CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Dhruv N. Aggarwal

Project Number

J0901

Project Title

Wi-Tricity: Wireless Electricity Using Resonant Inductive Coupling

Abstract

Objectives/Goals

To learn more about wireless power transfer, its current limitations, and begin to recognize future applications of this technology.

Methods/Materials

My research pointed me to resonant inductive coupling, and I selected to work on a Bifilar Coil implementation and a Slayer Exciter Circuit. Bifilar Coil: My design uses a bifilar coil setup in a circuit to switch at 30Hz converting a DC voltage into an AC that coupled inductively with two receiving coils transferring power. Slayer Exciter Circuit: My preliminary design used a secondary coil with nearly 350 turns and I initially did not realize the criticality of the geometrical aspect ratio between the tube diameter and the winding length. I researched coil inductances further, and built prototype 2 which worked, however only after adding physical capacitors to the earth capacitance. To debug the issues, I simulated the circuit in LT Spice, and learned its intricate workings, which helped me build prototype 3 and confirm measurements using an oscilloscope.

Next, I investigated the effect of resonance frequency and secondary voltage on the power transfer distance. I used prototypes 3, 4 and 5 which had different secondary inductances, therefore resonating at different frequencies, and collected the power transfer distance data while changing the turns, ratio. I took multiple measurements using a fluorescent bulb held horizontally, vertically, and on top of the toroid.

Results

The Bifilar Coil transferred power up to a distance of 6 inches to another coil, and even powered a DC motor. The Slayer Exciter circuit ionized the inert gases inside a fluorescent bulb making it glow. When the circuit was resonating at the lowest frequency the power transfer distance was the maximum around 12 inches. The secondary voltage also increased the distance.

Conclusions/Discussion

One of my key learnings on the Slayer Exciter circuit was the criticality of the build of the secondary coil to achieve a particular oscillation frequency. Fortunately, this circuit does not require tuning between the primary and secondary due to the feedback loop from the secondary directly to the base of the transistor. As my next build, I want to increase the power output using a better driving circuit instead of my single transistor.

Summary Statement

This project studies methods to transfer power wirelessly including specific implementations of the Bifilar Coil and the Slayer Exciter circuit.

Help Received

My father helped with soldering the electrical connections.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Yusuf Amanullah

Project Number
J0902

Project Title
Play Safe: An Arduino Based Solution to Sports Injuries

Abstract

Objectives/Goals
Injuries are a common occurrence in sports of all types. Football, in particular, causes concern in coaches and parents because of the higher incidence of injuries. Often times injuries that seem to be trivial end up having severe consequences due to negligence(e.g. players fail to seek immediate medical attention and continue playing). The purpose of this project was to address two common injuries in football namely concussion and heat related injury, and to develop a small, inexpensive, and lightweight device attached to a players helmet that would help coaches and guardians to monitor concussion and the temperature statuses of the players. This device could also guide the coaches and inform them when a player should stop playing, seek medical attention or cool down.

Methods/Materials
Used Arduino microcontroller as the programming platform for my device to which accelerometer and temperature sensors were connected to obtain data. Accelerometer is used to detect any shock or vibration to the device which is expressed in terms of 'g' values. A Bluetooth module was attached to the device to send the information to mobile devices. Developed the app for the smart phone or tablet that allows a user to set a threshold for both sensors according to players age or weight. A timer was built into the app that facilitates notification to coaches to take breaks for cooling down.

Results
I tested the device by subjecting it to conditions that simulated hit on the players head as well as temperature. This involved shaking or oscillating the device at different oscillating speed along x-y and x-z axes and noting the reading. The temperature sensor was tested by placing the device under different temperatures and then comparing the readings to the actual temperature measured by a conventional thermometer. Several trials were performed and the readings were averaged. I set different threshold in the smartphone app and verified that the alarm indicator on the app got activated whenever the reading of vibrations or temperature exceeded the threshold.

Conclusions/Discussion
This device could be an inexpensive solution for early detection of a hard hit (by creating a potential concussion warning) and heat injury (by making a heat alert) in football, or other sports like hockey.

Summary Statement
Developed a small, inexpensive, and lightweight device that can be attached to a player's helmet and helps coaches and guardians to monitor concussions and the temperature statuses of the players.

Help Received
Parents helped in purchasing materials and the display board.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Ian T. Austin

Project Number
J0903

Project Title
Gauss Gun

Abstract

Objectives/Goals
The object of my experiment is to see if the kinetic energy of the projectile that is being shot by the gauss gun will increase linearly as the magnetic stages increase.

Methods/Materials
Made gauss gun with grooved wooden planks and neodymium magnets, steel balls. Built velocity measuring device with 2 small planks, infrared emitters and detectors. Wired this device to an arduino board using a you tube source# breadboard basics# made a few modifications of my own and measured the velocity of each magnetic stage on my computer. Then converted the velocity to kinetic energy using the equation (KE=mv^2) and graphed it to see if it was linear.

Results
After multiple tests, my results showed that the kinetic energy did increase with each added stage, but it increased at a decreasing rate and eventually leveling out.

Conclusions/Discussion
In conclusion, the kinetic energy of the projectile does increase but it is not linear. This may be caused by variables such as surface friction, deformation of balls, or moving of magnets.

Summary Statement
My project is about investigating the properties of a gauss gun with increasing stages to see if the kinetic energy will increase linearly.

Help Received
Dr. Max Austin, my father, helped me figure out the circuit of the velocity measuring device. General Atomics provided me with surplus wires.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Zak H. Bamford

Project Number
J0904

Project Title
Constructing a Noise Generator to Interrupt Multicopter Flight

Abstract

Objectives/Goals
For my project, I built a noise generator in order to prevent multicopters (drones) from flying in areas where they could cause danger. I had heard that multicopters had blocked fire crews from extinguishing a recent fire, so I wanted to attempt to create a solution for these fire crews to ground multicopters. I hypothesized that I would be able to build this device, and that adding a Yagi-Uda antenna to this device could send signals in the direction of the multicopter.

Methods/Materials
I put together materials for my anti-multicopter device, including an Arduino, a 2.4GHz RF module, the Arduino IDE, an AirView 2 spectrum analyzer, and paperclips, which were used to create the Yagi-Uda antenna. I put my device through a variety of tests, including using it to emit a frequency on a specific channel, and using it to emit radio waves on the most heavily used frequencies of a specific multicopter remote, with and without the Yagi antenna attached. During these tests, I used the AirView 2 spectrum analyzer to determine if radio waves were being transmitted.

Results
When I programmed the RF emitter to emit radio waves of one specific frequency without the Yagi antenna, it performed as expected; it emitted radio waves of that frequency, and significantly weaker waves of surrounding frequencies. When I tested the circuit with a program that cycled between four different frequencies, similar results were produced, on all four frequencies. These emissions were very similar to those of the multicopter remote. When I tested the circuit with the program running and the Yagi antenna attached, the results varied greatly from the expected outcome. The emissions were no more powerful than those with the default whip antenna, but they were more strongly focused on the four dominant frequencies.

Conclusions/Discussion
In my project, I found reasonable evidence that supported my hypothesis that I would be able to build an RF emitter circuit. However, the emissions of the circuit with the Yagi antenna, contrary to my hypothesis, did not strengthen the radio waves in the direction it was pointing. This may have been due to imprecisions in the construction process, since the antenna was homemade from consumer grade materials. My findings could be used to create a device that could interfere with multicopter signals for government use; however, this would require a significantly more powerful RF module.

Summary Statement
In my project, I created a proof-of-concept electrical noise generator to interrupt the flight of multicopters, more commonly known as drones.

Help Received
My science teacher provided guidance throughout the project, and my father provided guidance with soldering the circuit.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Anay Bhakat

Project Number

J0905

Project Title

A Tool to Effectively Water Plants by Measuring the Soil Moisture

Abstract

Objectives/Goals

The objective of this project is to create a tool that can water plants with the appropriate amount of water thus reducing water wastage and ensuring proper plant growth.

Methods/Materials

Arduino Uno,Electronic Soil Hygrometer, Electronic Relay, Solenoid Valve, Bread Board

Results

The experiments showed that we can effectively water plants by measuring soil moisture. A simulation of watering a 150 sq. ft of vegetable patch using this tool taking into account the daily temperature and precipitation of San Francisco for a year predicted about 6000 gallons of water savings.

Conclusions/Discussion

This tool is a significant improvement over the current timer based drip irrigation techniques. It saves water and ensures proper plant growth.

Summary Statement

I have developed an effective tool to optimize the water given to plants thus reducing water wastage and ensuring proper plant growth.

Help Received

I developed the code for the Arduino Micro Controller based on some tutorials that came with the tool. My Father helped review the code for correctness.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Sophie Q. Carter

Project Number
J0906

Project Title
Indoor Navigation Using Magnetic Fields

Abstract

Objectives/Goals
The goal of my project is to be able to locate a person indoors using a magnetic map created by data collected on a cell phone.

Methods/Materials
I used a Motorola Droid cell phone equipped with magnetometer, gyroscope, accelerometer, and GPS. I used the AndroSensor app to record sensor data from the phone. I also used the computer program Matlab to create my magnetic maps.
I collected magnetometer data in nine aisles at Ralphs. I took three runs down each aisle, two facing South and one facing North. I interpolated the magnetometer data and created magnetic maps of each aisle. Then I had an assistant collect data in four of the nine aisles. I compared the four mystery aisles to my magnetic maps and could determine which aisle the mystery data was collected from. I used Matlab to write a computer algorithm that could match the mystery data to the correct aisle by reading it's mean squared error(MSE). The lowest MSE would be the corresponding match for the mystery data.

Results
The magnetic field throughout the aisle varied from about ten to fifteen micro Teslas and these variations could be detected by the cell phone. The data could be used to create accurate magnetic maps. The Matlab program matched the mystery runs correctly to their corresponding aisle. Overall, the experiment was successful.

Conclusions/Discussion
Buildings have magnetic signatures that are unique and reproducible from one location to the next. I created an algorithm that correctly identified which aisle of a grocery store I was walking through using my cell phone. My experiment has many future applications and can eventually be used as an indoor navigation system.

Summary Statement
I demonstrated the possibility of indoor navigation using a cell phone to measure magnetic fields in buildings.

Help Received
Dr. Carter advised me in the project by showing me how to use Matlab.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Andrew C. Chiang

Project Number

J0907

Project Title

Force Sensing Techniques for Robotic Arms

Abstract

Objectives/Goals

The goal of this project was to investigate gripping force sensing techniques for robot arms. My design criterion was to control a robot gripper with a programmable gripping force from 50 gram-force (gf) to 500 gf at 50 gf increments.

Methods/Materials

I designed and built a robot gripper using LEGO Technic parts. I incorporated Arduino DUE to control linear actuators and sense from Force Sensing Resistors (FSR), load cells (strain gauge), and stretch sensors. I implemented sensing circuits to interface the sensors to Arduino. I used standard weights to calibrate sensors. I then built lookup tables using sensor calibration data, and used the tables to estimate measured force. Later, I verified measurement accuracy by using standard weights. Lastly, I wrote a gripper control program in C++ to limit gripping force to a programmable value.

Results

Stretch sensor deformation limited maximum force to 170 gf. Stretch sensor was affected by friction and was not effective in sensing gripping force. FSR and load cell can effectively handle force up to 500 gf. FSR force measurement accuracy was +/-120 gf or +/-30% in 0-500 gf range. Load cell force measurement accuracy was +/-20 gf or +/-10% in 0-500 gf range. FSR force measurement was sensitive to the shape of the contact point, but load cell was insensitive. FSR force measurement was sensitive to the centering of contact point, but load cell was insensitive.

Conclusions/Discussion

Stretch sensors are not effective in sensing gripping force due to friction in the gripper. Load cell is more accurate in force measurement than FSR. Inexpensive but effective gripper with force sensing capability can be implemented with FSR and load cell.

Summary Statement

I built a robot arm that used force sensing resistors and load cells to sense and control gripping force.

Help Received

I designed, built, and performed the experiments myself. My father supervised me in using power tools and soldering iron.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Matthew Cho

Project Number

J0908

Project Title

Smart Shoes: An Innovative Method to Analyze and Correct Improper Gait

Abstract

Objectives/Goals

My project goal is to measure the angle of the user#s feet, to determine if their gait was proper, display the collected data or allow for real time correction of the feet, and provide a program that professionals could use to analyze data.

Methods/Materials

Arduino Nano, 3 axis gyroscope and accelerometer, Bluetooth module, buzzer, button, battery, and a pair of shoes.

Results

Using gyroscopes and accelerometers, the shoes can measure the angle and acceleration of your feet. The shoes can beep when your feet exceed an angle. When the user hears beeps, they will adjust their feet, which leads to better gait. They can also send data to a computer for a deeper analysis of the data.

Conclusions/Discussion

The shoes can identify the angles of the user's feet to identify if they have improper gait. The shoes can also correct gait by alerting the user of their gait. The user will in turn correct their feet until their gait is proper. Professionals can also analyze the data for a deeper understanding of their patient#s gaits.

Summary Statement

Smart shoes are shoes that measure the angle and acceleration of your feet to allow for correction and identification of improper gait.

Help Received

My father helped me understand some of the programming subjects such as wireless connection.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Marco R. Evans

Project Number
J0909

Project Title
The Energy Shoe: Generating Electricity while You Walk

Abstract

Objectives/Goals
The design goal was to make a Faraday generator that is attached to your shoe and could charge a 5V mobile device.

Methods/Materials
The battery charger consisted of the Faraday generator and the charging circuit. Faraday generators were made by placing different sizes of cylindrical rare earth neodymium magnets in plastic tubes that were wrapped with copper magnet wire. The charging circuit consisted of diodes for the rectifier bridge, capacitors and various voltage regulators and rechargeable batteries.

Results
My prototype design proved that I could measure voltage and charge a 1.5 volt battery. Larger magnets generated more voltage than smaller magnets, and shaking by hand generated 500mV per shake, but walking produced significantly less. In order to generate 5 volts, a booster voltage regulator was installed in the next circuit design and current was measured by placing different resistors in the circuit and measuring the change. The power output was calculated for each generator to determine which size was best for charging while walking.

Conclusions/Discussion
I was able to make Faraday generators that can fit on your shoe, and charging circuits that can charge batteries. The final design must be a reasonable balance of size and power output.

Summary Statement
Design a battery charger that is mounted on your shoe that will charge a 5V mobile device while you walk.

Help Received
James Evans helped with getting materials and building this project. The Santa Cruz County lead judges suggested improvements.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Jordan S. Feldman

Project Number

J0910

Project Title

Controlling a Robot with Electromyography

Abstract

Objectives/Goals

The goal of this project was to create a robot that could be controlled by EMG signals. This approach could lead to improved prosthetics as well as to advancements in remote surgery.

Methods/Materials

Electrodes were placed on the subject's left arm. The subject was asked to perform various movements, such as clenching their left fist or extending and flexing their left wrist, interspersed with periods in which the subject performed no movement. Via a DSP board, the electrodes then relayed the EMG signals to a computer. The board filtered the signals to remove noise. Then, the digitized signals were used to design a classifier to distinguish between the various movements. Once the classifier was designed, the subject was retested. However, this time, the computer used the classifier to identify the subject's movements and sent the results to a robot that moved accordingly.

Results

The classification algorithm was able to correctly identify the subject#s movements. Based on the algorithm#s classifications, corresponding commands were successfully transmitted via Bluetooth to the robot, which responded accordingly.

Conclusions/Discussion

The project was successful. It showed that it is possible to identify a movement based on the EMG signals that occur when it is performed. It also suggests further lines of questioning: how do EMG signals differ between different individuals, and what movements have sufficiently distinct EMG signals that they could be used for controlling a robot.

Summary Statement

EMG signals were processed in real-time and used to remotely control a robot.

Help Received

I would like to thank my dad for giving me helpful critiques on my writing and for helping me write the computer program. Also, I would like to thank Mr. Hartung for advising me on my choice of a project and for discussing with me how to write each section in my report.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Nicholas R. Ford

Project Number

J0911

Project Title

Trailer/Truck Light System Tester

Abstract

Objectives/Goals

My projects goal is to find out if I am able to test a commercial trailers light system without having a truck available as a power source. The tester I will build needs to be small and light enough so that I can move it from trailer to trailer by hand.

Methods/Materials

Looking through several wiring schematics I chose the materials for my list. I had to modify the schematics with two flashers so that it would work with my toggle switches. This was to simplify the system and still mimic the commercial truck light system. The first time I used my new tester it didn't work with every trailer. I found that the tester worked with the old incandescent lights but didn't work with the newer L.E.D. lights. Replacing the flashers with a lower amperage style fixed this problem. Retesting showed the tester working properly with both style lights.

Results

I now have a tester small enough to push by hand that I can take out into a parking lot and test commercial trailers. I went from trailer to trailer to test each of their light systems. By building this tester I was able to eliminate having to hook up each trailer to a truck to test the trailers light system. This Trailer/Truck light system tester cost $ 500.00 to build.

Conclusions/Discussion

By using my tester on commercial trailers the first time I was able determine that it needed different flasher to work properly with all styles of lights. With that being fixed I was able to prove my hypotheses true. By building this portable trailer/truck tester I was able to test the commercial trailers light system and it worked without having to hook up to a truck as the power source. Having this tester will save a commercial trucking company money each time they use it.

Summary Statement

By building a portable trailer/truck light system tester I can eliminate using a truck as a power source.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Aidan D. Garamendi

Project Number
J0912

Project Title
Will Water Cooling Speed Up My Computer?

Abstract

Objectives/Goals
The objective of my project was to learn if water cooling would improve the performance of my computer.

Methods/Materials
I tested my hypothesis using my custom built computer with a fan cooling system, a water cooling upgrade and a downloaded program that assessed computer speed.

Results
There was a negligible difference in performance between the fan cooling system and the water cooling system for single, quad and multi core processing speed.

Conclusions/Discussion
My conclusion was that while the water cooling system lowers noise output and cools the CPU better, it does not improve its performance.

Summary Statement
I determined that installing a water cooling upgrade in my computer did not improve its processing speed.

Help Received
I designed, built and performed the experiment myself after internet research. I got some advice on project presentation from my advisor.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Thomas (Casey) C. Hubbard

Project Number

J0913

Project Title

One Quarter Wavelength Ground Plane Antennas

Abstract

Objectives/Goals

My objectives were: To build a 2m and a 70cm one-quarter wavelength ground plane antenna; to determine their standing wave ratio (SWR) and resonant frequency to see how well I built them, and finally to use my amateur radio handset to test their transmit and receive capabilities with other HAM radios and stations and compare it to the factory made 2m/70cm dual band antenna included with my radio.

Methods/Materials

I used 12 gauge copper wire and SO-239 UHF/VHF connectors to construct the antennas' radiator/radial wire elements. Two BAOFENG GT-3TP Mk3 Two Way Ham Radios and two FCC Ham Radio Operator#s Licenses were also required to conduct my tests. I used a MFJ 209C Antenna Analyzer and a MFJ 886 B- Frequency Counter to determine the SWR and resonant frequencies of the antennas I built. For the Repeater and Simplex tests I selected several repeaters in the area and transmitted to them with my antennas on the low, medium, and high power (1, 4, and 8 watts) settings and listened for a response. I then rated the clarity and volume of the transmission. The same process was used for the simplex tests at varying distances.

Results

I successfully built a 2m and a 70cm one-quarter wavelength ground plane antenna and tested them. The 2m one-quarter wavelength ground plane antenna target frequency was 147 MHz, testing showed its resonant frequency was 146.856 MHz with a SWR of 1.1. The 70cm one-quarter wavelength ground plane antenna target frequency was 440 MHz, testing showed its resonant frequency was 440.025 MHz and a SWR of 1.05.

The antenna with the best performance was the 70cm one-quarter wavelength ground plane antenna, broadcasting to beyond 12 kilometers. The second best antenna was the 2m one-quarter wavelength ground plane antenna which was able to broadcast 12 kilometers. The factory made dual band antenna was only able to broadcast 2 kilometers on the 70cm band and 3 kilometers on the 2m band.

Conclusions/Discussion

My tests proved that I was able to build two one-quarter wavelength ground plane antennas that worked well for the 2m and 70cm radio bands. The testing for repeaters and simplex broadcasts were able to show that the overall best antenna is the 70 cm one-quarter wavelength ground plane antenna; which broadcasted further and clearer than the dual band factory made antenna or the 2m one-quarter wavelength ground plane antenna.

Summary Statement

I constructed and tested two one-quarter wavelength ground plane HAM radio atennas and proved they worked by measuring their SWR and resonant frequency as well as testing them across multiple frequencies within their radio band.

Help Received

I designed and constructed the antennas with oversight from my father. Mr. Johnson and Mr. Boss assisted by providing the antenna analyzer and frequency counter which I used to determine the SWR and resonant frequency of the antennas I constructed.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Syed Musab Kazmi

Project Number

J0914

Project Title

The Road to the Artificial Pancreas

Abstract

Objectives/Goals

In this project, I want to make an Artificial Pancreas that can be used for any patient with Type 1 Diabetes. Instead of using actual insulin and glucose I will test the artificial pancreas with vinegar which represents high glucose levels and baking soda which represents insulin.

Results

The three amounts of vinegar used in this project are 200, 230, and 250 ml. Average amount of time it took to neutralize all of them after 10 trials each was 4:31, 5:12, 5:39 minutes respectively and always started the neutralization instantly. None of the three caused any problems the artificial pacreas

Conclusions/Discussion

This confirms that this type of an artificial pancreas can work on many people as long as there is an undesired amount of glucose (vinegar). This also means that the device will be quick and will give the right amount of insulin or baking soda in a short amount of time whenever is needed. All the device needs is an undesired amount of glucose to turn on.

Summary Statement

I created an artificial pancreas that can be used for any patient with type 1 Diabetes

Help Received

My adviser Mrs. Alkhawaja helped on deciding my project, my family got the materials for the project and helped on the research of the project

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Nolan C. Lautrette

Project Number

J0915

Project Title

The Effects of Varying Tube Materials on Electromagnetic Induction

Abstract

Objectives/Goals

The purpose of this study was to measure the efficiency of various tube materials (plastic, cardboard, steel, and aluminum) on electromagnetic induction, a process that produces electricity with a coil, magnet, and method of containment (tube). The technology was applied through a home-made circuit to power a flashlight.

Methods/Materials

Stopwatch, magnet (neodymium), various tubes of different materials, copper coil, LED, flashlight housing, and circuitry. Stopwatch was used to measure how long each system, comprised of the coil, magnet, and tube powered an LED after going through a circuit.

Results

After conducting the experiment for many trials to ensure accuracy, the results revealed that the plastic tube was most effective in harnessing changes in magnetic fields, thus powering the LED much longer than the others.

Conclusions/Discussion

Conducting the experiment revealed that using plastic encasing when applying electromagnetic induction was significantly better and much more efficient. The performance of the other tubes were decreased due to multiple factors including friction, magnetism, and properties describes in Lenz's laws. These methods can be used to further improve technology involving electromagnetic induction.

Summary Statement

I constructed a flashlight which contained no standard batteries, and tested the efficiency of various tubes of different materials on electromagnetic induction; the power-source of the flashlight.

Help Received

I devised and constructed the experiment by myself. My science professor, Christine Rizzo helped me make final revisions to the written portion of my project.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Kevin P. Lopatka

Project Number
J0916

Project Title
Building a Homerun

Abstract

Objectives/Goals

The goal of the project is to create a device that will help baseball players optimize bat motion. Two key components of a good swing are bat speed and followthrough.

Bat speed and followthrough can be tracked using a 6DoF (6 Degree of Freedom) sensor. This 6DoF sensor consists of a gyroscope and an accelerometer that can be used to track bat acceleration and angle.

Using this sensor for data collection, and an Arduino for data logging, data can be imported into Excel for data analysis.

With the data collected from the tests, charts can be created to identify swing acceleration, and deceleration, as well as time for followthrough or in other words, creating a better swing.
These charts will help a batter be able to see their swing information and would help them be able to see area for improvement.

Methods/Materials

METHODS:
Step 1- Insert SD card into arduino that is attached to the bat.
Step 2- Walk outside and wait for thirty seconds for the arduino to calibrate.
Step 3- Swing bat with small power and with bad followthrough.
Step 4- Take out SD card and insert into computer for post-processing.
Step 5- Identify swing in Excel.
Step 6- Keep good data and discard bad data.
Step 7- Repeat steps 1-6 for each trial, but on step three, choose one of the following swing types:
Soft Power/ Good Followthrough
Medium Power/ Bad Followthrough
Medium Power/ Good Followthrough
Maximum Power/ Bad Followthrough
Maximum Power/ Good Followthrough
MATERIALS:
6DoF (Includes Accelerometer, and Gyro)
SD Card

Summary Statement

The amount of acceleration and follow through can be charted by sensors which is attached to a bat in order to optimize a batter's swing.

Help Received

My father has experience in the field of micro-controllers an electronics and was able to show me how to set up my graphs, data, and charts. My mother was able to coach me in my speaking skills because she has experience in the field of education and interacting with students.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Anna M. Mathews

Project Number

J0917

Project Title

Water Saver: Moisture Detection for Sprinkler Control

Abstract

Objectives/Goals

Most California households use simple sprinkler controllers to help water their lawns and trees. These controllers use timers for fixed duration watering and often perform watering even after there has been rainfall. The project objective was to design a circuit that could use moisture sensing to prevent sprinkler operation when the soil was moist. The circuit should be able to work with the simple sprinkler controllers present in most homes. There are sensors on the market that can detect soil moisture, but they are expensive and often require specialized controllers, which are also expensive. The project goal was to design a circuit that would work with cheap sprinkler controllers that are in most houses.

Methods/Materials

Two metal electrodes were inserted in the soil and a digital multimeter was used to make measurements of soil resistance as a function of amount of rainfall. Measured amounts of water were poured over the ground to simulate rainwater. These measurements showed that soil resistance decreased with increasing rainfall. The variable resistance between the electrodes was used as an input to a digital logic circuit containing a NAND gate. The circuit was designed so that the NAND gate would provide an output signal that could be used to turn power to the sprinkler controller on or off based on the moisture content in the soil. A relay connected to the output of the NAND gate allows it to deliver or disconnect power to the sprinkler controller. Materials used to build the circuit include batteries, a circuit board, a relay and a NAND gate

Results

The circuit is able to detect moisture in the soil and use the relay to turn power to the sprinkler on or off To reduce risk, the relay output is used to turn a LED on and off rather than an actual sprinkler controller operating at 120V.

Conclusions/Discussion

Change in soil resistance due to addition of moisture causes the circuit to deliver or disconnect power to a sprinkler controller. This provides water savings by avoiding lawn watering after there has been rainfall. The circuit costs less than a tenth of the electronic moisture sensors available on the market and avoids the need for expensive sprinkler controllers that can be connected to a moisture sensor.

Summary Statement

My project is about designing and constructing an electronic system that can sense moisture content in the soil and automatically prevent sprinklers from operating when the soil is moist.

Help Received

My dad who is an engineering professor helped guide my studies of electronic circuitry.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Thomas W. Maxfield

Project Number

J0918

Project Title

Exploring Magnetic Levitation

Abstract

Objectives/Goals

Two magnets can attract or repel depending on orientation of their poles. I wanted to measure the repulsion forces of two magnets and find how it depends on the separation between the two magnets. My hypothesis is that the repulsion force of the two magnets is inversely proportional to the square of the separation, just like gravity.

Methods/Materials

In order to do this I set up an apparatus where two magnetic sources repel each other. One of the sources stayed stationary at the base while I dropped a single neodymium magnet along a wooden guide from the top. The magnet#s poles were the same polarity, so they repelled each other to the point where the top magnet stayed stationary as the acceleration due to gravity and the repulsion force was equal. I changed the amount of mass added to the top magnet in 50g nonmagnetic weight increments and measured the distance between the two surfaces.

Results

I plotted my results on a graph and added a trend line, which corresponds to the equation where the magnetic force is inversely proportional to the square of the separation of the two magnets. I have done this for different numbers of base magnets and weights added to the levitating magnet, and always got the results that followed this trend.

Conclusions/Discussion

This supports my hypothesis that the magnetic force is inversely proportional to the square of the separation of the magnets. Understanding of magnetic levitation can be used in designing future transportation systems, such as levitating trains, or mass drivers to launch cargo in space.

Summary Statement

My project is about understanding how the repulsive magnetic force that can be used to levitate a magnet above another one depends on their separation.

Help Received

My teacher, Mrs. Newman, helped me find some online sources and references about how to design and construct an experiment, and how to write a report.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Aidan J. Morris

Project Number
J0919

Project Title
Regression Analysis of Electric Output from Increasing Battery Cells

Abstract

Objectives/Goals
The objective of this experiment was to determine that if I increase the amount of cells in a battery, would the electricity produced increase in a linear relationship.

Methods/Materials
The materials I used for this experiment were 5 pieces of copper/pennies, 5 pieces of zinc/washers, 5 pieces of felt, white vinegar, and a multimeter. I tried to use a galvanometer, but it did not work. To perform this experiment, I used the materials to create battery cells and then measured the electricity produced on the multimeter. Then graphed the results.

Results
When I graphed the data points, I observed that none of the test results formed a straight line on the graph. Then, I performed a regression analysis and found the data points had a more linear than exponential relationship.

Conclusions/Discussion
I can conclude from my tests, graph and regression analysis that when I increase the amount of cells in a battery, the electricity produced by the battery will increase in relatively linear proportion.

Summary Statement
I determined that when the amount of cells in a battery increases, the electricity produced increases in a linear relationship.

Help Received
I conducted the experiment myself. I received my understanding of regression analysis in discussions with my father.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Adam J. Phillips

Project Number
J0920

Project Title
Get It Going with the Gauss Gun: Magnetic Linear Acceleration

Abstract

Objectives/Goals
The objective of this experiment is to test the Gauss Gun to find out which combination of magnetic stations and the distance between those stations, will shoot the ball bearings the farthest.

Methods/Materials
Two 3/4" dowels, wood glue, 1/2" ball bearings, 1/2" neodymium magnets, tape, ruler, tape measure, shallow box full of sand, sharpie, table, flat piece of styrofoam.

Results
In testing the different distances between magnetic stations, I found that the distance that produced the farthest shot was seven centimeters between magnets. I also found in my tests that the more magnetic stations included in the chain reaction, the farther the ball bearing would go.

Conclusions/Discussion
I found that there was an optimal distance between magnets that produced the best result. The number of magnetic stations also had a direct impact on the results of my trials. The best combination of distance between magnets and number of magnetic stations was 7 cm between stations and 8 magnetic stations total. Small adjustments in distance or quantities of stations had a significant impact on the results. This means that accelerating an object with magnetic forces has an optimal calibration.

Summary Statement
This experiment demonstrated that there is an optimal combination of magnetic stations and distance between magnetic stations that will produce the farthest shot from the Gauss Gun.

Help Received
I researched the topic on-line and my dad helped me build the track and assisted me in changing the magnetic stations during the trials.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Daniel P. Ridley

Project Number

J0921

Project Title

What Gauge of Magnet Wire Makes Paper Speakers the Loudest?

Abstract

Objectives/Goals

The purpose of this project is to find if a change in the diameter (gauge) of the wire used in the electromagnetic coils, located in speakers, made a difference in sound output.

Methods/Materials

Cut two strips of paper about the width of the magnet. Then Wrap one strip of paper tightly around the magnets. Next, Take the second strip and wrap it around the first. After, slide the stack of magnets and the inner tube out of each other. Then put the magnets inside the large tube and start wrapping one of the 4 gauges of wire neatly around the tube. When you are done wrapping, glue the coil of wire in the center of the plate. Next fold 2 business cards in a #M# shape. Glue the business cards onto the plate on each side of the coil. Attach another plate on the free end of the business cards to act as a base. Afterwards, strip the enamel coating off of the free ends of the coil#s wires. Finally, Connect your speaker to the amplifier and turn it on.

Results

I found that the thinner gauge wire worked better in building a paper speaker. The two thinner gauges gained almost 20 decibels in some cases! I also noticed the two larger and the two smaller thicknesses of the wire seemed to have similar results between themselves. The smaller diameters of magnet wire consistently proved to output more sound than the larger gauges of wire.

Conclusions/Discussion

My hypothesis proved to be correct, a smaller gauge wire did actually perform better in a paper speaker. The larger gauge wire was about 11 decibels quieter in comparison with the smaller gauge wire. The gap in loudness was lessened when the higher frequency tones were tested. I believe this is because the cone (the plate in this case) didn#t have to move very far to create a high tone. I think the thicker wire couldn#t transfer as much energy to the magnets because of how they had to overlap each winding. The smaller gauges of wire also sounded better in general. To strengthen my findings and improve this project, I could test more gauges of wire and use more precise ways of measuring the sound output of the paper speakers.

Summary Statement

This project tests what thickness of magnet wire makes home-made speakers the loudest.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Suhina Sharma

Project Number

J0922

Project Title

TempBot: Device Preventing Febrile Seizures and Other Fatal Complications by Monitoring Sudden Rise in Body Temperatures

Abstract

Objectives/Goals

The goal was to create a low cost continuous temperature monitoring device that detects sudden rise in body temperature and helps prevent Febrile Seizures and other high fever complications in children. It would work as a wrist band and alert adults whenever the temperature crossed defined threshold limits or when the rate of rise in temperature was high.

Methods/Materials

Arduino Uno microcontroller, temperature sensor, cables, LED, and buzzer were used to build the device. Tested device on humans and to simulate sick person initially, meat was heated in oven at different temperatures. Accuracy tested with thermometer and cooking thermometer. Tests were done on healthy and sick adults and kids in different environments and with different types of clothes to study the impact of clothes blocking the sensor. Impact of distance on the accuracy of device was also studied.

Results

Multiple tests were performed with different variables to test accuracy. Tests done on healthy human and meat for simulated sick person showed consistent results. Tests done in different ambient temperatures and different clothes like fleece, cotton, wool showed that the thicker cloth lowered TempBot readings. Readings were less accurate once the distance of object from TempBot was more than 2 cm. Tests done on healthy and sick child and adults showed nearly accurate readings.

Conclusions/Discussion

I observed that TempBot readings were about 3-4 °F lower than thermometer. This is because skin temperature for humans is less than core body temperature. LED bulb lit up for anything over 101 °F. I also added another parameter that made buzzer beep and LED bulb light whenever the rate of temperature increase was >= 2 °F in 15 minutes.

This project helped me expand my knowledge on how to prevent Febrile Seizures and other high fever complications by creating and programming a simple device. This kind of device currently does not exist in the market for household use.

Summary Statement

I created a low cost continuous temperature monitoring device that could prevent Febrile Seizures and other fatal high fever complications in children by alerting adults on sudden rise in body temperatures.

Help Received

I created and programmed the device myself. I researched on internet by watching videos and joining programming forums. My science teacher reviewed my findings.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Aryansh Shrivastava

Project Number

J0923

Project Title

Microcontroller Based Bionic Eye for the Blind

Abstract

Objectives/Goals

The objective of my project is to create a cost-effective electronic bionic eye, which can help the blind maneuver around and complete daily activities and livelihood, without assistance.

Methods/Materials

This device includes an Arduino microcontroller board, which is the brain of the device, an ultrasonic ping sensor which resembles the eye, and a voice recognition module and push button switches, both of which are used to control the system state and change the pre-programmed unsafe distances. The ping sensor will first send out ultrasonic pings, to the obstruction in front of the user, to sense it in real time. It will then return the ping time to the microcontroller, which will then, using this ping time, calculate the distance between the user and the obstruction and determine whether or not it is unsafe and alarm the user accordingly using a vibration motor.

Results

I conducted several tests to check the accuracy and reliability of the device. The speed of sound calibration constant is found to be 344.57 m/s for the device. The maximum deviation of inaccuracy in the calculated distance is found to be .2 ft. for 8 ft. The projected error at 32 F, in the distance calculated by the device, is found to be 4%. With completely random obstacles, the reliability of the device is 96% (168 times detected in 175 observations). The duration of the battery powering the device is found to be 9 days before recharge. In the realistic human testing of the device for six untrained people, they came into contact with 11 of 48 random obstacles. After a short training session, they came into contact with none of the obstacles. Out of 25 observations of random moving obstacles, the device detected the obstacles a total of 22 times. The overall cost of the device is also found to be eighty dollars.

Conclusions/Discussion

The results meet the objective, because they show that this bionic eye device is very accurate and reliable. The tests on real human subjects showed the same. Therefore, the device is ideal for the blind or visually impaired, allowing them to complete daily activities, without assistance.

Summary Statement

The purpose of my project is to create a bionic eye for the blind that is wearable, lightweight, inexpensive, reliable, and accurate.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Shruti Sridhar

Project Number
J0924

Project Title
A Novel Sensor-Based Device to Detect Heatstroke and Dehydration

Abstract

Objectives/Goals
The purpose of this engineering project was to create a prototype that would detect heatstroke and dehydration. The portable device aims to detect heatstroke based on body temperature and heart rate. Skin resistance is measured to detect dehydration.

Methods/Materials
Firstly, a pulse sensor and an infrared thermometer were paired with the Arduino Uno, an SD logging shield, a 5V battery shield, and an LCD to display the heart rate and body temperature. The accuracy of the prototype was also confirmed. Secondly, to test the pH of sweat, a 0.2 micron membrane used to mimic the sweating human skin was taped to a pH strip and a water-filled jar. The water#s pH was continually manipulated through the addition of baking soda and vinegar. Also, human testing was performed to prove the efficiency of the prototype. Tests of ten-minute jogging periods were performed on two participants.

Results
The pH strip had a faint color change after the addition baking soda and vinegar consecutively four times, proving this method of detecting dehydration to be ineffective. Therefore, I researched more and found out that skin resistance, a more quantitative and accurate measurement, could be measured instead to detect dehydration in the human participants.

The human testing data showed that as body temperature rose, skin resistance fell, which is a healthy trend.

Conclusions/Discussion
After testing on human participants, which served as a proof-of-concept of my prototype, the efficiency and accuracy of the device were affirmed. Regarding human testing, a dangerous trend would be a rising skin resistance and rising body temperature, which would indicate low sweat levels and no heat regulation. In the future, the wireless transmission of Arduino data to a smart phone could be explored. In addition, the risks of heatstroke and dehydration in animals could be investigated. Lastly, algorithms to automatically convert Arduino output for skin resistance into the actual resistance could be developed to quickly find trends and detect dangerous or fatal situations early.

Summary Statement
I constructed an efficient and accurate device to detect heatstroke through body temperature and heart rate, and dehydration through skin resistance.

Help Received
Dr. Youssef Ismail helped me decide on which electronic components to purchase and taught me advanced principles of circuitry.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Krishna Lian D. Tuazon

Project Number

J0925

Project Title

Simplest Electromagnetic Train

Abstract

Objectives/Goals

My project was to determine if a neodymium magnet, battery and a copper wire are capable of creating a high source of magnetic field resulting in constant motion making it the world#s simplest electric train. The number and set-up of a magnet, voltage of a battery and a uniform winding of a copper wire into a coil all have its effect in generating movement of the train testifying its speed producing an increase strength of magnetic field. I believe this new mode of transportation will help the environment, make faster transactions, and bring convenience to people. This is the future!

Methods/Materials

To create my train, I put neodymium magnets on each side of the battery. Magnets used were classed in between N35s-N52s. Magnets on either end of the battery should have their North poles pointing in opposite directions. Three different sizes of alkaline battery were tested to establish average performances. Wrapped the copper wire clockwise in tight smooth coils and made a big long train track. I constructed 3 different spaces of winding the copper wire coils and determine which spacing works best and runs faster. Push the newly created train into the copper wire and watch it travel through the wire.

Results

I was able to create my train using N52 neodymium magnets. A stack of four magnets, a 1/2 diameter and 1/8 inch thickness on each end of the battery. I used a half-size AAA battery and 1.5 V alkaline AAA battery. Winding the tracks coil tightly, the train will fly around so fast, however, winding the coil loops too far apart and the train will run slow. A bare copper wire wounded about 20-24 turns per inch has the greater speed as I tested and determined the optimum turns per inch by speed in seconds.

Conclusions/Discussion

I learned that a battery, neodymium magnets and a copper wire are capable of creating the world#s simplest train. Adding more magnets to the battery, the more winding the wire into a coil, the stronger the magnetic field produced and the higher the induced energy resulting in greater speed. This project would have to go into a bigger scale and this design would be a great advancement in terms of modern and efficient mode of transportation.

Summary Statement

My project is about creating the simplest electromagnetic train.

Help Received

Mother helped me put together my display board, conduct my testing and type my report. Father helped with building the model.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
Daniel W. Yao

Project Number
J0926

Project Title
The Magical Stabilizer

Abstract

Objectives/Goals
The project's primary objective is to find what threshold values at which the Schmitt trigger, a decision-making circuit, which turns on at a high threshold and stays locked on until it falls to a lower low threshold, would function the best, or turn off or on according only to the operator's control, regardless of noise or deviations from the form of the desired signal.

Methods/Materials
The data collection involved feeding a noisy signal from a signal generator or the hand-built alternator, which uses magnets, PVC piping, 30 AWG copper wire, and other construction material, and is amplified if necessary into the Schmitt trigger. I used the potentiometers attached to the voltage source and the transistors collectors to modify the threshold values. The rest of the materials includes typical electronics hobbyists' supplies, such as resistors, jumper wire, a breadboard, an ammeter, and an 1.8V LED.

Results
The experiments revealed that the highest reliable low threshold value would be the lowest voltage the input voltage reaches. The high threshold would be about the middle point of the voltage range for the input when turned on.

Conclusions/Discussion
As previously stated, the high threshold would be around the middle of the range of which the input voltage reaches, and the low threshold would be preferably be a little lower than the lowest voltage the "ON" state would reach. The results of my experiments provide far more specific guidelines of which the threshold values should pertain to, in other words, increasing the reliability of a mechanism designed to increase reliability. Hobbyists and engineers alike can rely on these results to find appropriate component vales for designing integrated circuits and other more commonly used versions of the circuit specifically designed towards the context of the situation, finally utilizing the true value of the Schmitt trigger's ability for customization.

Summary Statement
Through repeated testing of various threshold values, my results revealed that the best positioning of the thresholds depend on the "ON" voltage's range and its lowest "ON" voltage.

Help Received
Dr. Jeffrey Cheung, Dr. Derek Cheung, and Dr. Jian Xu all acted as advisors and assisted me with some technical issues along the way. Dr. Reuben Bushnell was my instructor for a time, providing me nearly all of my knowledge in electromagnetism. I myself constructed all of the hardware, the poster, and the data.

CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Maxim Zhulin

Project Number

J0927

Project Title

Effects of Pipelining on CPU Speed

Abstract

Objectives/Goals

This experiment examined the effects of pipelining on the speed of CPUs. The goal was to test which CPU type (pipelined and not pipelined) was faster at executing programs.

Methods/Materials

Mac book Air with Minecraft, stopwatch. Two CPUs were built in Minecraft, one was pipelined with 2 stages, the other was not pipelined and had only 1 stage. They were tested on 3 different programs: Fibonacci sequence function program (a program that calculates the Fibonacci number for a given input), multiplication program (a program that multiplies two numbers), and odd number tester program (a program that tests if a given input number is odd or even).

Results

The pipelined CPU was faster on both the multiplication and the Fibonacci programs, but the Odd Tester program was different. On the unpipelined CPU, it was faster on large numbers.

Conclusions/Discussion

The results suggest that in most cases, pipelined CPUs are faster, but in some cases, where there are data dependencies with branching, the unpipelined CPUs are faster. This shows that pipelined CPUs should be used in computers, for they would make them faster overall.

Summary Statement

I ran different programs on 2 types of CPUs (pipelined and not pipelined), and found that a pipelined CPU performs better unless it execute a large number of branch instructions.

Help Received

I made both CPUs and all the programs myself. I got help with understanding pipelining from the users of OpenRedstoneEngineers server.