CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Paolo Abundez; Christian Aguilar

Project Number

S1001

Project Title

Increasing Bluetooth Range with Different Antennas

Abstract

Objectives/Goals

This project seeks to use different antennas to increase the signal strength in a wireless Bluetooth connection between a speaker and a host device.

Methods/Materials

Jam Speaker and Thinkpad Laptop.
Three antennas primarily made out of copper wire.
Bluez: Free Linux software package for measuring Bluetooth signal strength.
Custom made Python script for quickly tabulating measurements.

Different antennas were connected to the Jam Speaker. From a radius of 50 feet, the custom Python script on the laptop measured and tabulated the received signal strength (RSSI) from the Jam Speaker at various angles. The script saved the data as a standard spreadsheet. Microsoft Office Excel was used to calculate averages and generate graphs.

Results

The antennas in order from lowest to strongest RSSI were as follows:
-Wire/Pole antenna
-No antenna (control group)
-Loop antenna
-Yagi antenna

Conclusions/Discussion

A Yagi antenna yielded the strongest average signal strength. However, the increase in signal was not uniform as the "back" of the antenna had a significantly weaker signal than the "front". The Yagi antenna's large size also reduces its practicality in mobile Bluetooth applications. Ultimately, the project did managed to increase the possible range between Bluetooth devices.

Summary Statement

This project determined that Bluetooth signal strength is greatly increased when using a Yagi antenna.

Help Received

We got some assistance from our chemistry teacher as we designed our charts and graphs. At the time of this application we expect to soon meet with Dr. Gavor at UCR to discuss our experiment.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Yusra Arub

Project Number

S1002

Project Title

Smart+Connected Doorbell with Real-time Coordinated Continuum of Care Information: A Path to End All Homelessness

Abstract

Objectives/Goals

Despite nationwide attempts to solve homelessness, the main problem lies in the the lack of coordinated outreach programs and CoC provider data between shelters. According to the Department of Housing and Urban Development, over 500,000 people across the nation remain homeless, and 15% of them are families, veterans, drug addicts, or unemployed in spite of over 5,000 shelters and $45,000 invested annually in supportive housing placements for homeless families.

To address this problem, the Smart+Connected Doorbell, a self-learning, data-driven system, presents the user with comprehensive information about available housing options and various resources such as food, clothing, medicine, and other services. Additionally, Connected Doorbell tracks, reports, and presents shelter information to homeless individuals which is then shared with participating shelters thereby enabling the shelters to monitor and meet their needs.

Methods/Materials

To build the Smart+Connected Doorbell, SPDT miniature rocker switch (represents bell) with center off was fit into a picture frame. The doorbell was attached to a Raspberry Pi and a 7-inch interactive touch-screen display. This display is connected by a Raspberry Pi Flex Cable. Data from various Continuum of Care providers was collated by the Doorbell. Doorbell Hub, a cloud-based, data driven system hosted on an Amazon web server. Additionally, the BellTracker(TM) implemented within doorbell evaluates the number of times the bell was rung by individuals and the shelter preferred by the user. Effective bell rate is determined by correlating the raw bell count against the actual number of participants that show up at the CoC provider because of the information presented by the Doorbell.

Results

When implemented in LifeMoves and Rahima Foundation shelters, the average number of user clicks was 55 and the effective bell rate was 8. SmartCities around the globe are significantly increasing. Mathematical models was constructed to study effect of Doorbell. When the rates of homelessness that were proportional to the demand for housing were graphed against the BellTracker(TM) , a clear decrease in homelessness was shown because of the BellTracker system

Conclusions/Discussion

Effect BellRate generated from BellTracker# has proven to be effective in eliminating homelessness over a period of time.

Summary Statement

As demonstrated by Field Tests, Smart+Connected doorbell can be this first ring to eliminate homelessness from our societies.

Help Received

I would like to thank volunteers at LifeMoves and Rahima for their continued feedback to improve the Smart+Connected Doorbell User Interface and Provider Content.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Rishabh R. Bose

Project Number

S1003

Project Title

Modeling and Improving the Performance of a Thermoelectric Generator

Abstract

Objectives/Goals

The purpose of my Science Fair Project is to model the performance of thermoelectric elements, which uses Seebeck and Peltier effects to generate electricity and temperature difference. Thermoelectric generators are important for harvesting energy from wasted heat. The harvested energy has the potential to be stored in batteries for later use.

Methods/Materials

The thermoelectric effect is an interchange between temperature differences and electric voltage. My project explored two main aspects of thermoelectricity, the Seebeck effect and the Peltier effect, and I experimented with five hypotheses to investigate some of the practical aspects of these effects. Hypotheses related to the Seebeck effect were tested using semiconductor-based Peltier modules. The Peltier effect was tested using the modules and DC voltage.

Results

Based on my experiments, the appropriate thermoelectric efficiency for an application depends on few parameters. These parameters are the hot surface temperature, the cold surface temperature, the temperature difference (∆T), current and the heat load to be absorbed at the cold surface.

Conclusions/Discussion

The aim of my experiment was to evaluate the performance of Peltier module and modeling the parameters for improving the efficiency of the modules. The efficiency tests of the operation of the Peltier modules were carried out. I observed that the surface temperature on the hot and cold side and the ∆T has a direct impact on the efficiency of the Peltier module. In order for improving the electricity generation capabilities of the thermoelectric modules, a high temperature gradient will be required. Capturing waste heat and high degree of cooling the other side of the thermoelectric generator will be required to generate electricity.

Summary Statement

Identify important parameters for modeling and improving the performance of a thermoelectric generator

Help Received

My father was my guide. My mother helped me with the printouts and display of the science board.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Micah A. Boursier

Project Number
S1004

Project Title
Sedentary Sensor

Abstract

Objectives/Goals
Sitting too long everyday increases the risk of obesity, diabetes and heart disease. I developed a sensor that monitors how long someone is sitting. The user can set a time period at which they would like to be reminded to get up and move. The sensor communicates via Bluetooth to the users cell phone.

Methods/Materials
Arduino Lilypad
Force Sensitive Resistor Sheet (Velostat)
HC - 06 Bluetooth module
Breadboard for prototyping
Wires
Aluminum Foil
Computer/phone
Seat materials, Fabric

Results
The monitor and program perform as intended.

Conclusions/Discussion
The seat will remind people to be more active and reduce sitting.

Summary Statement
My project provides a simple and interactive way to remind people to be active and reduce sitting.

Help Received
I researched, designed, built, and programmed the project myself.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Kellie R. Cao

Project Number

S1005

Project Title

Optimizing Wireless Energy Transfer System to Power Biomedical Implants

Abstract

Objectives/Goals

Many patients depend on implantable medical devices, such as pacemakers and left ventricular assist devices (LVAD). Some of these devices require electrical wires to supply energy from external power sources, making patients vulnerable to infections from the exposed lead. A wireless power transfer system would eliminate the wires, and thus reduce the risk of infection. This project highlights the potential use of wireless power technology in biomedical devices. The goal of this project is to compare two different wireless energy transfer systems in circuit designs with regard to their impact on the power capability and efficiency.

Methods/Materials

Computer simulations were conducted to optimize the circuit designs for Class-C and Class-E based power oscillators. Two types of power oscillators with resonant inductive links were built into wireless energy transfer systems on breadboard to study the total power transfer and system efficiency.

Results

The Class-C based system transferred about 60 mW to the receiver with a total system efficiency of about 13%. In comparison, the Class-E based system transferred about half of a watt of power with a total system efficiency of about 15%. It is clear that the Class-E system transferred 800% more power than the Class-C system, with greater efficiency.

Conclusions/Discussion

While the Class-C oscillator is relatively easy to tune, it is limited by the operating voltage and current imposed by the bipolar junction transistor. The Class-E oscillator makes use of the high current capacity and fast switching characteristics of the MOSFET, as well as the zero-volt/zero current switching tuning, achieving higher performance than the Class-C oscillator. I hope that better tuning strategies can be achieved for the Class-E oscillator so the efficiency can be further improved in the future to use wireless energy transfer for fully implantable artificial heart systems.

Summary Statement

Resonant coupled inductive links based on Class-E power oscillator was built to demonstrate potential to power biomedical devices to eliminate the risk of lead-induced infection.

Help Received

I used lab equipment at the University of California, Irvine under the supervision of Professor William Tang. He also provided different papers to read, explained the concept of wireless energy transfer, and helped with circuit design selection. My parents drove me to the lab and purchased the supplies.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Sara Y. Du

Project Number
S1006

Project Title
Mobile Message Propagating Protocol for Disconnected Bluetooth Based Ad Hoc Networks

Abstract

Objectives/Goals
In disaster situations, communication is vital for minimizing time wasted and lives lost. However, the failure of traditional communication infrastructure in these situations often hinders communication. The objective of this research is to develop and apply routing protocols to mobile Bluetooth ad hoc networks.

Methods/Materials
The research occurred during a period of over a year. I started by familiarizing myself and experimenting with Bluetooth on several layers. A C++ simulator was later created to test the theoretical aspects of my proposed protocol while real life conditions were explored using an Intel Edison microcontroller and iPhone 5.

Results
The proposed Message Propagating Protocol shows significant advantages over traditional connected routing protocols in terms of packet delivery rate and storage requirements. It guarantees message delivery with fewer hops and less overhead compared to traditional proactive and reactive routing paradigms. The results indicate that routing in disconnected networks is both practical and achievable in real world scenarios.

Conclusions/Discussion
Even though routing in Bluetooth ad hoc networks has received little attention in comparison to scatternet formation, the results of this research show that this area can make a difference in the performance of networks by minimizing network reformations. These findings can be applied to devices that are used in critical situations.

Summary Statement
I designed a routing protocol which can be applied to disconnected Bluetooth ad hoc networks and achieve high delivery rate with minimal storage tradeoffs.

Help Received
I conducted the research and experiments without any outside aid.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Aidan D. Garamendi

Project Number
S1007

Project Title
A Better CPU

Abstract

Objectives/Goals
My objective was to learn if and by how much overclocking can improve my computer.

Methods/Materials
I used my custom built computer to test overclocking. I used a dowloaded program called user benchmark to do a before and after test of my CPU. To overclock my CPU, in increased it's clock speed by 250MHz.

Results
My CPU had a drastic increase in performance with all measures increasing in performance.

Conclusions/Discussion
The implications of this increase in performance are many. However, it primary impact is that it gives people the ability to increase the computing power of a computer without any cost increase.

Summary Statement
My project is about how overclocking a CPU can increase the power of a computer in a significant way.

Help Received
I got suggestions and tips from Don Maund but I did all the work and research myself.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Gautham Reddy Gujjula; Yash Tandon

Project Number

S1008

Project Title

Demystifying Electromagnetic Coupling within Antenna Arrays: An Analytical Model to Approximate Radiative Coupling

Abstract

Objectives/Goals

Electromagnetic Coupling occurs as the presence and activity of one antenna, when in close proximity of another, can modify the received signals of the nearby antennas. Electromagnetic Coupling can be accounted for by using several techniques, such as with computational models. This project explores the possibility of an alternative program that is faster than the conventional standard, in hopes of bringing similar capabilities to a more mobile setting. The current programs that are used to simulate environments to obtain response data are very computationally heavy because they utilize the Method of Moments approach, which utilizes partial differentiation. Although they are accurate, these programs take time to generate results. Our goal going into this project was to create a mathematically simpler and faster way of estimating the responses of antennas in an antenna array while accounting for mutual coupling and to test our created model's accuracy.

Methods/Materials

The mathematical model we created uses linear algebra, along with coupling matrices and a multitude of equations such as the steering vector equation, to approximate the response of an antenna array with certain specifications. The program itself was written by us and run in Matlab. To determine the accuracy of our analytical model, we compared its output to that of a set of reference values from 4NEC2, a computationally heavy and accurate antenna modeling software program that utilizes the more complex Method of Moments approach (was developed by Lawrence Livermore National Laboratory).

Results

After conducting tests, we found that our model had about a 0.3 percent error on average from its reference for its generated results. In terms of time, our program generates results in, at most, 0.634 seconds faster than our reference program 4NEC2 (with a total runtime of about 5-10 seconds depending on exact specifications), when the number of elements being processed was 18 or less.

Conclusions/Discussion

This non-computationally intensive model can potentially be used instead of, or in addition to, more time-consuming or computationally heavy methods of calibrating an antenna array, especially on less powerful devices, such as FPGAs and microprocessors.

Summary Statement

We created an analytical model in Matlab to approximate electromagnetic coupling among antennas; our model requires less computational resources than existing models and posted a 0.3% error and ~.6 second faster run time than our reference.

Help Received

Wrote algorithm ourselves but received guidance from mentor Patrick Ellis (met through Science Internship Program at UCSC) for how to display results and improve aspects of our project.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Alisa Y. Hathaway

Project Number

S1009

Project Title

Increasing Wifi Signal Strength Using a Phased Array Helical Antenna System

Abstract

Objectives/Goals

This experiment was conducted to investigate the feasibility of utilizing a phased array that is able to focus its signal strength on a specific location. In the 21st century, where robust internet is a vital necessity, consumer requirements drive the need to investigate methods to enhance WiFi signal strength.

Methods/Materials

A 5 GHz phased array with helical antennas was constructed, and a circuit board was designed. Many different physics formulas were applied to calculate dimensions. The board incorporated phase shifters, shift registers, 0.1 uF capacitors, 2 6-pin connecters and 1:2 Wilkinson dividers. An Arduino Uno was programmed to shift the beam to a specific location, and the time was delayed between each element.

Results

The phased array antenna system was tested and optimized using a Keysight Fieldfox Microwave Analyzer. The phased array antenna system was able to ameliorate the wifi signal strength significantly.
The antenna gain of a phased array was calculated:
Ga = 4πAN/ λ^2
The phase shift between two elements:
Ψ = 2π(d/λ) . sin θ

Conclusions/Discussion

The hypothesis, #A stationary array of helical antennas could be digitally controlled using phase shifters, in order to form a focused beam that could be steered to a specific target location.# was accepted. The phased array board was created to shift beams in certain locations to allow a higher concentration of energy to be placed within a smaller area. This also shows why an original router would not be as effective, considering the fact that the classic router sends out signal isotropically.

Summary Statement

In order to increase Wifi signal strength, a phased array helical antenna system was designed and implemented.

Help Received

Mr. Neil Yamamoto - Keysight Fieldfox Microwave Analyzer borrowing , Mr. Mike Herndon - understanding tuning (impedance matching), Mr. Ameesh Pandya - MATLAB understanding

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Simrithaa L. Karunakaran

Project Number

S1010

Project Title

SafetyStep: A Novel Device Using IoT to Provide Safe Navigation for the Visually Impaired

Abstract

Objectives/Goals

The objective of this project is to invent SafetyStep, which is to be a novel invention to provide safer, more independent, more mobile, and more accurate self navigation for the visually impaired with the ability to detect if the user can self navigate safely as well.

Methods/Materials

Main components (for the prototype used in the demonstration): 1 Arduino Uno (integration of all electrical components), 2 Ultrasonic Sensors (detect distance and direction of obstacles from user), 2 Vibration Motors (create various vibrations), 1 GSM/GPRS Shield (send text messages), and 1 Speaker (sound various alarms) Coded using Arduino language, which is a set of C/C++ functions. Made to be used with as many ultrasonic sensors and vibration motors as prefered by user and device can be placed anywhere on the body to detect objects in all levels. Final prototype had cost of about $50 and per-unit materials cost will drastically decrease during mass production.

Results

Objective was accomplished by invention of SafetyStep. SafetyStep was made to use vibration motors to alert the user of the direction and distance of obstacles in the vicinity of the user, an alarm to alert the user of the distance of the obstacle, and text messages to alert the caretaker of whether the user is adequately processing the information SafetyStep is giving and if the user has the capability to even self navigate safely. Prototype tested 70 times using all possible test scenarios using different obstacles at different distances from the ultrasonic sensors. Final prototype received accuracy level of 95%

Conclusions/Discussion

According to the WHO, about 285 million people are visually impaired worldwide and about 90% of the world's visually impaired live in low-income settings. Objective of project met through invention of SafetyStep. SafetyStep is a novel, low cost, haptic (using vibrations), hands-free approach to increase mobility, safety, and independence during self-navigation for the visually impaired while also being high in accuracy and universally usable by people with specific accommodations and disabilities.

Summary Statement

Novel, low cost, hands-free device to detect obstacles' distance and direction via vibrations and alarm sounds and identification of unsafe self navigation via text messages for exponentially safer self navigation for the visually impaired

Help Received

Parents provided monetary help for purchasing components of SafetyStep; All research, design, development, and testing of SafetyStep done by me

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Patrick Liu

Project Number

S1011

Project Title

CordisX: Personalized Cardiac Monitor

Abstract

Objectives/Goals

Nearly a fourth of the U.S. population suffers from cardiovascular diseases and require regular checkups with clinicians. CordisX aims to provide a cost-effective, personalized cardiac diagnosis system that integrates the hardware and software aspects of automated ECG interpretation and the monitoring of the correlation of heart rate and oxygen saturation data. The ECG signal is compared to a normal (baseline) database, while the heart rate/oxygen saturation system retrieves the user's age and gender for healthy ranges.

Methods/Materials

Theorized relationship between heart rate and oxygen saturation, derived 'normal' range of vital data based on age/gender through experimental data set. Created LCD hardware interface for dual-sensor system, established Bluetooth link with self-made Android app for diagnosis based on age/gender. Researched automated ECG analysis and feature extractions, drew out data flow. Perfected circuit, displayed real-time ECG signal on JSCanvas and MATLAB. Machine learning technique for extraction of baseline features from MIT-BIH Database. Developed method to export data to MATLAB, and created algorithm to detrend and diagnose ECG signal through comparing wave components to baseline features.

Results

The smoothing method in MATLAB resulted in efficient color-coded filtering of noise and variation in the ECG signal. Peak analysis techniques recognized different segments and peaks of the signal, but simulated irregular signals resulted in lack of signal component recognition in the output. An overall percentage error of 8.02% of my ECG signal compared to the database was calculated, proving the system's reliability. The dual-sensor system took around 30 seconds to stabilize its data, providing consistent general diagnoses.

Conclusions/Discussion

The ECG analysis system proved to be useful in data transmission and recognition of the different components of an ECG wave. The MATLAB script filtered noise and produced a cleaner signal, recognizing different components of the ECG wave. In combination with the dual-sensor mobile system, the ECG analysis framework allows a user to better visualize his or her overall heart health through vital heart data and examinations of the ECG signal. A total cost of $131 was calculated for CordisX, a midrange price compared to other cardiac monitors. However, its measurement capabilities and personalized diagnosis features outweighed other market devices.

Summary Statement

In combination with a self-made ECG interpretation framework based on MATLAB, the dual-sensor system synced to a mobile application allows a user to better visualize overall heart health through diagnosis based on his or her age and gender.

Help Received

Dr. Zhaoxia Yu of UCI's Data Science Department provided me with insight into statistical analysis methods. Dr. James Li gave me general advice on my overall research process.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Sarthak Mishra; Siddhant Sharma

Project Number

S1012

Project Title

Project S.O.D.A., the Smart Obstacle Dodging Assistant: Helping the Visually Impaired Be Safer Outdoors

Abstract

Objectives/Goals

The objective of our experimentation is to determine if ultrasonic sensors and vibration motors attached to walking canes help the visually impaired avoid obstacles better than traditional walking canes.

Methods/Materials

3 ultrasonic sensors, 3 Arduino Nanos, 3 vibration motors, 1 metal cane, 1 walking cane, 1 pack of jumper wires, 3 small breadboards. Programmed the Arduino Nanos to warn the users of objects in the vicinity and assembled the Project S.O.D.A. walking cane using ultrasonic sensors, Arduino Nanos and vibration motors.

Results

The test subjects used regular walking cane and Project S.O.D.A. walking cane to walk through closed course and the number of unwanted collisions were recorded. The Project S.O.D.A. walking cane significantly reduced the number of accidents.

Conclusions/Discussion

The Project S.O.D.A. walking cane proved to be much safer for the user than traditional walking cane. The average number of accidents that occurred for the test subjects while navigating through the closed course from 12.166, while using the traditional walking cane, to 1.5, while using the Project S.O.D.A. walking cane.

Summary Statement

We have designed a walking cane for the visually impaired using sensors that proved to be much safer than traditional walking canes.

Help Received

None. We designed, programmed and conducted our experimentation independently.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Sina Moshfeghi

Project Number
S1013

Project Title
Comparing the Radiation Effects of Cellular vs. WiFi Calling

Abstract

Objectives/Goals
The Radio Frequency (RF) radiation emitted from cell phones exposes humans to potentially harmful radiation that may cause cancer. It is therefore important to discover methods that reduce the RF radiation of cellphones. The objective of this project was to determine whether WiFi (Wireless LAN) calling exposes humans to less RF radiation than cellular calling because of the shorter distance to the WiFi access point.

Methods/Materials
Innovative measurement and calibration methods were designed to compare the transmit powers of WiFi calling and cellular calling. These procedures overcame challenges such as antenna efficiency, antenna gain, interference, reflections, and the surrounding environment. The power transmissions of an iPhone were measured in the near-field of the phone using a magnetic loop probe and a spectrum analyzer. Magnetic loops were built and calibrated for their frequency-dependent response because WiFi calling and cellular calling used different frequencies. Power measurements were repeated at different distances from the WiFi access point to determine if separation distance affected transmission power.

Results
The results of the experiments showed that WiFi calling used more transmission power than cellular calling; in some instances up to 1000 times more power. Transmission power measurements of WiFi calling did not change as the cell phone got closer to the WiFi access point, demonstrating that WiFi calling did not use power control effectively. On the other hand, cellular calling used adaptive power control, which lowered its power transmission and radiation effects.

Conclusions/Discussion
Contrary to conventional thinking, the experiments illustrated that current system implementations of WiFi calling emit greater RF radiation than cellular calling. This discovery means that improved voice calling methods with lower power transmit are needed to reduce RF exposure to the human brain.

Summary Statement
This project designed innovative measurement and calibration methods that measured and compared the RF radiation of two cell phone voice calling techniques in order to identify a safer voice calling technique that reduces the RF radiation.

Help Received
Ed Roth provided me with his spectrum analyzer and signal generator and showed me how to use them for my measurements.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Andrew B. Nazareth

Project Number

S1014

Project Title

Cell Phone Radiation: Watts Worse, Voice or Data Transmissions? A Comparison of Electromagnetic Field Strength

Abstract

Objectives/Goals

The objective of this study is to determine which source of cell phone transmission- voice or data - emits more non-ionizing electromagnetic radiation, to determine if the data supports the inverse square law and to seek ways for users to reduce their EMF exposure

Methods/Materials

The EMF radiation from different smartphones (LG-4S and iPhone-SE) and accessories (a virtual reality headset and blue tooth), was measured using an RF detector (Tenmars TM-195 3 Axis RF Field Strength EMF Meter) under different operating conditions (voice, video, mobile games, and a 3d virtual reality app). The distance from the phones was varied (from 0 cms to 15 cms) to see how this affected the EMF exposure. Readings were taken (every 30 seconds) over a 150 second interval for each test. In addition to distance, alternative approaches to reduce EMF radiation exposure were considered, including the use of a Bluetooth device, and a homemade Faraday cage (made from aluminum foil). A total of 140 trials were completed.

Results

Total averaged EMF readings tested at 0 cms showed voice transmission to be 42% higher than averaged data transmission (including You Tube, Clash Royale Video Game and Virtual Reality video). 97% drop in EMF exposure for data (You Tube) and 63% drop in voice (Phone Call) from 0 cms to 15 cms. 77% drop in EMF exposure between Bluetooth and voice readings at 0 cms.

Conclusions/Discussion

The data from this experiment proved my hypothesis wrong as Voice calls had a higher EMF exposure than Data usage (including You Tube, video downloaded through Virtual Reality and Video Games). Downloading You Tube videos or playing video games has lower EMF exposure than watching videos/movies using a Virtual Reality headset. Blue tooth is a safer solution than texting or using a shield. Talking emits more radiation than receiving a call. Results from this experiment supports the inverse square law for both voice and data transmissions where EMF exposure reduces with an increase in distance between the phone and the user#s head- which is the most effective and inexpensive way to shield users from radiation.

Summary Statement

Over 140 trials, I proved that cell phone voice tranmissions have a higher EMF exposure than data transmissions, the results support the inverse square law and blue tooth usage and distance away from the user's head reduces EMF exposure.

Help Received

Erik Perkins from Kirby School was my project advisor. I worked with Mr. Williams to understand the physical concepts involved in this experiment.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Atul Raghunathan

Project Number
S1015

Project Title
Six Degree Positioning Based on Laser Plane Projection and Inertial Navigation

Abstract

Objectives/Goals
This project aims to provide 3D spatial orientation in an unknown space through the establishment of thermal patterns (beacons) on objects within the environment. Utilizing the skew, rotation, and size of the pattern, this method can derive six degree of freedom data (x, y, z, pitch, yaw, roll). The goal is to generate position and orientation accurate within 1 decimeter and 5 degrees.

Methods/Materials
The final design of the sensor unit used three 2 watt blue heating lasers. The lasers are powered until three spots are raised to a temperature 3, 6 or 9 degrees Celsius above the ambient temperature. A thermal camera mounted on a pan tilt roll servo mount track these dots. A thermometer, accelerometer and gyroscope unit mounted on the roll adjusting servo, provides the rotation and temperature data needed to filter the output of the camera. Comparing expected distances between spots to angular distance between spots produces a measurement of distance from the beacon. Viewing angle to the beacon is calculated using servo position. After conversion to Cartesian coordinates, noisy output data is passed through a dynamic filter that adjusts its parameters with accelerometer data.
To measure position accuracy, data was collected at 12 points within a 1m cube. To measure angular accuracy, data was collected at 18 points within the same cube.

Results
The engineering goal of sub decimeter accuracy was achieved and surpassed. Positional XYZ data was consistently accurate within 5 centimeters and degree data was accurate within 2 degrees. This prototype has shown higher accuracy of 1 centimeter and 1 degree within a 30 centimeter radius of the tracking dots. These results serve as a validation of the geometric principles used to conduct this project.

Conclusions/Discussion
Current indoor navigation systems use a pure inertial navigation unit (INU), Simultaneous Localization and Mapping (SLAM), stereo cameras, or a radio beacon. Combining the benefits of all current solutions, this system is self contained like an INU, light independent like LiDAR based SLAM, drift free like stereo cameras and accurate like a radio beacon. This technology enables various applications such as beacon free indoor mapping, geo referencing underground locations, and navigation in parking structures and tunnels.

Summary Statement
This project provides three dimensional position and direction by placing thermal patterns on nearby objects and measuring their movement.

Help Received
I designed, built, and tested my apparatus and algorithms myself after conducting internet research and consulting with my physics teacher.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Ryan M. Ramsey

Project Number
S1016

Project Title
Stepping into the Future

Abstract

Objectives/Goals
Determine the relationship between walking and the energy produced to charge a cell phone. The goal of this experiment is to charge the cell phone's battery up to 50% from 3 hours of walking.

Methods/Materials
Tested the percentage of cell phone battery charged from walking using a piezoelectric energy harvester. The energy harvester converted the mechanical energy of walking into electrical energy. The produced electrical energy from the piezoelectric actuator was stored in an external storage battery to charge the cell phone later.

Results
The large piezoelectric actuator produced 1.10mA and 80v. The smaller actuator used produced 0.58mA and 60v. The relationship between the amount of time walked and phone battery percentage charged was linear. For every hour walked, a percentage of the phone was charged.

Conclusions/Discussion
Many people own a hand held device(cell phone). With this is mind, providing an alternative to the standard, stationary way of charging a cell phone would provide more convenience. I built a shoe capable of charging a cell phone using piezoelectric actuator to convert the mechanical energy of walking into electrical energy. This is possible due to the molecular structure of the piezoelectric material.

Summary Statement
I built a shoe that can charge a cell phone.

Help Received
I designed, built, and tested the shoe. My biology and physics science teacher reviewed my reults. A proffessor from Calofornia State University San Bernardino provided me with piezoelectric actuators.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Anshul Singh

Project Number
S1017

Project Title
Prototyping an Omnidirectional Drone Collision Avoidance System with Sweeping Ultrasonic Sensors

Abstract

Objectives/Goals
The objective was to design a reliable omnidirectional drone collision avoidance system to assist drone users and expand drone capabilities.

Methods/Materials
The task of creating a collision avoidance system was split into three different subcomponents: an onboard drone collision avoidance system, a ground control system, and the drone itself. The onboard system had an Arduino Microcontroller running two ultrasonic sensors mounted on top of a servomotor. The motor swiveled the sensors, and collected data from its surroundings. Based on the data, the system chose whether to give the user control or take actions to move the drone away from the object. The data was passed onto a ground control system, where the data was processed. The commands to move the drone away from objects were forwarded to the drone, and user control was taken in when the drone was in any safe zones. The drone then received all of these commands from the ground control station over Wi-Fi protocols and maneuvered accordingly. The Drone was tested through two different types of test cases, and data was recorded and mathematical models were developed.

Results
The drone was run through twenty presentations of obstacles. The drone successfully avoided seventeen out of twenty and failed to avoid three presentations of objects. The presentations had different types of objects, forms of presentation, and methods of avoidance to them.

Conclusions/Discussion
Based on the experiment, a mathematical model was developed. The net velocity shared between the drone and the object was strictly limited by the time it took to rotate the servomotor. By either decreasing the time it takes to rotate the servo, increasing the threshold of the drone, or increasing the number of sensors onboard the drone, the amount of net velocity can be increased. By changing any of these factors, the drone system would be improved, and obstacle detection successes would be greatened.

Summary Statement
I created an omnidirectional drone collision avoidance system with sweeping ultrasonic sensors and drone apis.

Help Received
Did internet research to help with component selection and coding.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Vasily A. Tremsin

Project Number
S1018

Project Title
Less Water, More Food? A Novel Low-Cost System for Real-Time 3D Imaging of Soil Moisture for Intelligent Irrigation

Abstract

Objectives/Goals
Hunger, one of the most prominent problems in the world today, is primarily caused by a shortage of fresh water. Significant optimization of water use can be achieved by knowing the time and amount of watering, as well as the specific location of soil that requires irrigation. However, most existing techniques of soil moisture measurement can only provide results at one point in the soil, require frequent calibration, and remain very costly.

Methods/Materials
I created a novel system capable of real time assessment of soil moisture content, which consists of a self-sustained data acquisition device, three-dimensional data analysis algorithm, and a real time visualization program. The system is very low cost compared to analogous instruments (can be under 30 dollars), is capable of wireless data transmission, is solar-powered, features one-button calibration, provides accurate time and location from the GPS signal, and can store historical data over long periods of time. It is based on using simultaneous measurements of resistance between two arrays of electrodes (up to 48 electrodes). After the data is digitized, coupled with GPS information and stored on a local SD card, it is sent via a wireless connection. An algorithm uses resistance values to construct a three-dimensional image of relative soil moisture content, which is visualized in real-time.

Results
I found that After the application of water, there was a substantial change in soil resistivity across all measurements, which justifies that resistivity can be used for a relative assessment of water content. I observed a distinct difference in resistance near the top and bottom of the soil volume, showing the dynamics of water penetration downward. Even before the application of water, various electrodes exhibited different resistance measurements. In order to account for these irregularities, a ratio of the present resistance values to the resistance of dry soil is computed. This process separates the variation of resistance due to moisture from the variation of resistance due to instrumental factors.

Conclusions/Discussion
By significantly increasing the efficiency of agricultural irrigation, this unique system can help to preserve precious freshwater resources and potentially alleviate the problem of hunger all around the world.

Summary Statement
I created a novel low-cost system for real-time three-dimensional imaging of soil moisture content which can be used to save precious freshwater resources.

Help Received
My physics teacher helped me to explore present soil moisture measurement methods. My sister helped with transmitting the data from the data acquisition device to the computer via a Serial port.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Edward Yang

Project Number
S1019

Project Title
An Advanced Vehicle Warning System to Prevent Rear End Collisions

Abstract

Objectives/Goals
The US Department of Transportation states, in one of its reports, rear-end collisions contribute to more than 33% of all car accidents. The objective of this engineering project is to create a low-cost rear vehicle warning system that can prevent rear end collisions from occurring that can be used commercially.

Methods/Materials
Previously, a prototype of this vehicle alarm system was built using only an LDM and Raspberry Pi. This year, the system is improved by developing a dynamic safety distance model using the actual speeds and stopping distances for both vehicles through the application of all the variables that affect vehicle stopping distance. A GPS is integrated into the system to obtain the actual speed of the installed vehicle and the road slope. Using the distance obtained by the laser distance meter, the speed of the following vehicle is accurately determined. Additionally, a camera is added to the system to take a picture of the following vehicle. Paired with a machine learning program that had been edited from source code found from SourceForge for object-detection by bikz05, it is able to recognize whether the following vehicle is a truck or a car because trucks require double the stopping distance of a car. The system was then tested by attaching it to a car and driving the car on a highway and in a neighborhood and in rainy and sunny weather.

Results
The system was able to successfully warn or alarm the rear vehicle when it was too close. The model that was created accurately predicted the distances at which the rear vehicle is or is not a safe distance away. The cost of the whole entire system was less than $200 and is able to work under difference circumstances.

Conclusions/Discussion
This project successfully built a vehicle warning system and demonstrated the ability of the system to predict and warn when a rear-end collision may occur and validates the efficacy of the model that was created.

Summary Statement
My project is a vehicle warning system that uses a novel model to calculate whether or not the rear vehicle is a safe distance away and warns the rear driver if the car is not.

Help Received
I designed my own vehicle recognition program after referencing Bikramjot Singh Hanzra#s (bikz05) object detector program as an example to create my own with.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Michelle Y. Zhu

Project Number
S1020

Project Title
A Novel, Inexpensive, Portable Medication and Vaccine Refrigeration Device

Abstract

Objectives/Goals
The objective is to build a pocket-sized, user-friendly, everyday refrigeration device suitable for transporting pharmaceuticals in developing countries and other areas where electricity is nonexistent. With a couple of accessories, the device has potential to treat cardiac arrest, stroke, neonatal encephalopathy, Parkinson's disease, and head trauma in active elderly, car crash victims, athletes, service members and more.

Methods/Materials
The project contains a proof-of the concept prototype and is tested against design criteria. It needs to be inexpensive, small, light, reliable, and able to keep a stable temperature of under 8ºC, the temperature that common vaccines need to be stored.
The design of the device consists of two parts. One is the thermo electro static refrigeration component that becomes cold when electric current flows through it. The second part is the rechargeable battery power source that can be recharged with numerous sources of renewable energy. The temperature of the prototype was tested with a thermo coupler wire over periods of operation.

Results
The temperature of the device over three 15-minute operation periods demonstrated its ability to maintain below 8ºC for an extended period of time. During its operation, the device was independent from any outside sources of electricity.

Conclusions/Discussion
This device is inexpensive, reliable, and portable, making it suitable for operation without external sources of electricity. With accessories, it can be used as an everyday medical device to treat cardiac arrest, stroke, Parkinson's disease, neonatal encephalopathy, and traumatic head injuries in active elderly, athletes, service members and more.

Summary Statement
I built a pocket-sized, user-friendly, everyday refrigeration device suitable for transporting pharmaceuticals, with potential to treat cardiac arrest, and other diseases, without external sources of electricity.

Help Received
I designed and built the prototype myself using my school's industrial art facilities. My STEM teacher reviewed my results and made sure safety precautions were followed during experiments.