Name(s)
Arhana V. Aatresh

Project Number
J1001

Project Title
Up, Up, and Away: The Effect of Substrate Type, Substrate Temperature, and Load on Hover Engines and Hovering Efficiency

Abstract

Objectives/Goals
The objective of this experiment was to determine the order of energy efficient conditions for hover engines by varying the type of substrate (surface below them), substrate temperature, and payload on the Whitebox (the box with the hover engines).

Methods/Materials
The Whitebox was tested with all combinations of substrate type (aluminum and copper), temperature (room and cold, the metals being frozen in a freezer), and payload (none, 500 g, and 1000 g). The Lithium Polymer battery was balance charged to 3.75 V, and the battery alarm was set to ring when the battery reached 3.4 V. These two materials were plugged into the Whitebox. A stopwatch recorded the duration of time between the start of the trial and the moment the alarm rang.

Results
The Whitebox was tested under all different conditions. The most efficient condition was room temperature copper with no weight, and the least efficient condition was cold aluminum with 1000 grams weight. Aluminum, cooler temperatures, and increasing load reduced hover engine efficiency. Copper, room temperature, and decreasing load increased hover engine efficiency.

Conclusions/Discussion
All conditions affected hover engine efficiency. Copper is more conductive than aluminum, room temperature metals are still less electrically conductive than cooler ones but work more efficiently with the hover engines than cooler metals, and increasing weight strains an object. Different conditions can increase the efficiency of magnetic levitation with eddy currents.

Summary Statement
This project served to determine the most efficient conditions with substrate type being copper, substrate temperature being room temperature metals, and load on hover engines being no weight for hovering.

Help Received
Mr. Greg Henderson from Arx Pax gave me the materials and advised me about the Whitebox.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Saivee Ahuja

Project Number
J1002

Project Title
Smart Mirror: An Informative Mirror that Displays Date, Weather, and Homework Data

Abstract

Objectives/Goals
Problem: How can technology be used to make a hectic morning easier?

Solution: A smart mirror can be built by designing an HTML page which is displayed on a mirror. The mirror contains weather information and assignments.The useful information exhibited can make mornings more relaxed.

Methods/Materials
For my project, I used a monitor which displays an HTML webpage, a laptop with python (a programming language) installed, a custom shadow box built to the size of the monitor, and a two-way mirror which acted as both a glass and a mirror. Datetime javascript displayed the current date and time as well as auto-update information to keep the page running in real time. A CSS file formatted the display. Also, Accuweather's developer API fetched the forecast and other weather information in JSON format. I took the homework information from the teachers Weebly sites.Finally, Beautiful Soup parsed the information from the teachers' web pages and extract the day's homework.

Results
A python script was written to create a webpage which is the format of the mirror. The webpage and mirror both displayed the date, time, and weather. Along with the weather, it displayed the suitability of certain activities and assignments from two classes. The design became more appealing when clipart images were added next to each of the various activities. The scripts were all searchable online, and for weather, accuweather.com was used. The webpage was displayed on the monitor, and a two-way mirror was attached to the monitor and framed. On the bottom, the homework assignments from two classes were shown. The homework for one class was shown for 5 seconds, then the homework for the other class was shown for 5 seconds, and the two were looped. Ultimately, the mirror displayed beneficial information in a sleek design.

Conclusions/Discussion
After finishing this project, it is much easier to interpret programming language. Weather icons can be added to the weather side to depict a certain forecast, such as a sun for a sunny day. Later on, instead of connecting a Mac to the monitor, a raspberry pi can be used, as it is far smaller and much more portable while still serving the same purpose as a laptop computer. It could also be voice controlled or gesture controlled. The basic idea and design of a smart mirror can be expanded on to create something that would largely impact the world of technology.

Summary Statement
An HTML page was developed which contained weather information, the date and time, and homework data, and was displayed on a mirror from a monitor.

Help Received
I developed the script myself, but received help to implement the desired functionality by my dad, Mr. Ahuja who is a Hardware Engineer.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Harjaisal S. Brar

Project Number
J1003

Project Title
Blocking RFID Readers

Abstract

Objectives/Goals
The objective of this project is to determine which metal blocks RFID reader from reading RFID tag the best.

Methods/Materials
I first downloaded Serial Terminal Emulator software and the Parallax RFID drivers on my computer. I glued 2 acrylic tubes to each of two acrylic plates. I used a powered metal shear to cut each metal sheet to a size of 8.5 cm x 5.5 cm. I screwed the RFID reader to one set of tubes, and I mounted the RFID card on the other set. I used rubber bands to attach the copper sheet to setup with RFID card. I taped a ruler to my work surface and moved the setup with the RFID reader to 0 cm mark. Starting from 1 cm away, I moved the setup with the RFID card and metal back until the card couldn't be read. I recorded the maximum distance the card could be read at, in cm. I repeated this with other metals (brass, silver, nickel, stainless steel, control). I recorded data and analyzed it.

Results
I observed that with copper, the mean distance was a about 4.6 times the control. With brass, the mean distance was about 3.4 times the control. With nickel, the mean distance was about 2.7 times the control. With stainless steel, the mean distance was about 2 times the control. With silver, the distance was about 1.6 times the control. Results show that copper blocked RFID reader from reading RFID tag the best, followed by brass, followed by nickel, followed by stainless steel, followed by silver, and the control.

Conclusions/Discussion
In conclusion, my hypothesis was correct. Copper did block the RFID reader from reading a tag the best. This is most likely due to the absorption of the electromagnetic waves by the copper sheet.

Summary Statement
I showed that all the metals I tested had a blocking effect on the electromagnetic waves emitted from the RFID reader.

Help Received
My dad supervised me while using the powered metal sheer, and my mom helped me purchase supplies.

Name(s)
Isabella Correa; Gwyneth Prata

Project Number
J1004

Project Title
The Ever-Last Battery: Building a Super Long Lasting, Self-Recharging Battery through the Capture of Radio Waves

Abstract

Objectives/Goals
Our objective was to create a battery that would harvest radio frequencies in order to continually charge a crystal battery so that it could possibly last forever.

Methods/Materials
We made crystal batteries by blending together equal parts of borax, Epsom salt, potassium chloride, and Alum. We melted the mixture around a 16mm magnesium rod encapsulated by a 1 1/4 inch copper tube. We tested our battery with a voltmeter to confirm charge and repeated the processes 3 times. Next we created a radio antenna to capture radio waves from the environment. We did this by wrapping 100' of copper wire around a 2 inch black PVC pipe and then added a metal hanger to create an antenna. We also added a rectifying diode to convert our A/C electricity captured from our radio wave harvester to D/C for our homemade crystal batteries.

Results
We were able to get an average of 1.47 volts per homemade crystal battery. We connected 4 batteries in series and were able to light up a string of LED lights for 2 weeks nonstop. After 2 weeks we disconnected the batteries and tested them with our voltmeter and realized the batteries lost about half of their volts. After 2 hours of resting, we re-tested the batteries and noticed that they fully recharged themselves. We plugged our batteries back into our LED strip and they stayed lit for two more days. We then built a radio frequency receiver and attached the antenna to our batteries. After some trial and errors, we were able to add additional charge to our crystal batteries.

Conclusions/Discussion
Our Science project was very successful. We were able to create batteries that recharged themselves and lasted several weeks while being continually used. And once we disconnected the draw from the batteries, our batteries rejuvenated themselves after a couple of hours and were able to be used again. Adding the RF antenna helped power up our batteries faster. It is our hope that someday homes can have RF antennas on their roofs, which will be attached to a battery source inside a home so that people can charge their small electronics like cell phones, remote controllers, and other items that use batteries. In conclusion, we believe that harvesting radio waves can be a new source of free, clean, renewable energy. Our crystal batteries will also reduce the toxic waste in our landfills buy limiting the need to purchase acid batteries.

Summary Statement
We created crystal batteries that are able to recharge themselves through the capture of radio waves based on the works of Nikola Tesla.

Help Received
Ryan Hickman helped with soldering our circuit boards as well as the wires to our copper tubes for our batteries.

Name(s)
Dasiy Ding; Vikas Ramasubban

Project Number
J1005

Project Title
Exploring a Method for Cell Phone Signals to Penetrate Energy Efficient Windows

Abstract

Objectives/Goals
The objective of this project was to design a prototype of a heat-reflecting energy efficient window that does not block cell phone signal (radio waves). In every energy efficient window, there is a thin film of conducting material that blocks infrared radiation (heat) from penetrating the window. The challenge is that, while energy efficient windows aim to block infrared radiation, it also blocks all electromagnetic radiation that has a lower frequency than that of infrared waves, including cell phone waves.

Methods/Materials
A building was simulated by a cardboard box wrapped in aluminum foil. One side was cut open. The energy efficient window prototypes were put above the open side of the box for each test. A regular piece of glass was wrapped with aluminum foil, which simulates the energy efficient window coating. This is effective because both materials block infrared and radio waves. We cut the aluminum foil in different designs and tested how much cell phone signal was received with an iPhone 4. Depending on results in the tests, we made changes to the size, shape, and pattern on the aluminum foil to improve the cell phone signal.

Results
Our Grid C prototype was able to let in nearly the same amount of cell phone signal as with a regular window. Grid C was also able to greatly reduce the transfer of heat through radiation because only around 10% of the aluminum foil was removed.

Conclusions/Discussion
In this project, we have designed a prototype (Grid C) that was able to effectively block nearly all heat radiation (infrared radiation) yet still allow essentially all cell phone signals (radio waves) to pass through. Such design could potentially be manufactured and introduced to the market. In addition, we have designed a new experimental method for testing radio and infrared radiation using aluminum foil wrapped glass instead of actual energy efficient windows. It is not only more efficient than before, it is also more accurate.

Summary Statement
We created an energy efficient window prototype that not only blocks heat (infrared) radiation to save energy, but also allows cell phone signals (radio waves) to penetrate.

Help Received
We built the energy efficient window prototype by ourselves at home and got help from Guowen Ding (Partner's Dad) to help explain the theory behind the energy efficient windows.

Name(s)
Vedansh Goenka

Project Number
J1006

Project Title
Lock That Can Operate Using Three Mechanisms: Magnetic Key Combination, NFC Card, and Remote IP Network

Abstract

Objectives/Goals
Build a prototype lock that replicates the multiple modes of operation common in today's smart locks, but one that is secure, and can be designed and printed with readily available tools and components such as 3D printers, magnets, Raspberry PI, a simple DC motor, a hotel key card, and so on.

Methods/Materials
Tinker CAD for 3D design of the lock. 3D Printer for printing the lock. Strong magnets purchased online and glued to operate. Raspberry PI kit and an NFC reader to operate a DC motor, assembled with a number of step-up gears salvaged from Lego set. Python code samples and sample audio files found online to program Raspberry PI and turn the motors with the tap of an NFC card key recycled from a hotel room key, and portable speaker to provide audio confirmation.

Results
Building a working engineering prototype requires several iterations and precise connection between parts. For instance, turning a motor to move a lever by an exact amount requires computing how consistent and accurate the motor turns, and reducing the noise through a system of gears.

Conclusions/Discussion
This project was really about overcoming a large number of engineering and design challenges in creating a repeatable locking mechanism that survived multiple iterations of testing to ensure it was reliable, quick to operate within 10 seconds, and allowed me to learn and explore several faculties, including programming a Raspberry PI. I learnt a great deal about practical 3D design, one that can be used to create a solid working prototype. I also learnt how to accomplish a goal through trial, error, and discovery with online resources.

Summary Statement
I designed, 3D printed, and assembled a mechanical lock that operates in 3 ways (1) mechanically using combination of magnetic taps (2) an NFC card tapped on an NFC reader connected to Raspberry PI (3) Remote login from a phone or computer

Help Received
I designed, built, and assembled the prototype myself. I searched online for sample computer programs. My dad reviewed and explained python programming and remote login concepts.

Name(s)
Roy C. Gross

Project Number
J1007

Project Title
An Emergency Communication Mesh Network for Civilians: Lessons from Puerto Rico

Abstract

Objectives/Goals
Motivated by the communication failure in Puerto Rico, I designed a low-cost, portable, person-to-person, communication network called WAEF-EL. The goal is to let civilians communicate with one another using their smartphones without relying on cell or Wi-Fi signals, or external power. It was designed to be self-contained, easy to use, rugged, and cost less than fifty dollars.

Methods/Materials
I designed a prototype on a breadboard, using an Arduino Uno, a small VHF radio, and an Android App that I wrote to control the unit. Once this was working, I built two mobile units using the smaller Arduino Nano, self-contained power systems, and prototyping boards. I placed them in waterproof cases. Debugging the units was difficult, requiring many experiments and tools, like voltmeters, oscilloscopes, and audio wave analysis software.

Results
Test 1: Unit-to-Unit Field Test. One unit was stationary, while the other was in a car which drove around the neighborhood. I tracked communication between the units and analyzed the resulting GPS data.
Test 2: Mesh-Network test. I created a simple Y-shaped mesh network shape, using the two WAEF-EL units I made, plus two additional radios which could only receive the data. I successfully propagated a message through the network.
Test 3: Satellite Communication. I located an APRS satellite using free software, aimed an antenna at the satellite, and sent a message from a WAEF-EL unit. It was received by the satellite and retransmitted back to Earth. An amateur radio operator 800km away received the message and posted it online to confirm the contact.
Test 4: Battery Life. I modified one unit to auto-transmit a message every ten minutes. I built a voltage logger and tracked the system voltage. It performed reliably for 18 hours until the battery voltage fell too low and the radio stopped transmitting.

Conclusions/Discussion
Inspired by the events in Puerto Rico, I designed and built a low-cost emergency communication system. My system allows people to use their existing cell phones to communicate with each other when all other systems are down.
The final design requires no external power. It is rugged, waterproof, and costs about fifty dollars. I demonstrated unit-to-unit communication, LEO satellite communication, and propagation across a mesh network.

Summary Statement
Motivated by the communication failure in Puerto Rico, I designed a low-cost, portable, person-to-person, communication system.

Help Received
The author of a programming library gave me advice on how to properly use the library.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Fatimah Ismail

Project Number
J1008

Project Title
Developing an Artificial Pancreas: Dealing with Diabetes

Abstract

Objectives/Goals
The objective of the project is to create an artificial pancreas and provide a solution to increase efficiency of the closed-loop system.
It is tested to see if it can model a real pancreas and tested on different levels of pH (modeling glucose and insulin).
The goal is to find an optimum range of the difference in the pH of the modeled solutions that will reduce dangers involved with incorrect dose of insulin for a Type 1 diabetic.

Methods/Materials
A conductivity sensor is designed using plastic straw, copper wire, and Styrofoam. The artificial pancreas is designed on a breadboard using resistors, jumper wires, potentiometers, MOSFET, and AA batteries. The conductivity sensor is connected to the artificial pancreas using alligator clip wires. The artificial pancreas is tested using vinegar and baking soda modeling insulin and blood sugar levels. Peristaltic liquid pump with metal leads is used. The resistors form voltage divider. The potentiometers and conductivity sensor form a voltage divider. The output of the second voltage divider is equal to the voltage of the gate on the MOSFET. The voltage divider controls whether the gate conducts energy between the drain and source. When pH of the solution turns 7, the conductivity sensor senses and the MOSFET turns off so current doesn't flow and the pump turns off.

Results
The conductivity sensor senses the solution with pH above 7. The pump starts to run and neutralizes the pH of the solution to 7 and stops. This happens 50 times, which means the pump works. The pH of vinegar solutions ranged from 2.5-6.5 and that of baking soda were 6, 6.5, 7, 7.5, and 8. I observed that if two sets of vinegar and baking soda solution have same difference in pH levels, the time taken to neutralize the solutions are same.

Conclusions/Discussion
The artificial pancreas met all requirements in the engineering goal. It sensed the low pH making the pump run, which operated 50 times. Another observation is when the difference in pH and time taken to neutralize the solutions are plotted on x-y plane, the graph is a straight line. There is a linear correlation between difference of pH levels of solutions and time to neutralize the solutions. Correlation is modeled by the equation $y = 3.75x - 0.01$ with $r^2 = 1$. From the correlation line, it is concluded that if we can maintain the difference of the pH level at some central tendency, the risk of Type 1 diabetes can be minimized.

Summary Statement
I created and tested an artificial pancreas using various pH levels of baking soda and vinegar (modeling glucose and insulin); linear correlation was found when difference of pH and time to neutralize the solutions were plotted on x-y plane

Help Received
I designed the project and conducted the experiment independently. My science teacher guided me through this project and reviewed my results.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Kunal Jain

Project Number
J1009

Project Title
An Earthquake Warning System

Abstract

Objectives/Goals
The purpose of this engineering project was to develop a warning system which would detect, measure, and alert everyone in the building based on the intensity of the impending earthquake.

Methods/Materials
Raspberry PI with audio library installed, mini speaker, sensor module(accelerometer), EV3 lego kit, and rubber bands. I used the EV3 kit and rubber bands to build an earthquake simulator to test different sensor configurations with Raspberry Pi.

Results
The device I built can alert people with the appropriate warning message 100% of the time, and can measure earthquake intensities with only 5% error margin.

Conclusions/Discussion
I have invented an earthquake warning system by using a Raspberry Pi, speaker, and an accelerometer. The system is capable of detecting different earthquake intensities based on the Mercalli Scale. The Mercalli intensity scale is a seismic intensity scale used for measuring the intensity of an earthquake. Using the accelerometer sensor, a Python software, running on the Raspberry Pi, detects the earthquake and sends an appropriate audio alert to a wired speaker. My system is able to detect earthquakes in an area like a room or a building and can alert the people inside so that they can evacuate. I have used sensor technology and computer programming to build a user-friendly device for this application.

Summary Statement
I have invented a device that can detect, measure, and then based on the intensity, sound an alarm through the area.

Help Received
None, I programmed, built, and experimented for this project all by myself.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Michael R. Julian

Project Number
J1010

Project Title
Renewable Energy Generation Using a Fidget Spinner

Abstract

Objectives/Goals
My question for my science fair project was 'Can I turn mechanical energy into electrical energy using a fidget spinner?'. I recorded the voltage I was producing from my fidget spinner generator by connecting the output to an oscilloscope. From the voltage I calculated the speed of the fidget spinner. recorded the graphs I had collected from the oscilloscope into my notebook for further analysis.

Methods/Materials
Create a structure to keep the fidget spinner stationary using 2 longs bolts and 2 little bolts. Place 2 permanent magnets in each of the 3 fidget spinner holes using a hot glue gun. Wind as many coils in the stationary part of the fidget spinner. Put as many turns as possible to obtain maximum output voltage. Connect output to an oscilloscope to record data. Spin the fidget spinner with your finger. Download the recorded data of the voltage produced by the fidget spinner generator. Analyze the data and compute speed. Add a super capacitor and a switch to the circuit. Calculate the amount of energy in Joules being stored into the super capacitor. Graph the data. Calculate the energy in Joules required to charge a small electronic device, such as an iPod or kindle.

The materials I used to test my hypotheses were a fidget spinner, 6 permanent magnets, 2 ferrite cores and miscellaneous circuit elements.

Results
The fidget spinner generator successfully produced 'green' electricity.
The first set of experiments showed that I could turn on a LED only for a second or so, so I created a second hypothesis and a second experiment. Adding a super capacitor and a switch, I was able to store the energy I was producing from my fidget spinner into the super capacitor. Then using a switch I was able to release that energy into the LED. I observed that the LED emitted light for a longer period of time. I calculated the energy produced and compared it to the energy needed to power small electronic devices.

Conclusions/Discussion
In this project I attached 6 permanent magnets to the holes of a fidget spinner and I built a generator to produce electricity from spinning the fidget spinner through 2 sets of copper coils. I then proved that my first hypothesis was correct: I could turn mechanical energy into electrical energy using a permanent magnet fidget spinner.

Summary Statement
I was able to turn mechanical energy into electrical energy using a permanent magnet fidget spinner and then I stored the energy for future use

Help Received
My mother and father explained the physics of electromagnetic induction to me and helped me build my permanent magnet fidget spinner generator.

Name(s)
Parisa N. Khashayar

Project Number
J1011

Project Title
Microcontroller Based Fire Fighter Assist Unit Using IOT: An Innovative Approach to Rescue the Rescuers!

Abstract

Objectives/Goals
Wild-land fire fighting can be a dangerous occupation. Heat stress, fatigue, respiratory hazardous issues due to smoke inhalation, and cardiac related events are the top most causes of fatality with fire fighters. The purpose of this project is To create a wearable device to be worn by fire fighters in the field.
1. To detect heart rate, motionlessness, surrounding temperature and gas level.
2. To send the measured data and potential warning to an outside team of responders via text massaging (GSM)

Methods/Materials
Sensors such as temperature, gas, motion and heart rate monitor, can be fire fighter's eyes and ears to help detect potential dangerous condition. Using Arduino and the above sensors, and software algorithm, I can monitor the environment as well as the condition of the fire fighter and make quick decision to warn them of danger. Once the sensor detects an abnormal measurement of heat, gas, or movement or heart rate, then it will check to find out the state of other sensors. The truth table in the program will set the threshold for each sensor to decide the presence of danger and issue a warning using (GSM cellular).

Results
I was able to repeatedly measure the increase of temperature and gas using a picnic stove as a source. I attached the motion and heart rate sensor to myself and my sister and measured the values while sitting and running several times. Tests show that my device is able to detect measured data from all four sensors accurately. The algorithm I used can collect the fire fighters' heart rate and motion as well as the rapid change in heat and gas surrounding them. The thresholds set in the software can decide in real time and send a text to another mobile phone using GSM.

Conclusions/Discussion
The capability of fire fighters to continuously detect, monitor and analyze thermal and environmental threats in real time and quickly respond, is out most important factor to decrease their number of fatality and injury.
I hope to be able to show that even with off the shelf everyday electronics we can put together a portable, battery operated system to help give our fire fighters an upper hand when battling raging fires. This complete unit can be placed inside fire fighter's fire retardant jacket and carried around with minimum effort.

Summary Statement
The purpose of my project is to decrease the rate of fatality and injury of fire fighters by using a wearable device that can detect heart rate, motionlessness, surrounding temperature and gas level and send a warning text using GSM communi

Help Received
My dad helped me learn C language.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Spencer T. King

Project Number
J1012

Project Title
Magnetic Levitation: Reducing Train Friction with Track

Abstract

Objectives/Goals
The purpose and objective of this project is to see if magnetic levitation (maglev) trains are faster and more efficient than conventional trains. The hypothesis is that the repelling magnets will reduce the friction of the wheels, enabling the magnetic train to move faster than the conventional train.

Methods/Materials
While many designs were tested, the final design of this experiment compared the speed of a train with both magnets and wheels, when it was on a conventional track, and when it was on a magnetic track. The strength of the repelling magnets was too strong for the guide rails: weight was added to make wheels touch the track, and create a friction reducing train using magnets.

Results
The time it took the train to travel the length of each track, which were the sames lengths, was recorded. The results consistently indicated that when the train was on the magnetic track, it traveled faster than when it was on the conventional track, when the same force was applied to both trains.

Conclusions/Discussion
This project demonstrated and proved why magnetic levitation trains are faster than conventional trains, which is because of reduced friction. While there are maglev trains in countries such as Japan and Germany, maglev trains trains are not widespread. If they were, they would help save energy and decrease the waste emissions of transportation. This is because maglev trains do not use fossil fuels, but rather electricity that can be derived from natural and renewable sources, such as solar, wind, and water energy.

Summary Statement
I created a train that was compatible with both a magnetic track and a conventional track to show that the magnetic track helps to reduce friction and increase the speed of the train car.

Help Received
My dad assisted in the cutting of the groves in the board that the track magnets were placed in because it required a special saw blade and the blade needed to be tilted at a certain angle in order to cut the right sized grooves.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Justin N. Levy

Project Number
J1013

Project Title
Building a Smart Home for Less than 250 Dollars

Abstract

Objectives/Goals
My objective was to create a smart home for less than 250 dollars. I set out looking for an inexpensive solution and discovered there was nothing established and budget friendly. This system was built to help the average person attain a smart home that is both practical and feature rich. Additionally, this smart home system can provide the consumer with added safety and energy efficiency. I achieved my objective by using inexpensive and widely available devices and open source programs.

Methods/Materials
I started out by creating a small server by downloading Open Habian, an open source operating system, and editing the source code using Notepad plus plus to add wifi connectivity onto the server. Then, I flashed the OS onto a MicroSD card which was inserted into a Raspberry Pi. I was able to boot up the system and set up the MQTT Broker to allow connection of the smart home devices. Next, I soldered pins onto the Sonoff switches and then wrote my own firmware to use on the Sonoff devices, so they would connect to the MQTT broker. I wired the Sonoff in order to connect it to the electricity in my home. Next, I added a switch into my server's code in order to tell the MQTT broker to turn on or off the devices. I bound the D-Link motion sensors to the Open Hab server. Next, I wired the magnetic door sensors onto a ESP8266 board using a custom PCB. I coded custom firmware for the ESP8266 and flashed the program onto it. I bound a Google Chromecast to the Open Hab server. The smart home devices connected to the hub included: 4 Sonoff Basic switches, 3 D-LINK motion sensors, 2 magnetic door sensors with ESP8266 boards and a Google Chromecast. Lastly, I installed the devices in my house and tested their connectivity and operation thoroughly and made any necessary corrections to the system.

Results
Through my research and time spent with the home automation devices, I was able to show that it is possible to build a fully featured smart home for under my budget of 250 dollars.

Conclusions/Discussion
This smart home system was fully automated to allow me to control the lights in my home from anywhere in the world, via cellphone or computer. It also enabled security features to protect my home from unexpected motion. I was able to create a budget friendly smart home with comparable features to a professionally installed retail system.

Summary Statement
I built a smart home for less than 250 dollars with comparable features to a professionally installed retail system.

Help Received
I designed, built and programmed my smart home project myself. My dad made sure my wiring was safe before plugging it in.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Luis F. Lupercio

Project Number
J1014

Project Title
The Gauss Rifle

Abstract

Objectives/Goals
My project's goal is to study the following question: Does the number of neodymium magnet stages affect the projectile distance and velocity of the steel plated ball bearings?

Methods/Materials
Procedure to build Gauss Rifle
Glue the two wooden dowels together.
Wait until completely dry.
Put finished Gauss rifle on table with ample space.
Procedure to set up Gauss Rifle and test
Place neodymium magnets first on the dowels.
Place nickel plated steel balls before the neodymium magnets.
Once set up, roll the steel ball down the surface so the magnets connect and launch.
Once projectile stops take tape measure and measure distance.
Track distance in lab book.
Repeat process with a different number of magnetic stages.

Results
The results of my tests show that more magnetic stages do increase the projectile distance of a steel ball.
One magnetic stage
-Least Distance: 0.635 meters
-Greatest Distance: 1.3208 meters
-Average Distance: 1.04926
Three magnetic stages
-Least Distance: 1.2192 meters
-Greatest Distance: 1.7018
Average Distance: 1.50368

Conclusions/Discussion
After completing my project on if more magnetic stages affect the travel distance of a nickel plated steel ball. I tested one to three magnetic stages for ten trials and in the end the more magnetic stages I had, the projectile distance would increase farther every time. In my hypothesis I had already knew that more magnetic stages would go farther than less, but I was wrong in how I thought the projectile would launch. Many times it would bounce back and I would have to retest because I wanted all my trials to be fair.

Summary Statement
In the end I learned that more magnetic stages do affect the travel distance of a little steel ball by making it go farther than with less.

Help Received

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Cody C.M. Orvis

Project Number
J1015

Project Title
Gaussian Linear Accelerator

Abstract

Objectives/Goals
Demonstrate the relationship between the number of magnet stages in a Gaussian accelerator and the distance and speed a steel ball travels.

Methods/Materials
Build a Gaussian linear accelerator with one through four acceleration stages and test the distance the ball travels off of a given table height onto a box of sand below. The velocity can then be calculated.

Results
Measurements taken and plotted of number of magnet stages vs. distance and number of magnet stages vs. velocity.

Conclusions/Discussion
The relationship between magnet stages and the distance traveled and the velocity of the steel ball is linear.

Summary Statement
My project is about demonstrating the transfer of kinetic energy using neodymium magnets and steel balls.

Help Received
Skip Orvis, Mrs. Susan Singleton, Mr. Doug Modlin

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Jyothikaa Ramann

Project Number
J1016

Project Title
The Posture Genie: "Better Posture, One Buzz at a Time"

Abstract

Objectives/Goals
My objective is to examine whether awareness of incorrect posture, communicated through as reminders, will induce a postural improvement among humans of all ages. Hypotheses:1)Posture Genie device helps users build an awareness of incorrect posture through persistent reminders generated by the device when they slouch. 2) Prolonged use of Posture Genie results in progressive and sustained improvement in overall posture and health.

Methods/Materials
The Posture Genie is a smart programmable device built to track and warn when you deviate from your correct posture. Posture Genie's base circuit is constructed with various chips, such as a Triple Axis Accelerometer and Piezo Vibration Motor. To use the device, attach it your shirt using a magnet. Position yourself in your best posture. By pressing the button, the device will buzz three times confirming calibration of your correct posture. The Posture Genie will gather your data and report your time in minutes per hour spent with good posture vs not. Use Posture Genie for one 12-hour period without vibrations to record your normal posture as a baseline. After, use the device for multiple 12-hour periods until you observe noticeably reduced or zero vibrations over contiguous periods.

Results
Posture Genie experiment was conducted among various users from wide range of age groups. Our experiment included 3 device trials for 12-hour periods excluding the baseline period. Subject A representing an age group of 10-20 years had an average of 56% increase in GPM(Good Posture Minutes) compared to baseline. Subject B, aged between 40 and 50 years had a 54% GPM. Subject C in 30 to 40 years age range had a 59% increase. Subjects E and F represented an older age range of 60-70 years who had a 44% increase. Without vibration reminders from Posture Genie they had an average of only 13 GPM per hour. But using the device in 3 experiments showed a 220% increase in GPM to an average of 28.6 minutes.

Conclusions/Discussion
The results of the experiment confirmed hypothesis #1 that use of The Posture Genie resulted in improving overall posture of users by increased awareness of their incorrect posture through persistent reminders. Results of the extended experiment on all subjects provides strong evidence to prove hypothesis #2 that use of Posture Genie provides progressive improvement and sustenance of good posture by a consistent increase in GPM.

Summary Statement
I used the Posture Genie device to test whether reminder and observation of postural imbalance can induce postural improvement and better health and body conditions.

Help Received
I built the circuit with the help of Shenzhen Ding Hao electronics in providing me with my basic circuit. My got help with the programming of the app. The subjects who volunteered in this project also helped in proving my experiment.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

Waleed W. Randhawa

Project Number

J1017

Project Title

Artificial Pancreas: An Automatic Insulin Delivery System

Abstract

Objectives/Goals

The objective of this experiment is to create an Artificial Pancreas using electronic components that is able to autonomously neutralize a baking soda solution using vinegar which represents high blood sugar levels and insulin respectively.

Methods/Materials

Developed an Artificial Pancreas using a solderless breadboard, a Metal Oxide Semiconductor Field Effect Transistor (MOSFET) and three potentiometers which regulated the speed of the pump. A liquid peristaltic pump was used to automatically pump vinegar into the baking soda solution until the latter is neutralized. In the experiment, the system was tested with four different concentrations of baking soda. The time the system took to neutralize the solution was recorded using a stopwatch and pH was measured using litmus paper and bromothymol blue.

Results

The Artificial Pancreas was tested with four different concentrations of baking soda per 200 ml of water. After completing more than 25 tests with each concentration, it was noticed that the solution took the longest amount of time when neutralizing a solution with 7.5 grams of baking soda and took the shortest time when neutralizing a 2.5 grams of baking soda solution. The Artificial Pancreas was most consistent when tested with a 7.5 grams of baking soda solution.

Conclusions/Discussion

The Artificial Pancreas effectively neutralized a baking soda solution without human intervention. It was proven the time the system took to neutralize the solution was directly proportional to the concentration of the baking soda solution. The Artificial Pancreas effectively neutralized four different concentrations of baking soda more than 85 percent of the time. In the future, this module has the potential to outperform current methods to normalize blood sugar levels in the human bloodstream and could be available for clinical use.

Summary Statement

An Artificial Pancreas was engineered using electronic components that aims to autonomously neutralize a baking soda solution using vinegar which represents high blood sugar levels and insulin respectively.

Help Received

I developed the Artificial Pancreas myself. My father explained the basics of electronic circuits to me. My science teacher, Mrs. Gillum, reviewed my results.

Name(s)
Nidhya Shivakumar

Project Number
J1018

Project Title
Spoiner Alert! An Arduino Sensor-Based Approach to Detecting Food Spoilage

Abstract

Objectives/Goals
Each year, approximately 600 million people fall sick and 420,000 people die from food poisoning. Often, people consume spoiled foods because there is no significantly visible sign of food spoilage. As foods decay, they give off gases such as methane, ethylene, and ammonia. The purpose of this study is to see if Arduino based sensors can be used to detect early food spoilage before signs are visible. Based on my research, my hypothesis is that, as foods decay, they emit certain gases which can be detected by arduino based-sensors, and the levels of these gases will vary depending on the extent of decay.

Methods/Materials
I used 3 arduino based gas sensors capable of detecting methane, ethylene and ammonia respectively. To measure food spoilage over time, an arduino circuit was assembled and placed inside an airtight container. A hole was drilled into the corner of the box and the wire to connect to the computer for data collection was run through it. The appropriate food items were placed into medium sized weighing boats, and equal weights of food was used for each test condition.The levels of methane, ethylene, and ammonia at the appropriate time points were recorded.

Results
The Arduino based gas sensors were able to sense gases well before visible signs of spoilage such as mold or odor were observed. The level of emissions of these 3 gases correlated with the degree of spoilage of food. The arduino-based gas sensors were sensitive enough to pick up low amounts of emissions of methane and ammonia which is generated by decaying food. When visible signs of decay started to show, the levels of the gas emissions were very high (>20-fold) relative to control. While I was able to observe these results in berries, the levels of gases in other foods that were tested such as rice and milk were much lower.

Conclusions/Discussion
Detecting naturally emitted gases such as Methane, Ammonia and Ethylene as foods decay can be used to detect food spoilage. The arduino gas sensors are able to detect gas emissions from food items even before the presence of any visible signs of spoilage. Using sensors to detect the presence of these gases among foods can help detect food spoilage early and prevent consumption of spoiled food. These techniques can be further developed to include other types of gas sensors and foods to increase the sensitivity of such detection methods.

Summary Statement
I created an arduino-based sensor system to prevent food poisoning by measuring the gases released during the process of early spoilage of foods.

Help Received
My parents purchased the materials required for the project and provided feedback on the experimental design.

Name(s)
Sangyani Sinha

Project Number
J1019

Project Title
Clean Your Air Now: An Indoor Air Pollution Control System

Abstract

Objectives/Goals
Devise software/hardware that can tackle the issue of indoor air pollution in the most optimized way: Assemble hardware with various readily available sensors and connect them to Arduino/Raspberry Pi, and write software that can measure, present, analyze and control the indoor air pollution levels.

Methods/Materials
The hardware consists of five Arduino MQ gas sensors, a dust sensor, Arduino UNO Rev3, breadboards, and several jumper wires. Each sensor detects air pollutants such as carbon monoxide and alcohol, however, the dust sensor senses dust density. I programmed software that can measure, present, analyze, and control the indoor air quality. I tested the accuracy of my software by exposing it to dust in the carpet before vacuum cleaning and during/after the use of the vacuum cleaner, nail polish, incense sticks, using a printer, etc.

Results
The software gave warnings and the indoor air quality was statistically worse after the use of items that were main causes of indoor air pollution, so the software proved to be accurate.

Conclusions/Discussion
One of the most surprising statistics reported by the EPA is that the level of indoor air pollution can be anywhere from 2 to 5 times more polluted than the worst outside air. But indoor air pollution is overlooked and outdoor air pollution is more in discussion. So, I built an indoor air pollution control system that is called CYAN (Clean Your Air Now). CYAN will alert people about indoor air quality in their homes, and so they will keep their homes properly ventilated and safe. CYAN is also cost-effective, and easy to assemble.

Summary Statement
I devised an indoor air pollution control system that can measure, present, analyze, and control indoor air quality levels.

Help Received
I designed and built the hardware myself. I wrote the Python programmed software with help from a family member.

Name(s)
Lennart R. Stockmanns

Project Number
J1020

Project Title
Does the Number of Turns per Inch within a Coil Affect the Speed of an Electric Train?

Abstract

Objectives/Goals
The purpose of this project was to find out whether the number of turns within a coil per inch affects the speed of an electric train traveling through the coil.
My hypothesis is that the train will travel through a coil faster if the turns within this coil are closer together (greater coil density). This is expected because a greater number of turns per length of the train makes a greater magnetic field pushing it forward faster.

Methods/Materials
In my experiment, I built an electric train consisting of a AAA battery with a front and rear magnet (1cm diameter). The train traveled through two copper coils. I created the coils by wrapping 18 gage bare copper wire around a metal rod then removing the rod. The two copper coils had 13 and 14.5 turns per inch. I measured the time the train traveled through this coils and repeated at least ten times.

Results
It took the train less time to travel through the coil that had more turns per inch. The average (of ten trials) for the train to travel through the coils of 13 turns/inch and 14.5 turns/inch was 1.336 sec and 1.126 sec. respectively. I calculated the speed to be 0.374 m/s with 13 turns per inch and 0.4 m/s with 14.5 turns per inch.

Conclusions/Discussion
My hypothesis that the train will travel through a coil faster if the turns within this coil are closer together (greater coil density) was supported by the data, with the train achieving a speed of 0.374 m/s in the coil with 13 turns per inch and a speed of 0.4 m/s in the coil with 14.5 turns per inch. This was expected as a greater number of turns per length of the train makes a stronger magnetic field pushing it forward faster.

Summary Statement
I showed that the speed of a train made of a battery and front and rear magnets riding through a copper coil depends on the density of the windings in the coil.

Help Received
I designed the train and my dad helped me building it. I performed the experiments, collected the data and got help in understanding the underlying electromagnetic phenomena from my mom.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Minh H. Trinh

Project Number
J1021

Project Title
Smart Burglar Alarm System Utilizing Open Source Hardware and Web Services

Abstract

Objectives/Goals
To construct a smart burglar alarm system that is capable of voice recognition using affordable open source electronic hardware, Arduino and Raspberry Pi, and publish the design to be used by the open source community.

Methods/Materials
My burglar alarm system, built on an Arduino controller board, incorporates a motion sensor which, when detecting motion, will set off an alarm consisting of a loud buzzer and a bright LED light. The alarm can be deactivated by two different ways: (1) entering a secret code through a keypad; or, (2) saying a secret phrase recognized by the Voice Recognition Module powered by the Raspberry Pi and Google Voice Kit. C and Python were used in programming.

Results
Making the system work reliably and integrating web service APIs were the most challenging parts. Each functionality such as motion detection, voice recognition, and alarm deactivation was first tested separately and then together in the final product. For each round of tests, I refined the code and improved the design until the alarm system became fully functional.

Conclusions/Discussion
My burglar alarm worked successfully according to my design goals of using open source hardware and low cost electronic components. My use of web service APIs helps add complex functionalities, such as voice recognition (I plan to add face recognition and text messaging in the next version). I published my design on Instructables.com for educational purposes. By combining different technologies and understanding the capabilities of each, I can create something more useful than what a single technology is capable of.

Summary Statement
I created a functional smart alarm system utilizing different open source hardware technologies and powerful web service APIs capable of providing sophisticated functionalities.

Help Received
I followed the Engineering Design Process introduced to me by my science teacher. My mom and dad helped me buy the components for the system. My thanks also go to my sister who helped proofread my notebook.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Jacob S. Vaughan

Project Number
J1022

Project Title
Can Your Wi-Fi Go Any Faster?

Abstract

Objectives/Goals
The goal was to build a parabolic Reflector and test it to see if it boosts the signal strength from a wireless routers antenna.

Methods/Materials
Materials: Cardboard, aluminum foil, a laptop computer, wireless antenna for the laptop, a wireless router, Wi-Fi connection, an angle chart with angles marked every 15 degrees from -180 degrees to 180 degrees and a computer program that can read the wireless signal strength. Method: I built a parabolic reflector using the cardboard and aluminum foil. I attached the reflector to the wireless antenna and attached both to my laptop. I used the angle template to show me where to aim the parabolic reflector. I took 3 readings of the wireless signal strength at each angle and got the average signal strength. I then recorded and analysed the data.

Results
My hypothesis was inconclusive because the wireless signal strength got both better and worse with the addition of the parabolic reflector. I expected the signal strength to get better not worse with the parabolic reflector. The signal strength did not get better or worse consistently, which is why I could not definitely state my hypothesis was correct or incorrect.

Conclusions/Discussion
My results were inconclusive because the wireless signal strength of my control variable without the antenna and reflector was sometimes better and sometimes worse than when the parabolic reflector was attached. However, in two of my experiments the best signal strength was at -30 degrees and in all the experiments when the parabolic reflector was facing -165 degrees the signal was the worst. I think a parabolic reflector would be helpful to people with bad a wireless signal if the reflector was built correctly. I think my reflector may have has some problems because the foil was crinkled and the cardboard in the middle may have blocked some of the signal.

Summary Statement
My project is about using a parabolic reflector to increase the signal strength given off by a wireless router.

Help Received
My mother helped me hold the laptop so I could read the signal strength at each angle.

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Anirudh Venkatraman

Project Number
J1023

Project Title
Friction Flashlight: Using Body Heat Energy to Power a Portable Flashlight

Abstract

Objectives/Goals
A flashlight is essential tool that is critical whenever a natural disaster occurs. However, what happens if the flashlight runs out of battery or there is no battery charger? The goal of this invention uses body heat that is generated from the heat of your hand instead of batteries to generate enough thermoelectric energy to power a flashlight.

Methods/Materials
When there is a temperature difference between two sides of a thermoelectric module, a current is created, and can be amplified through a series of transformers in an oscillator circuit. To create this temperature difference, a water cooling system is used, since water has a high heat capacity and is very thermally conductive. For my first prototype I reused the shell of an existing flashlight, cut in half, connected two Peltier tiles in series and attached them with epoxy on a copper plate which was mounted on the flashlight shell. The end wires of the peltier series was attached to the ground and input of the LTC3108 which was then connected to LED bulb. The hollow tube could be filled with water. For the second prototype I created a custom shell with a aluminum tube, aluminum plates with larger hole to fill water, attached peltier tiles on 2 sides of the tube to maximize the capture of heat from hand and powered 2 LED bulbs.

Results
My second prototype produced an average light intensity of 56 lux and stayed on for 35 seconds. It also weighed 350 grams and took average 6 seconds to light up.

Conclusions/Discussion
After testing my second prototype numerous times, I consider my invention an overall success because it had met all of the design criteria. My first prototype, on the other hand, works better with air since it is small, compact and more portable and is useful where dim lighting will serve the purpose.

Summary Statement
My invention will solve the battery-dependency problem by using easily found natural resources - air and water, and body heat to power the flashlight.

Help Received
Bill Zabor (understanding principles), Neighbor (cutting components), Mrs. Shalini D#Souza - science teacher (overall guidance), Mom (supplies)

CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)
Michael S. Zeng

Project Number
J1024

Project Title
Short and Steady Wins the Race! Exploring Antennas in RC

Abstract

Objectives/Goals
As a passionate RC hobbyist, I've consistently experienced range issues. The objective of this project is: using readily available resources around me, to create a stronger transmitter antenna of my own design which will improve range of the radio-controlled vehicle I'm building. I also want to test impact that specific factors can have on antenna performance such as material, thickness, length and shape.

Methods/Materials
Copper and steel wires, RF explorer signal generator, RF explorer spectrum analyzer, multiple SMA connectors and basic tools (wire cutters, pliers, measuring tape and soldering pen). Signal strength was tested for each antenna design from 10ft and 20ft distance with data recorded in dBm.

Results
Among the 48 different combinations of antenna design I created, not just one, but many outperform the factory-made reference antenna. Best overall performer is ¼ wavelength straight AWG 14 copper antenna - with signal strength 3dB (2 times) stronger than that of the factory-made reference antenna, which results in double the power and 42% improvement in range.

Conclusions/Discussion
I concluded that standard factory-made transmitter set does come with fairly poor quality antenna performance. With a little more thought into the design, much better performing antenna can be designed at home for RC hobbyists like me.
Some of the general learning I derived from this project include:
1. Material does have an impact on antenna signal strength, copper in general outperforms steel in transmitting strength.
2. No conclusive evidence can be found that length of antenna plays any determining role in signal strength (longer is not necessarily better).
3. Shape of antenna design plays a big part: coil and double coil lead the performance, followed by straight with L-shape lagging far behind.
As I move from terrain vehicles onto drones as my next step of exploration, I believe antenna design will play a much bigger role in drone performance. Further research on more complex designs, antenna placement and orientation, omnidirectional and obstacle overcoming capabilities etc. can be valuable next steps!

Summary Statement
To address the range issue of standard transmitter set for RC vehicle, I tested and created my own antenna design, which produces signal strength 3dB (2 times) stronger with 42% improvement in range.

Help Received
I had help from my school science teacher in undering the basics of radio frequency. I had help from my father in learing how to use the signal generator and spectrum analyzer tool. I researched, designed and tested all the antenna performance by myself.