CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Ashley M. Bianco

Project Number
S0901

Project Title
Common Electrical Appliances and the SID Monitor

Abstract

Objectives/Goals
To determine if common household electrical appliances with higher voltage disrupt my SID(Sudden Ionospheric Disturbance)monitor. The SID collects data on the effects of solar disturbances in the Earth's ionosphere. It is important to discover what common electrical appliances disrupt my monitor so that I may eliminate this disturbance and collect correct data.

Methods/Materials
SuperSID monitor, Dell PC laptop with a sound card that records 96kHz, PVC piping, 120 meters of insulated wire, Coax Cable RG - 58, BNC connector, terminal block. Antenna: PVC pipes glued in shape of box with wire wrapped around. Coax cable attaches the terminal block and plugs into SID. Monitor configured with longitude, latitude, and time zone (discovered using Garmin GPS and verified on Google Earth). Isolated antenna and monitor to record clean interference free data (Verified by GOES Data as Control). I then tested each electrical appliance separately and recorded its effects.

Results
Electrical appliances had an effect and caused either fluctuations or anomalies within the data. Electrical appliances with higher voltage created a greater effect. All data collected, measured, and graphed is displayed in report.

Conclusions/Discussion
The biggest offenders were the fluorescent light bulbs, vacuum cleaner, and the microwave oven with a greater amount of voltage causing high spikes on the readout. Some of which could be considered fatal to the SID monitors ability to continue operation. Some did not generate much sound but enough noise to cause an interference because low voltage. The microwave had the biggest effect, because it uses radio waves and because microwaves use high frequencies which can cause fatal malfunctions to the highly sensitive monitor. Vacuum cleaner had an effect because of how loud its motor was and it used a medium amount of voltage. Furthermore, I found that voltage does have an effect upon the monitor, but other factors can cause disturbances. During testing, I found that sound cards play a big factor in your data. An AC97, which only records sounds at 48 kHz, this only added to the preamplifier. Overall, I was able to correctly identify the offenders and I will begin working on isolating and eliminating these disturbances so that I may further my research into Solar activity.

Summary Statement
Testing the effects of common household electrical appliances with higher voltage on the SID monitor.

Help Received
mother provided glue, Stanford provided the SID monitor, Grandfather helped wire antenna.

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Weston D. Braun

Project Number
S0902

Project Title
Wireless Power Transfer: The Effect of an Intermediate Coil

Abstract

Objectives/Goals
The goal of this project was to increase the efficiency of resonant wireless power transfer by utilizing a passive tuned coil placed between a transmitter and a receiver, and to determine the ideal placement of this intermediate coil.

Methods/Materials
I built a transmitter to drive a resonant coil as a wireless power transmitter. I then built two additional resonant coils, one with a resistor across the capacitor to measure the voltage across it (receiver). The receiver was placed one meter away from the transmitter, and voltage measurements were recorded with the transmitter operating. I then placed the third coil 5 cm from the transmitter, between the transmitter and the receiver. The voltage was recorded and the coil was moved in 5 cm increments towards the receiver, recording the voltage at each position. The experiment was conducted five times.

Results
The intermediate coil increased the voltage in all positions but one, when it was closest to the transmitter. The highest voltage was when the intermediate coil was 90 cm from the transmitter, where it averaged 389% of the voltage without the third coil. The voltage with the third coil in the middle was 29% greater then without the coil.

Conclusions/Discussion
My hypothesis was wrong. The intermediate coil increased the voltage in the receiver coil, however the highest increase was not when the coil was in the middle. I believe that peaks and dips when the intermediate coil was close to the transmitter or the receiver were due to the higher coupling of the coils, which changed their resonant frequency.

Summary Statement
The use of a passive tuned coil to increase efficiency of resonant wireless power transfer is investigated.

Help Received
Used high school metal shop equipment to cut wire coils

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)

Philip R. Chang

Project Number

S0903

Project Title

Solar Panel Under Shadow: Increasing Efficiency via a New Configuration

Abstract

Objectives/Goals

It is known that shadows significantly reduce solar panels' output power in commercially available models. The objectives of this project are to investigate this phenomenon as well as develop a new configuration of solar cells so that the effect of shadows on output power is reduced, effectively increasing panel efficiency under shadow.

Methods/Materials

56 Electronic Goldmine Solar Cells (1.4" x 2.25" generating 0.5V and ~0.4A), wires, 8 resistors (2 Ohm), 2 LED modules as load, multimeter, soldering iron, construction light as indoor light source, wire cutters, solder, etc.

Most commercially available solar panels use series-parallel solar cell connections. I first measured solar cells' outputs (open circuit voltage and short circuit current) under different light intensities. I then connected two cells in series and parallel, measuring output powers when one cell of each pair is shadowed. This investigation allowed me to observe that under shadow, total output current is limited in a series connection and total output voltage is limited in a parallel connection, leading to low efficiency from traditional panels. To develop a new cell configuration, the series-parallel connection thus must be avoided. Guided by Kirchhoff's Laws and topological reasoning, I developed a new configuration. To compare an orthodox series-parallel configuration with the newly developed one, two 4 by 7 solar cell arrays were connected with both configurations. While total panel output powers under shadow were measured and compared quantitatively, two LED modules were used to demonstrate results qualitatively.

Results

Four shadow positions were used to evaluate the results. When the shadow was placed parallel to sides of the solar panel, the panels had similar, theoretically equivalent, outputs. However, when the shadow had a significant angle to the sides of solar panel, the new panel generated 56.3% and 71.1% more power than the other panel in two independent shadow positions.

Conclusions/Discussion

The new configuration indeed has a significant efficiency improvement over the conventional model under several shadow conditions. While only 4 by 7 solar cell arrays were used in this project, the methods and reasoning used here can be utilized to generate much bigger solar cell arrays that would have better efficiency than the simple series-parallel configuration. Such configurations have been proposed to be patented.

Summary Statement

Using a newly developed alternating-based solar cell configuration, as opposed to the traditional series-parallel based one, it is possible to reduce the effect of shadows upon a panel's current and voltage output.

Help Received

Ms. Cathy Prater (science teacher) helped review the project. Parents helped buy materials and provided a sufficiently resourced workplace.

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Alexander L. Chen

Project Number
S0904

Project Title
Characterization of Series-Parallel and Total-Cross-Tied Solar Modules

Abstract

Objectives/Goals
The objective of this project is to determine if solar modules in the total-cross-tied (TCT) configuration can generate higher maximum-power than those in the series-parallel (SP) configuration.

Methods/Materials
Six 4x4 solar modules were assembled and characterized, three in the TCT configuration and three in the SP configuration. In the SP configuration, solar cells were connected in series to form a column. Several columns were then connected in parallel to each other to form a module. The TCT configuration was obtained from the SP configuration by connecting ties across each row of interconnects. Performances of the modules were measured and compared under four operating conditions: 1) modules with proper wiring connection and under uniform illumination, 2) modules under uniform illumination but each with a short circuited solar cell, 3) modules under uniform illumination but each with an open circuited solar cell, and 4) Each module with a solar cell completely blocked from illumination. In addition to experiments, equivalent circuit model parameters were extracted and circuit simulations performed to validate measurement results.

Results
When all internal wires were properly connected and the modules were uniformly illuminated, both configurations exhibited nearly identical performance. In the presence of a short-circuited cell, however, the SP module outperformed the TCT module in terms of maximum output power. Conversely, in the presence of an open-circuited or shadowed cell, the TCT module outperformed the SP module. A completely shadowed cell was found to behave like an open-circuited one. Circuit simulation results agreed with measurement data very well.

Conclusions/Discussion
Although a solar module in the SP configuration has the simplest wiring configuration and one in the TCT configuration is the most complete, the latter does not always outperform the former. Therefore, the choice of an optimum solar module configuration depends on which non-ideal operating scenario is most likely to occur.

Summary Statement
Solar modules in the total-cross-tied and the series-parallel configurations were compared experimentally and by simulation, and it was found that the choice of an optimum configuration depends on the operating scenario.

Help Received
Mr. Peter Starodub, my science research teacher, guided me throughout the entire scientific research project. My parents provided support and supervision for online procurement and experimentation at home.

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Michelle Chen

Project Number
S0905

Project Title
Investigation of the Efficiency Droop Mechanisms in Wide Bandgap Light Emitting Diodes (LEDs)

Abstract

Objectives/Goals
Light emitting diodes (LEDs) are currently increasing in terms of application to lighting and electronic devices. However, it has been noted that LED efficiency is inconsistent; efficiency often decreases with increasing current. This experiment observes the effect of increasing current on various LEDs in order to determine the cause of this so-called LED efficiency droop phenomenon.

Methods/Materials
Red and Yellow InGaAlP based LED (Non-polar); Blue and Green InGaN based LEDs (Polar)
Electroluminescence meter
Pulsed current supply with computer control
Spectrometer

Results
Observing the EQE (efficiency) charts (which show the ratio if light power output to light input vs. current), both red and yellow LEDs are shown to have an power input/ light power output ratio beginning at 30% and increasing to about 35% before beginning to drop. The current at which efficiency begins to drop is approximately 30-50 mA. The blue and green LEDs have efficiencies that drop immediately. Efficiency drops from a high efficiency (about 61% green; 57% blue) to a low (18% green; 23% blue)for polar LEDs. The efficiency drop in these LEDs occur at around 3 mA.
The nonpolar LEDs exhibit redshifts, or change in wavelengths, as the input currents increase, made clear by the EL Spectra. The blue and green LEDs exhibit no significant change in wavelength as the current increases.

Conclusions/Discussion
Red and Yellow LEDs (non-polar) show an efficiency droop beginning at a much higher current input that that of the blue and green (polar) LEDs. The source of the efficiency droop in the non-polar LEDs is due to the joule heating effect, shown by the redshift. The change in wavelength of light shows that heat damage (due to resistance of the diode and the input current) has degraded the LED; not only is the wavelength of light changed, but the efficiency is affected as well. However, the blue and green LEDs do not demonstrate this joule heating effect. Thus, there is no way to conclude the source of the efficiency droop in these diodes.
My hypothesis was only partially correct: internal resistance and heat degradation only appears to affect LEDs made of non-polar semiconducting materials. It seems that the source of the efficiency droop is more complicated in polar LEDs due to the different polarity of the semiconducting materials.

Summary Statement
Exploring the efficiency droop of polar and non-polar LEDs in relation to increased input currents.

Help Received
Used lab equipment at Blue Photonics Inc. under the supervision of Dr. Milton Yeh.

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Rafael Cosman; Aaron Schild

Project Number
S0906

Project Title
Sun in Your Eyes? Electrochromic Sun-Tracking Windshield

Abstract

Objectives/Goals
The Electrochromic Sun-Tracking Windshield (ESTW) is an automatic machine vision system for cars which determines when the sun is in the driver's field of view and rapidly darkens a small portion of the windshield to block the direct sunlight. The goal is to minimize dangerous driver distraction due to bright, low-angle sunlight and eliminate the need for manual sun visors.

Methods/Materials
The engineering project involved system design, parts acquisition and integration, and creation of image analysis and camera calibration software. The project has been taken from initial concept through testing and deployment on a vehicle driving on city streets.

The ESTW prototype consists of six major components: ultrasonic range finder, camera, computer, microcontroller, relay circuits, and electrochromic panels. The camera sends images to the processing unit, which analyzes them to determine the sun's angle relative to the driver's eyes. The software instructs electrical relays to activate the specific panels necessary to block the distracting sunlight. Electrochromic gel in the panels darkens with the application of voltage. When sunlight is no longer in the driver's eyes, the panels quickly return to a transparent state. The ultrasonic range finder determines the driver's position in an initial calibration step, allowing the software to calculate the angle from the driver's eyes to each panel.

Results
The ESTW was tested on several days during the late afternoon, when a sun visor is frequently necessary. As the car moved, the ESTW darkened the appropriate panels to block the direct sunlight.

Conclusions/Discussion
The ESTW tracks and rapidly attenuates direct sunlight, eliminating the need for a sun visor during real-world driving conditions. The ESTW technology can be extended to other vehicular scenarios including ships, aircraft, and spacecraft. The ESTW has the potential to reduce driver distraction, automobile injuries, and loss of life.

Summary Statement
The Electrochromic Sun-Tracking Windshield (ESTW) is an automatic machine vision system for cars which determines when the sun is in the driver's view and rapidly darkens a small portion of the windshield to block the direct sunlight.

Help Received
Received $500 COSMOS-Intel grant; Gentex Corporation donated 40 electrochromic glass panels; Capturix donated video-capturing software

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Alex Hang; Duy Nguyen

Project Number
S0907

Project Title
The Applications of Resonant Energy Transfer via Inductive Magnetic Coupling

Abstract

Objectives/Goals
To manipulate factors in order to maximize efficiency output, increase the transmitting power and finally, to integrate applications to everyday use.

Methods/Materials
RF amplifier
Oscilloscope
Function generator
Copper coils/tube
LED
Incandescent light bulb
Power outlet
Multimeter
Meter Stick

Results
During our experimentation, we were able to power LEDs wirelessly at an approximate range of 3 feet.

Conclusions/Discussion
In the end, we were able to successfully light a gauge 18 copper coil, with 20 revolutions, that has 2 3volts LEDs; the coil was resonating at 3.38 MHz and had a max distance of 60 cm. Many of the other coils reached similar progress. It is possible to light all six coils at once using only one transmitter, the circular loop that was created by alligator clamps. We discovered that 2.1 MHz all the lights lit up.

Summary Statement
We are trying to power electronics wirelessly

Help Received
Mr. John Allen

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)

Abdulrahman Jones; Arnav Mishra

Project Number

S0908

Project Title

Feasibility of HEM Fuel Cells Today and Tomorrow: Comparing Performance and Economic Viability of Cataylsts in HEM Fuel

Abstract

Objectives/Goals

We compared nickel and silver in their respective reactions (anodic and cathodic) to platinum standard to determine their economic viability in HEM fuel cell. We hypothesized that nickel and silver, in their own respective reactions, are more economically viable than platinum in a HEM fuel cell.

Methods/Materials

Using a three rotating disc electrode (RDE) apparatus we establish the feasibility of our catalysts in a HEM fuel cell. We cleaned and polished Teflon-coated glass-carbon electrodes. Next we coated the electrode with nickel and then Nafion for the hydrogen oxidation reaction (HOR). We repeated the steps using silver instead of nickel for the oxygen reduction reaction (ORR). We sprayed the anode with an ink solution containing nickel on a gas diffusion layer and the cathode with platinum. The electrodes and the polymer membrane were placed in a molar solution of KOH. After drying the parts they were assembled into a membrane electrode assembly (MEA) and cold pressed at 3/4 metric tons. The MEA was tested in a single cell module. This was repeated for silver cathode.

Results

In RDE results the HOR with nickel preformed at 12.5% of platinum and silver performed at 0% of platinum's performance. Conversely in the ORR, silver performed at 72.7% of platinum while nickel performed at 54.5%. Thus nickel was used in the anode (HOR) and silver was used in the cathode (ORR). The fuel cell test results demonstrated that at 0.8V, Platinum performed at 116mW/cm^2 and 130mA/cm2. In the HOR nickel preformed at 23mW/cm^2 and 31.4mA/cm^2. In the ORR silver performed at 118mW/cm^2 and 190mA/cm^2. We computed that platinum costs $19.66/mW per electrode, nickel costs $0.0000188/mW in the anode, and silver costs $0.0000217/mW as cathode.

Conclusions/Discussion

Our results strongly support our hypothesis. Nickel did not perform as well as platinum in the anode, however nickel is less expensive and a non precious metal. Silver, on the other hand, outperformed platinum in the ORR. This was a remarkable breakthrough for HEM fuel cells because silver performed better than platinum in the cathode. The data shows that nickel and silver are both highly economic and viable catalysts to utilize in a HEM Fuel Cell. Our research has the potential to provide an alternative eco-friendly energy that can revolutionize the renewable energy market.

Summary Statement

Our project involves the comparison and evaluation of the economical viability of alternative catalysts, nickel and silver, to replace the industrial standard of platinum in a Hydroxyl Exchange Membrane fuel cell.

Help Received

Laboratory equipment used under the supervision of Doctor Yushan Yan, University of California at Riverside graduate students, Kurt Jensen and Shaun Alia for their guidance. A debt of gratitude to our beloved parents.

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Ben J. Kaiser

Project Number
S0909

Project Title
Thermoelectric Converter

Abstract

Objectives/Goals
In almost every form of energy use, whether it is braking on a bike or lighting a match, heat energy gets released and is most commonly lost. The purpose of this experiment is to use a thermoelectric converter to analyze how and how efficiently the Peltier and Seebeck effects could be used for energy recycling to convert electric energy to thermal energy and vice versa.

Methods/Materials
A thermoelectric converter was used to convert electricity into thermal energy and thermal energy into electricity. Calculations of the energy flow were used to analyze the efficiency. I further tested whether a temperature difference over a distance could be used.

Results
The experiments show that conversion of electric energy to thermal energy(heating and cooling) by means of a thermoelectric converter has a lower efficiency than conversion of electrical energy to thermal energy. The efficiency of both processes is less than 5%. -The practical part of the experiments show that the temperature difference can be separated over a physical distance and transported to the converter electrodes by means of a temperature transducer(aluminum rod).

Conclusions/Discussion
Thermoelectric conversion is not very efficient but can be of practical use, if it allows to recycle at least some of otherwise excessively lost energy (e.g. brakes), or if it takes advantage of naturally ocurring temperature differences.

Summary Statement
Conversion of heat into electricity and vice versa.

Help Received
Worked at Ribet Academy's Seeback Physics and Chemistry Lab

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Dante G. Kari

Project Number
S0910

Project Title
Increasing the Efficiency and Cost Effectiveness of Solar Panels Through the Use of Reflectors

Abstract

Objectives/Goals
This project was designed to discover the best design and position for a reflector to help boost the efficiency and cost effectiveness of solar panels. This objective was developed in response to both scholarly research and product research that determined that few companies have tried to make use of reflectors to enhance solar panels. Standard solar panels are so inefficient that they take 20 or more years to pay for themselves. In contrast, reflectors show significant promise for reducing this break even point in cost recovery.

Methods/Materials
This project involved two major phases of testing. For phase 1, four solar panels were used, each producing 6 volts, at 36.47 mW, used with 1000 ohm resistors at ½ watt. Of the four solar panels measuring 9.5 X 6.4 cm, one was used as a control, one was placed in a bowl reflector, one was placed in a two sided reflector, and one was placed in a mirror box reflector. These four panels were tested at positions facing east, then south, then sunward throughout the day on three different days. For phase 2, a channel reflector was designed to take advantage of the best results from phase 1 testing. A control panel and the channel reflector were faced south and tested at angles of 0, 15, 30, and 45 degrees. Efficiency factors were then calculated using the formula Power = Volts^2/Resistance.

Results
All of the reflector designs performed better than the control in terms of power output, especially in cloudy weather or shade. The channel reflector outperformed the control panel in power output and efficiency at all times of the day. The glass reflectors for phase 2 added less than 1% to the cost of the panel, but boosted efficiency per square meter by an average of 11.97%, but sometimes by as much as 122.86% during the early morning or during cloudy weather.

Conclusions/Discussion
After two phases of testing, I discovered that the best design was the channel reflector set due south at a 30 to 45 degree angle. This reflector design is simple, inexpensive, easy to build, and easy to maintain. This design could revolutionize the use of solar energy in America by improving efficiency and greatly reducing production costs, allowing solar power installations to pay for themselves in about 10 years instead of the typical 20 years they now take.

Summary Statement
This project explores various reflector designs at different angles to see which combination best boosts the efficiency and cost effectiveness of solar cells.

Help Received
Mr. Tim Tasabia of See Bright Solar provided entrance to The National Solar Science Fair and Expo in Anaheim, 2009. Dr. Barth at the Universityof California at Riverside gave advice about solar cells at the early stages of the project. Dr. Daven Kari, my father, helped me gain access to university libraries.

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Ronald W. Lee

Project Number
S0911

Project Title
The Construction and Testing of a Hybrid Rail/Coil Electromagnetic Launcher

Abstract

Objectives/Goals
This project aims to build an operational dual stage electromagnetic launcher with a coil gun as its initial stage and a rail gun as the second stage. A number of tests will be conducted that includes measuring of the velocity of the steel projectile and its energy efficiency to assess the practicality of the launcher.

Methods/Materials
The launcher itself was built in accordance to a schematic created with the help of my mentor. Also, in order to measure the velocity of the steel projectile shot from the launcher, an improvised velocity meter was built. The test itself quantifies the velocity, kinetic energy, and energy efficiency when the projectiles were fired from only the coil and rail stage, and the combined electromagnetic launcher. The time the projectile takes to cover an established distance was recorded for several voltage values stored in the capacitor banks. When the separate stages were tested, the capacitors were charged to approximately the same voltage and fired. For the use of both stages together, the capacitors attached to the rails were charged to a constant charge of 250V. With the measured time and distance, the velocity and kinetic energy was calculated and the energy efficiency (energy output to energy input) was determined. The velocity was measured in meters/second while the energy was measure in joules.

Results
Overall, through the three trials conducted at 175, 200, and 275 volts, the combined launcher#s velocity, energy, and efficiency were greater than that of the separate stages.

Conclusions/Discussion
This data showed that the dual stage launcher is overall more effective (in efficiency and velocity) in shooting a steel projectile. In conclusion, the project demonstrates the feasibility of constructing such a launcher.

Summary Statement
My project succeeded in constructing a working hybrid electromagnetic launcher and demonstrated that this setup produces a higher projectile velocity, kinetic energy, and efficiency than those produced by the separate launchers.

Help Received
Worked under supervision of Mr. Lee (my father); Mr. Starodub gave guidance in conducting the research; Ines Madison helped in providing tools to construct parts of the project; Sister helped in taking pictures and videos of the project

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Anand G. Lodha

Project Number
S0912

Project Title
Converting Chemical and Biological Energy into Electricity using the ZAFC and MFC: Maximizing Energy Output

Abstract

Objectives/Goals
The objective of this project is to generate electricity using the Zinc-Air Fuel Cell (ZAFC) and the Microbial Fuel Cell (MFC). I demonstrate that these renewable energy fuel cells can be used in series to produce enough electricity in off-grid locations to power small appliances, and potentially meet the power demands of many households.

Methods/Materials
Zinc-Air Fuel Cell: Zinc,Powdered Graphite,Nonmetallic Mesh Tube,Gauge Pad,Salt,Water. Microbial Fuel Cell: Sediment from a Pond (microbes),Agar Jelly,Carbon Cloth, Copper Wire,Aerator Pump,Tube,Brick,PVC pipes of various shapes. Zinc-Air Fuel Cell Method: Make the cathode (zinc); wrap a gauze strip around the zinc; insert into a mesh tubing. Make the anode (air) by spreading powered graphite paste on a gauze strip; wrap the gauge around the mesh tube. Create in-series fuel cell by connecting zinc cathodes to successive air anodes using copper wires. Make the electrolyte by dissolving salt in water; dip cathodes and anodes into the electrolyte. Microbial Fuel Cell Method: Prepare agar jelly by boiling water, mixing agar and salt. Pour agar jelly inside a PVC pipe, the salt bridge. Make the anode and cathode chambers with PVC pipes. Join them with the salt bridge. Make the electrodes using two pieces of carbon cloth and sowing copper wires to them. Add pond sediment (microbes) to the anode. Put cooking oil on top to make the chamber anaerobic. To the cathode add salt water solution. Aerator pump, tubing, and brick are placed for oxygen circulation.

Results
Both ZAFC and MFC cells work at room temperature, can be store and transported easily, and can be built using inexpensive, and non-toxic materials. The steady state voltage reading for the single MFC was 0.16 V, for single ZAFC was 0.59 V, and for two ZAFC's in-series was 1.17V. Increasing the area of zinc increased the current and power of the ZAFC. The ZAFC in-series resulted in increased voltage and power production.

Conclusions/Discussion
I conclude that zinc-air fuel cells with solar regeneration process and microbial fuel cells with continuous flow possess great potential for producing safe electricity at competitive prices to power small appliances and meet the power needs of several households at a large scale. Unlike solar power and wind, which are intermittent and dependent on weather, fuel cells have the advantage of being able to run 24 hours a day, 365 days a year.

Summary Statement
Increase electricity production by an order of magnitude using the ZAFC and MFC.

Help Received
Daniel Tate, a UCSC student helped me to measure the electricity using high-precision instruments. Mark Akeson, UCSC professor, and Joe Jordan, Cabrillo Faculty, helped me to find places for materials used in this project.

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)

Kunal Rathi; Andrew Wong

Project Number

S0913

Project Title

Developing a Low Cost Method of Detecting Nuclear Magnetic Resonance

Abstract

Objectives/Goals

Nuclear magnetic resonance (NMR) provides us with the ability to nondestructively image the internal properties of materials. Being able to portably apply such a technology at a low cost would open up the ability for field researchers to examine the substance composition of material which cannot be removed from their environment for an extended period of time. The purpose of this project was to design a prototype to test whether we could still obtain a signal, even with a nonuniform magnet, which is a major problem with signal quality in NMR.

Methods/Materials

The methods we used to bring down the cost of developing an NMR revolved mainly around having a small, non-uniform magnet with a strength of .43 Tesla (T). We used a radiofrequency generator to create pulses necessary for NMR usage. In order to regulate the length and delay of the pulses, we created three separate timer circuits. We also created circuits to amplify both the frequency inputted as well as received in order to compensate for the magnet strength. The received signal is then filtered to remove unwanted interference and directed to an oscilloscope and observed for analysis. The circuits were constructed from individual components, which lowered the manufacturing costs to under $400. We used a sample of water to test the viability of our method. The large number of hydrogen protons in the water would ideally display a noticeable change in received frequency.

Results

The prototype was successful in receiving and displaying signal from the resonance of hydrogen protons in the water sample. The signal strength observed lasted about 5 μs and included a noticeable change in signal height.

Conclusions/Discussion

A smaller MRI is plausible with a magnet strength of .43T. It has the potential to be applicable in field research and integrated into machines for imaging using smaller and less uniform magnets. Possible ways to improve both the design and signal quality would include using a more precise radiofrequency generator as well as having a higher quality coil to detect resonance and reduce interference observed through the system.

Summary Statement

This project explores the possible implementation of a smaller, less uniform magnetic field in NMR in order to save costs and increase transportability.

Help Received

Large permanent magnet donated by Weston Anderson

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)

Jessica A. Richeri

Project Number

S0914

Project Title

Autonomous Robotic Vehicle: Saving Lives, Preventing Accidents One at a Time

Abstract

Objectives/Goals

My goal was to design and manufacture an autonomous car that improves safety on the road by preventing accidents, saving one life at a time. My second phase consisted on the creation of hardware which showed a 3D virtual mapping with the used of 2D sensors and a monocular camera. The three major modules that have been developed to feed the virtual mapping are: Marginal Protection, Line Detection and Road Guidance, and Obstacle Detection and Avoidance.

Methods/Materials

I took a remote controlled car, removed the transmitter and connected an array of infra-red sensors to a Phidgets interface kit. A Hokuyo LIDAR was connected to the car via a RS232 port. A Point Grey Firewire camera with a variable lens was used to capture the images and send to the Processing Cluster. All the hardware was connected to a Tablet PC, running XP Pro. A computer cluster is made up of four HP DL360 Servers. Windows Compute Cluster Server 2003 R2 was used to do the processing and calculate the Steering angle and Speed and send them to the remote car via wireless. The three main modules that I developed were Marginal Protection, Line Detection and Road Guidance, and Obstacle Detection and Avoidance. These modules were written on Microsoft Visual Studios 2008 C# language with the help of Image Processing libraries.

Results

The long and short distance sensors overlapped with each other so I had to install an opto-relay switching system. The amount of processing was directly proportional to the speed of the car and the fps of the images captured by the camera. I learned that 10 fps was the ideal speed to calculate the steering at 65 mph car speed. In order to reduce the false positives, I created a fusion from the infra-red and LIDAR sensors. The Marginal Protection System kept the autonomous car with in the lanes, at the same time, detect and avoid obstacles creating a 3D virtual map.

Conclusions/Discussion

Subsequent to adding more image processing hardware and upgrading the servers video cards, my car was able to travel seamlessly in the 3D virtual world created. The curvature of the street and the cars proximity had an effect on how the car will find its way, but the steering needed to be proactive, adjusting the direction of the car before it arrived to the curve. The system was able to use sensor and camera data to create a virtual map.

Summary Statement

My project consisted of desgining and implementing an autonomous car that creates a 3D virutal map with the use of 2D technology and follow lines and avoid obstacles.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Prithvi N. Undavalli

Project Number
S0915

Project Title
Encrypted Parallel FM Transmission Using Arduino Chipsets

Abstract

Objectives/Goals
The objective was to develop a prototype that used a low-level architecture that not only established a faster and a more secure wireless connection but also demonstrated the feasibility and efficiency of using parallel transmissions to increase the bit transfer speeds of wireless connections.

Methods/Materials
The system used multiple Arduino Pro microcontrollers for data processing and hardware control. Two FM transmissions were established using NS73M and AR1010 FM transmitters and receivers. For the encryption system, a 128-bit Camellia S-block cipher was implemented. Among other hardware, a multiplexer/demultiplexer device was employed to handle the multiple of data connections. A sample connection using 5-byte packets and 4-bit data chunks was created for data analysis and testing.

Results
There was approximately a 80 percent increase in data transfer speed with the use of two parallel FM transmissions.

Conclusions/Discussion
The use of the Camellia encryption allowed for a suitable method of security. Additionally, the usage of low-level architecture improved the overall functionality and security of the device. The use of low-level structure permitted optimal data handling and transfers. The simple and low-level nature of the device allows for a system with less vulnerabilities. The device clearly demonstrated the practicality of parallel transmissions.

Summary Statement
Two chips were developed that established an encrypted wireless connection that used multiple FM transmissions to communicate at faster speeds.

Help Received
Parents gave me funding and garage; Ivan Sergeev and David Eldon gave advice on the signal filtering and encryption

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Mike Wu

Project Number
S0916

Project Title
The Use of Background Suppression in MRIs to Increase Signal

Abstract

Objectives/Goals
The objective of this project is to increase the efficiency of ASL (Arterial Spin Labeling) perfusion imaging. This is done through the application of Background Suppression (BGS) in MRI to decrease the signal and the excess noise, but overall increase the signal to noise ratio.

Methods/Materials
First, the volunteer must be informed of the proper safety and given the consent form to sign. Then a localizer scan is performed to get a general image of the brain. After that, the 4 ASL scans are conducted: a control (no BGS), traditional BGS (tag location and up), extended BGS (+100mm area) and global BGS (maximum area). The raw data from the scans must be extracted and then converted to number/picture form through a Matlab code. Lastly, the Signal to Noise ratios of each scan are compared to find which produces the greatest ratio to make a conclusion.

Results
Format = experiment: signal/noise/ratio
Trial 1:
Control: 34.7345/22.3955/1.5063 : 1, Trad. BGS: 26.7062/12.6313/2.1143 : 1
Ext. BGS: 23.9428/8.5707/2.7936 : 1, Global BGS: 33.0131/7.2024/4.5836 : 1
Trial 2:
Control: 29.4384/22.3672/1.3161 : 1, Trad. BGS: 23.6377/10.5630/2.2378 :1
Ext. BGS: 21.8008/8.3783/2.6021 : 1, Global BGS: 28.7263/5.8229/4.9333 : 1
Trial 3:
Control: 29.4355/15.3740/1.9146 : 1, Trad. BGS: 21.2455/9.2045/2.3082 : 1
Ext. BGS: 19.3661/10.8103/1.7914 : 1, Global BGS: 33.2441/5.3993/6.157 : 1

Conclusions/Discussion
The 3 trials unanimously showed that BGS did increase the signal to noise ratio. The general trend found was that the greater the area covered by BGS, the higher the signal to noise ratio. Thus, global BGS was the best option. This finding is beneficial to the world of medicine in that currently, doctors use the traditional BGS, but if they switched to global BGS, the ratio would increase 4 to 6 fold. Thus, that create higher quality images purely from signal. The global BGS is easy to use: it can be activated with a click of a button.

Summary Statement
The use of background suppression to increase the signal to noise ratio in ASL scanning so that images are more efficient and better quality.

Help Received
Used MRI equipment at UCSD under the supervision of Dr.Eric Wong and his student Guo Jia

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Eddie Q. Yan

Project Number
S0917

Project Title
An Analysis of Clock Rate and Thermal Scaling in Modern Mutli-Core Microprocessors

Abstract

Objectives/Goals
The drift speed of electrons traveling through a circuit is directly related the current traveling through the circuit. Based on the idea that the current through a transistor can be manipulated by adjusting its input voltage, the drift speed of electrons can be increased to lower the delay time of the processor's logic gates and increase clock rate. This project investigated the relationship between core voltage and the clock rate of a microprocessor, along with the effects core voltage has on temperature and power consumption.

Methods/Materials
1) Modern multi-core microprocessor (G0 Revision Intel Core 2 Quad)
2)Aftermarket cooling solution (Xigmatek S1283) Heatsink/Fan
3)Motherboard with configurable BIOS (ASUS P5Q-E P45 Chipset)
4)Memory/RAM 4GB Samsung DDR2 800 6-6-6-18
5)Other hardware components -Graphics Chipset (Nvidia G92), Power Supply (700W OCZ Modular Power Supply)Optical Drive, Hard Drive, Display
6)Peripherals -Keyboard, Mouse

Results
As predicted, the temperature of the processor as well as its power consumption increased linearly with core voltage. The maximum operable clock rate increased initially with core voltage, but this increase quickly diminished while power consumption and temperature climbed steadily. Eventually, there was a point where the maximum clock rate ceased to increase at all. Testing ended when the processor's maximum temperature exceeded 100°C the maximum safe temperature given by the manufacturer.

Conclusions/Discussion
The results of this experiment point directly to inherent barriers in increasing microprocessor clock rate directly via voltage. Not only did the gains yielded in clock rate diminish rapidly as the voltage increased -the relationship was essentially logarithmic, but the rate at which temperature and power consumption increased relative to the obtained clock rates were quadratic. As the operating temperatures of silicon are limited, the trend of increasing temperature suggests that even if clock rate were to steadily increase with increasing voltage, the problems associated with operating temperatures would prevent such an option from being viable. The results indicate that alternative methods must be used to increase processor clock rate and speed, especially in environmentally friendly applications of computers where efficiency (low power consumption) are paramount.

Summary Statement
What is the relationship between increased core voltage and the maximum clock rate, temperature, and power consumption of modern multi-core microprocessors?

Help Received

CALIFORNIA STATE SCIENCE FAIR
2010 PROJECT SUMMARY

Name(s)
Kenny Z. Lei

Project Number
S0999

Project Title
Autonomous Robot Modeling of Bacterial Motion and Chemotaxis

Abstract

Objectives/Goals
Some forms of bacteria have flagella to move through water and have two movement phases: straight swim and random tumbling. Certain forms continuously transition between the movement phases, while other bacteria, such as E. coli, employ chemotaxis to decide between movement phases. Chemotaxis is a process in which bacteria direct themselves toward highly favorable areas of food by either straight swimming when conditions are improving or randomly tumbling to reorient themselves when conditions are unfavorable. A comparison between the completely random movement method and chemotaxis movement was made. In addition, an evaluation of how frequently to check food concentrations and decide between transitioning was completed. Finally, the effects of external disturbances on bacteria were explored.

Methods/Materials
Due to the complexity of creating a bacterial environment with a wide range of food concentrations, a bacterium was modeled using an autonomous robot created with the Arduino platform and programmed in Python. The modeled environment contained a dynamic gradient of light levels that represented food concentrations in a bacterial environment.

Results
Findings show chemotaxis movement performs better than completely random movement by an average of 57 percent. Furthermore, checking food concentration levels every 0.5 seconds was the optimal frequency and resulted in the highest average light level. Additionally, external disturbances caused detrimental effects on collecting light for the chemotaxis movement while having minimal effects on the completely random movement.

Conclusions/Discussion
This model demonstrates that random movements are not completely random: there is a clear evolutionary benefit of chemotaxis movement and the frequent checking of concentration levels.

Summary Statement
The completely random movement and chemotaxis movement of bacteria were modeled and compared utilizing an autonomous robot programmed in Python.

Help Received
Used robotics lab at Harvey Mudd College under the mentorship of Dr. Dodds.