefully fill the tank to approximately to 1' 8" height. The last step is to measure your waves force and height.

Results
After doing all three tests I was successful in my result with an average decrease of the waves height about 56%.

Conclusions/Discussion
My hypothesis was proven correct. Although further testing must be done, and new methods must be analyzed, this experiment has opened a new route to stopping tsunamis

Summary Statement
Finding a new and effective counter-measure against tsunami, while considering feasibility issues

Help Received
Dr. Armen Baronien , Mr. John Shiradjian, Professor Claire Atsinkon

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Gajan R. Nagaraj

Project Number

S0316

Project Title

A Novel Fire Hazard Autodetect System for Vents, Pipes, and Chimneys

Abstract

Objectives/Goals

The goal of this project is to develop a gadget with can be latched onto a vent and detect any clogging, heat buildup, and/or combustion in an air vent. Design criteria of the device are that the device must be equipped with a functioning temperature sensor that can sense heat buildup within an air, a functioning pressure sensor that can sense pressure build up within an air vent, the device can detect the dust density within the air vent and process whether the vent is clogged, the device should be able to adapt to various set points depending on the type of air vent, and the device should have connectivity capabilities so that it can send alerts depending on the status of the air inside a given vent.

Methods/Materials

In this project, I constructed a device from commercial grade electronics (temperature sensor, pressure sensor, opacity sensor, and arduino 101) to fit my design criteria. I then wrote my own software to control these electronic components and make them function to fulfill my design criteria, do set points, provide alerts based on exceedance of those set points, and achieve the overall goal of the project.

Results

After rigging the device to a mock air vent (which was connected to a heater/fan), the device performed per the design criteria. The device was able to react the build-up of these factors fairly quickly and with a reasonable amount of accuracy. Testing of the device shows that it was triggered within a small reasonable margin of the set point. The device adapted to the various set points the user set and sent alerts via Bluetooth when set points were violated for temperature, pressure, and dust density.

Conclusions/Discussion

In the end, the design criteria were satisfied. A device which was equipped with a functioning temperature sensor, pressure sensor, dust sensor, and Bluetooth connectivity was created. These sensors were also configured in such a way which allowed the device to detect any extreme values within the air vent and report it back to the user. The user was also able to set values which fit their environment and the device adapted to these conditions. This is a powerful tool which can be used to save many lives around the world and prevent the possibility of property damage/total loss of a house. This device ought to be deployed around the world for this specific use immediately.

Summary Statement

I developed a gadget which can be latched onto a vent and detect any clogging, heat buildup, and/or combustion in an air vent.

Help Received

None. I designed, built, and performed the experiments myself.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Lauren Ribancos; Nathan Ribancos

Project Number

S0317

Project Title

Can You Hear It Now? The Comparison Between Dynamic Driver and Bone Conduction Headphones

Abstract

Objectives/Goals

The objective of the project was to differentiate the operation and sound quality of bone conduction and dynamic driver headphones.

Methods/Materials

The following materials were from Adafruit Industries: MAX9806 Class D 3.7w Stereo Amplifier, 8 ohm 1 Watt Bone Conduction transducers, 3.7w 150 man Li-Ion battery. The following materials are from Apple Inc.: audio source, dynamic driver earbud headphones. The materials from Adafruit Industries were used to construct bone conduction headphones, which were compared, in operation, to the dynamic driver earbud headphones from Apple. To test the operation of both headphones, 75 subjects were brought in to listen to each headphones type and answer a survey based on the experience.

Results

After the surveys were collected, the responses were translated onto a statistical graph that represented the results. The bone conduction headphones, according to the data collected from the surveys, had a significant amount of distortion, ambient sound leakage, and lacked frequency responses when compared to the dynamic driver headphones. The dynamic driver headphones were unable to cope with higher frequencies and blocked out more ambient noises.

Conclusions/Discussion

The data received from the surveys did not support the hypothesis. Despite producing stimuli, the bone conduction headphones could not produce "quality" sound compared to the dynamic drivers It may also be more difficult to hear audio through the bone conduction headphones since the conductors do not directly stimulate the eardrum, since the eardrum is not involved at all. In the end, bone conduction headphones are a less harmful alternative, can help the hearing impaired, and has the capability to prevent hearing loss more so than dynamic driver headphones, but has yet to offer the sound quality the general public is used to.

Summary Statement

We have found that bone conduction headphones cannot match the sound quality of dynamic driver headphones.

Help Received

The construction of the bone conduction headphones and experiment was designed by us, but our anatomy and biology teacher explained the operation of the ear and provided resources for it.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Tyler E. Robertson

Project Number

S0318

Project Title

Improving Residential Solar Panel Efficiency in a Drought: Cleaning Solar Panels without Water or Manpower

Abstract

Objectives/Goals

Despite a non-drought year in 2016-2017, during the summer months in the Central Valley dry dusty conditions in the surrounding agricultural areas and poor air quality with high particulate and ozone levels will lead to a buildup of material on solar panels, reducing their efficiency. Even if water restrictions are lifted, water is still a valuable resource and valley residents need a cost effective way to remove dust and dirt from their solar panels without using water.The goal of this project was to design and build a cost-effective robot that would clean residential solar panels without the use of water or manpower. Year Two of the project focused on continued redesign and testing of prototypes to achieve the goal.

Methods/Materials

Robot prototypes were designed and built using Arduino microcontroller and Actobotics robot components. Each prototype was tested for effectiveness at driving straight and turning on a solar panel placed at an increasing angles (0-40 degrees). The ultrasonic sensor provided distance feedback to keep the robot from running off the edge of the solar panel. Prototypes were programmed to be autonomous or remotely controlled with either Bluetooth or radio frequency technology. Initial testing was completed to test improvement in solar panel power output.

Results

The tracked robot design was effective for driving straight on slopes up to 40 degrees, but demonstrated difficulty negotiating turns due to the increased traction. Improved robot control and consistency were noted using Spektrum DXe radio system compared to the Bluetooth phone control. The ultrasonic sensor provided consistent edge detection during autonomous running of the robot. Traction continues to be the limiting factor in the robot#s effectiveness as roof slope increases.

Conclusions/Discussion

Year Two prototypes demonstrated improved ability to clean residential solar panels on sloped roofs without the use of water to allow improved solar panel efficiency in high particulate regions. Without water as a cleaning substrate, there is a limit to the extent a solar panel can be cleaned. The robot is designed to be portable, cost-effective, and easily controlled with a remote, reducing the need for physically washing solar panels on a roof. I still believe that my project has potential on the market, especially for homeowners in areas of high dust or pollution.

Summary Statement

I designed and built a cost-effective robot that cleans residential solar panels without the use of water or manpower.

Help Received

Fresno IDEAWorks provided feedback with robot design. My parents supervised operation of power tools required during build.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Jordan A. Semprevivo

Project Number
S0319

Project Title
Drawing Optimization Technology (DOT)

Abstract

Objectives/Goals
The objective of DOT is to facilitate the process of stippling and pointillism, but also to prevent as well as aid those of have ailments such as arthritis that are easily caused by the repetitive motion of the traditional method of this art form.

Methods/Materials
LuzBot Taz 3D Printer, SolidWorks CAD Software, Solder and Soldering Iron, AA Battery, Pen Cartridge, and Motor.

Results
The amount of dots I was able to lay on the paper using DOT was exponentially greater than manually laying dots down by hand. Additionally, the ergonomic shape of my pen made it more comfortable for users and after using it they had less stress within their hand.

Conclusions/Discussion
The mechanics behind DOT prove to increase the efficiency of stippling and pointillism while the ergonomic shape makes for a much more comfortable and healthier way of drawing. I learned just how much the manual method of this art could be strenuous on the hand. My product helps those who have ailments such as arthritis to perform this form of art but also prevents such ailments due to the automation and ergonomic factors.

Summary Statement
DOT facilitates the process of pointillism, but also prevents as well as aids those of have ailments such as arthritis that are easily caused by the repetitive motion of the traditional method of this art form.

Help Received
None, I designed, built, and performs prototype testing myself.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Nicole M. Stokowski

Project Number

S0320

Project Title

Drive or Drag

Abstract

Objectives/Goals

The goal of my project was to determine whether driving force or drag force on an object has more of an affect on an object's speed in water.

Methods/Materials

A wooden boat equipped with a cutting board (to change the amount of cross sectional area or drag) pulled through the water by a string and wooden stake, attached to a spring scale (allowing me to measure the amount of force being applied). A timer was used to calculate the boat's speed at any given amount of force and drag.

Results

My experiment showed that both driving and drag forces have unique relationships to speed in water, and therefore cannot be compared outright. Driving force becomes more effective as cross sectional area increases and drag force becomes more effective when driving force decreases. For instance, in terms of driving force, at a 2% change in driving force there was over a 1% change in speed (when the area was 47.88 in^2). However, there was only a little more than 1/2% change in speed when the area was 10.50 in^2, at the same percentage change of driving force.

Conclusions/Discussion

From my project I began to understand the logic behind certain behaviors in swimming. I know from experience that swimmers will focus on different things depending on how far they have to swim, but I could never understand why. I understand now that because drag force has little effect at larger amounts of driving force sprinters don't often worry about it. Conversely, drag force has a much larger effect at lower amounts of driving force, so it would make sense that those who swim longer distances, at a slower pace, would focus on drag.

Summary Statement

I showed that Driving force and drag force have varying effects on the speed of object in water depending on the amount of each force present.

Help Received

I constructed and built the boat with some help from my dad. I also came up with the experiment and my dad helped me to find ways in which to expand my data set. I also received help from my physics teacher and student teacher, Mr. Fabini and Ms. Galloway, when I was trying create an experiment.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Megan T. Tang

Project Number
S0321

Project Title
Using Dropsonde Descending Speed to Determine Vertical Air Velocity in a Hurricane

Abstract

Objectives/Goals
The objective of this project is to derive the vertical air currents in hurricanes using a physics-based model to describe the dropsonde fall speed in still air.

Methods/Materials
Assumed dropsonde fall velocity in still air follows its terminal velocity and deviation in descending speed in real atmosphere is a result of atmospheric vertical motion. The drag coefficient for calculating terminal velocity was determined empirically by searching for the best fit fall speed in an altitude range that can be approximated as still air. Wrote MATLAB codes for model calculation, data analyses, and graphics.

Results
A total of 291 complete dropsonde measurements of Hurricane Joaquin were analyzed. The terminal velocity model fit 260 of them, or about 89%. The resultant drag coefficients from each sounding were used to derive the vertical air velocity from each sounding.

Conclusions/Discussion
Two factors affecting the accuracy of the derived vertical velocity were examined. One is related to the range of altitudes used to optimize the drag coefficient to simulate the drop speed in still air. The other is associated with the tilting and tumbling of the dropsonde that change the vertical cross-section area. It was found that any large errors may be associated with cases with extreme winds in the hurricane, while the majority of the cases show consistent drag coefficients throughout the measurement depth. Soundings in close proximity to each other also show consistent features of updraft and downdraft, indicating that the derived vertical velocity is physically consistent.

Summary Statement
I derived a method to obtain the vertical air velocity, an important physical parameter in hurricane development, from dropsonde measurements.

Help Received
I derived the drop speed model and the method to obtain drag coefficients. The dropsonde data was provided by my mentor.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Samrat Thapa

Project Number
S0322

Project Title
Accuracy of Novel Based Methods in Finding Blood Impact Height

Abstract

Objectives/Goals
My objective was to determine which, trigonometric method or stringing method is more accurate when finding blood impact height.

Methods/Materials
Simulation blood was absorbed by a sponge, which was then hit by a hammer to create blood spatter on a large sheet of paper for analysis. Same steps were repeated for two heights.

Results
After using blood spatter drops to gather basic data (angles, point of convergence, length/width of drops), both the trigonometric and stringing methods were applied in order to determine blood impact height. Upon comparing the average calculated height of the trigonometric data and stringing data to actual data, the trigonometric method had average of only 8.42% of error, leading the stringing method with 9% of error.

Conclusions/Discussion
From my project I concluded that the trigonometric method is more accurate when finding blood impact height than stringing method. The results may be accurate but in practical use both methods still need to be applied for better understanding a crime scene.

Summary Statement
I found out that finding blood impact height through trigonometric method is slightly more accurate than stringing method.

Help Received
My father, a physics instructor helped me in understanding basic physics concepts when figuring out blood spatter trigonometry.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Quang-Dan T. Tran

Project Number

S0323

Project Title

Innovative Magnetic Shock Absorber Concept for Machines and Vehicles

Abstract

Objectives/Goals

The common shocks absorbers for vehicles use mechanical springs as cushion with air, fluid as damping. My goal is to design a shock absorber using only magnetic force as cushion as well as damping. This will make the design much simpler, cleaner, and smoother in operation compared to the traditional approach. Also, the goal is to investigate if this magnetic shock absorber concept could be used in applications involved in axial, lateral, tangential, or radial motion directions.

Methods/Materials

For the scope of this project, the spring/shock absorbers were simply built using mechanical springs for cushion and air for damping. The passive neodymium magnets were used to build the magnetic shock absorbers. All structure components were built using plexiglas for visual inspection and the ease of fabrications. Testing fixtures were made to test magnet arrangement and performance in different designs either in axial, lateral, longitudinal, or radial motion direction to confirm the possibility of being able to make magnetic shock absorbers for these applications.

Results

The concept design was able to absorb shock load in as little as three cycles or less. The operation was smooth and quiet. The concept is scalable to different size and shapes. The testing results showed this concept worked in all arrangements to reflect axial, lateral, longitudinal or radial motion directions. Testing results were obtained showingthat magnetic shock absorbers always out performed the common mechanical spring/air set up, and the magnetic shock absorber with side damping features performed best.

Conclusions/Discussion

The new magetic shock absorber concept was simple in construction, used less materials, were quiet and smooth operation, and had less contact surface(less friction and wear). It worked well in either axial, lateral, tangential or radial motion. Also, the magnetic forces could pass through plastic enclosure making this concept very suitable in fluid and piping system. It allowed to have minimal instrusion of extra mechanical parts into the fluid line, if required. Further more, this concept also could be extended to be used as a speed reducer, as a angular stabilization, or as a center stabilization.

Summary Statement

By rearranging magnets to act as cushion and also damping, I have created an innovative shock absorber design concept could be used for machines and vehicles.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Suryaprakash Vengadesan

Project Number

S0324

Project Title

Carbon-MEMS Suspended Nanogap: Current Amplifying Working Electrode for Biosensor

Abstract

Objectives/Goals

Point-of-Care diagnostics demand for a versatile, inexpensive, sensitive, and simple-to-use electrochemical sensor. Currently, many products on the market use expensive optical detection techniques that require bulky, complicated instruments, when compared to electrochemical detection. Thus, I fabricated a novel working electrode utilizing the electrochemical redox coupling phenomenon which enhances and amplifies the generated current for selective detection of biomarkers.

Methods/Materials

Utilizing scalable microfabrication techniques including Electromechanical Spinning, pyrolysis of UV-cured microstructures and a Joules heating process, I was able to produce inexpensive and scalable working electrodes. I proceeded to run COMSOL Multiphysics simulations to analyze the effects of various geometries on the performance of the electrode, simulating and running Cyclic Voltammetry experiments for the detection of ferricyanide. With proper sample preparation and integration into a Lab on Chip device, the electrochemical sensor can be used for early stage cancer detection, bacteria detection, antibiotic susceptibility testing (AST) and other diagnostic applictions.

Results

Merging inexpensive manufacturing techniques, I was able to control the length and position of glassy carbon nanofiber. By inducing high biases through the CNFs, gradual fiber thinning and eventual breakdown resulted in a working electrode with sub 100nm gaps to manipulate nanoscale objects. The Cyclic Voltammetry simulations and experiments quantify the electrode#s high sensitivity and ability to detect ultra-low concentrations of analytes.

Conclusions/Discussion

The electrochemical properties of the nanogap, which were computed through mass transport simulations, illustrate the effect of nanogap size and CNF#s diameter # both increasing current density. Furthermore, calculated surface concentrations confirmed the low limit of detection, ideal for commercial use.

Summary Statement

I fabricated nanometric electrodes from carbon nanofibers and performed electrochemical simulations & experiments to quantify their high selectivity and ability to amplify signal current while maintaining an inexpensive price.

Help Received

Professor Marc Madou, Ehsan Shamloo, and Dian Song supervised the progressions of this project and provided useful discussions.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Ashwin Viswesvaran

Project Number
S0325

Project Title
The Making of a Maker: How I Built My 3D Printer

Abstract

Objectives/Goals
Main aim of my project was to create a 3D printer mostly using recycled computer parts. Another objective was to do this within a budget of $150. Functionally, the goal was to be able to print a 16mm cube perfectly (within the margin of error) without any issues.

Methods/Materials
Two DVD drives and a Floppy drive from old computers provided the 3 stepper motors and the housing needed to drive the X, Y and Z-axes of the printer. Other off-the-shelf 3D printing parts include the hotend, extruder and the Arduino Mega 2560 microcontroller which was paired with RAMPS 1.4 controller board.

The hardware specs allowed for a max print volume of 34x34x16mm. The hotend with 200C rating allowed PLA plastic to be extruded.

Open source Marlin firmware and Open source Repetier 3D printing software were used as well.

Results
The printer works by receiving a 3D model from a file and slicing it into multiple layers which are created one at a time with appropriate movement of X and Y axes. When a layer is done, Z axis moves up a layer high to start the next layer. This meant obtaining a close enough alignment of the three axes perpendicular to one another and printing surface parallel to the resting surface.

After many cycles of calibrations both at the Marlin firmware level and the Repetier 3D printing software level to map the physical distances to motor steps, I was able to print a near perfect 16mm cubes realizing my set objective.

Conclusions/Discussion
In conclusion, my project was a success as I was able to print several other objects with very high resolution beyond the set objective of printing a 16mm cube. The printer design is very versatile and will allow some easy modifications to meet my future needs. The project clearly demonstrated to me that not all highly advanced technologies have to be expensive or complex to build or use if right design principles are applied while creating them.

Summary Statement
I built a fully functional 3D printer using some old computer parts, some off-the-shelf parts and a budget of $150.

Help Received
I obtained useful tips from my mentor Dr. Wilmot. My father helped me with the needed complex woodwork & tuning.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Natalie C. White

Project Number

S0326

Project Title

An Altitude Control System for Long Duration, High Altitude Balloon Flights

Abstract

Objectives/Goals

The primary objective of this project is to design, build, and test an altitude control system for high altitude, long duration weather balloon flights. Ordinarily, weather balloons are filled with enough helium so that they rise rapidly to maximum altitude and burst in less than two hours. This ensures that the balloon does not drift very far from the launch site and makes recovery easier. However, this technique does not allow data to be gathered over long time periods or at specific altitudes. An altitude control system would enable flights of many days over thousands of miles. The secondary objective is to develop an electrical system with solar panels and rechargeable batteries capable of providing power for multi-day operations. Last, the balloon should send telemetry and be trackable anywhere on the planet, over both land and sea.

Methods/Materials

The vertical speed of a balloon can be controlled by venting helium or by releasing sand ballast. My altitude control module consists of three Arduino Mini Pros (Primary, Secondary, and Reset), a GPS, and an SD card for data storage. The GPS unit sends time, coordinates, and altitude data to the Primary which then calculates the average vertical speed. The Primary sends the altitude and vertical speed to the Secondary and this data is used to operate the helium and sand valves, as needed. Linear functions of the form, $t = a+bv$, where v is the vertical speed and t is the valve opening time, were used to control the valve operation. Computer simulations were used to determine workable values for a and b.

Results

To date, one flight has been made to test the altitude control system. The plan was to ascend to 8,000 m and then maintain this altitude for four hours. Although helium was released during the flight, the ascent rate was not brought under control before the balloon burst at 25,885 m. The electrical system and GPS trackers worked as expected.

Conclusions/Discussion

Further simulations and ground testing will be conducted and the results used to improve my software and equipment. Once improvements are made, another test flight will be conducted. My long term goal is to fly a weather balloon around the world while recording cosmic ray counts, track the balloon during the entire flight, and then recover the equipment at the end of the flight.

Summary Statement

My goal is to develop a weather balloon altitude control system that will make it possible to make long duration studies of cosmic rays on an around the world flight.

Help Received

My sand ballast bottle was made by Mr. David Bezinque using the 3D printer at the Fresno State Physics Department. Paul McWhorter#s tutorial on the Arduino GPS tracker was helpful. My father taught me how to program an Arduino and helped to get my program working.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Harlan I. Wiitala

Project Number

S0327

Project Title

Innovative Thermal Regulation Device for Small Satellites Using a Phase-Changing Substance

Abstract

Objectives/Goals

A CubeSat is a small satellite, where 1U, measures 10cm^3. These satellites can be built in different sizes, such as 1U, 2U, etc. They serve a variety of functions including technology demos and Earth imaging. The first CubeSat missions had short lifespans. More recently, these satellites have been proposed for complex endeavors such as interplanetary missions. A combination of on-board electronics, the sun#s radiation, the Earth#s own infrared radiation and albedo radiation causes these small satellites to overheat and damage important components and avionics and can lead to a total loss of the satellite. It is therefore necessary to ensure that satellites will function for extended periods.

Methods/Materials

The device proposed in this project is designed for use in micro-class satellites and can be scaled for larger satellites. A rectangular vessel with hollowed halves was created using a CAD software. Each half was filled with melted paraffin, then screwed to seal the container after the paraffin cooled. Filling with liquid paraffin maximized the mass inside the vessel and also prevented possible leakage due to change in volume expansion during phase change. Paraffin has a melting point lower than the critical temperature of most on-board electronics, and can be used without damaging the aluminum casing. Measurements using a controlled heat source were used to confirm heating properties. Three methods were used to corroborate temperature data.

Results

Paraffin provides sufficient phase-changing performance at low powers. The first test was consistent with a heat curve that demonstrated the heat of fusion of paraffin. Further energy input after this point caused the temperature of the device to increase. This is explained by the energy required to break the bonds for the phase change from solid to liquid (consistent with calculations for the heat of fusion). Data supported this expectation.

Conclusions/Discussion

The device was found to be suitable for applications below 10 W. It can dissipate excess heat into the paraffin's bonds during melting. This energy is released by the paraffin and the casing temperature, decreases. This can keep sensitive electronics from overcooling. Next efforts focus on increasing the paraffin-to-casing ratio in order to increase the energy storage capabilities of the device. Future experiments should be performed in vacuum to test the device in realistic conditions.

Summary Statement

The project studies the characterization of a device designed to store and dissipate heat away from sensitive electronics in small satellites.

Help Received

Equipment used were purchased with support from the Oak Grove High School Science Department and from suggestions from Jennifer Claudio, Science Research instructor. Feedback was received from judges at the NCCAVS Symposium and previous qualifying fairs (SCVSEFA).

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Tristan H. Williams

Project Number
S0328

Project Title
Efficiency of Swept Wings

Abstract

Objectives/Goals
The objective of this study is to learn what sweep of wing has the greatest lift to drag ratio.

Methods/Materials
3 different wings, a fuselage, a wind tunnel.

Results
Each of the wings was tested within the same wind tunnel and at the same wind speed. After testing both the lift and the drag multiple times on each, the forward swept wing finalized with the greatest lift to drag ratio.

Conclusions/Discussion
To within the accuracy of the measurements, the lift between the swept wings were the same while the straight wing had significantly less, while the drag was greatest with the reverse swept wing and least with the forward swept wing. I then concluded that the forward swept wing was the most efficient for it had the highest lift to drag ratio.

Summary Statement
I showed that the efficiency of a forward swept wing was greater than the other wings by use of a wind tunnel.

Help Received
A good friend of mine helped me build the wings, I was educated on the use of the school wind tunnel from my Pre-Engineering teacher, and I received help editing from my mother.