CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)

Zack M. Anderson

Project Number

S0701

Project Title

CESAR: Computer Executed Semi-Autonomous Robot

Abstract

Objectives/Goals

I plan to design a computer-controlled robot which will demonstrate the capabilities of robotic autonomy. By designing an "intelligent" program to control the robot, it will be able to navigate around obstacles without user input by using a sonar transducer. Furthermore, I plan to show the limitations of full autonomy for a mobile robot of similar function. My working model will be semi-autonomous. This robot will be designed primarily for reconnaissance-type missions, rescue work, and as a semi-autonomous powered vehicle for the handicapped. CESAR's semi-autonomy will allow for very little human control thus granting one human operator the ability to control many such robots.

Methods/Materials

In order to create CESAR, I had to first design and then build a working, all-terrain mobile robot. For maximum effectiveness, I installed two wireless video cameras, a two-way audio system, a variety of switched devices such as headlights, beacons, and a siren, and I also implemented both sonar and bump sensors for autonomy. For exact position determination, an onboard GPS system is used. Once I had a working model, I had to write a program in Visual Basic to control the robot wirelessly (via a wireless LAN) while taking both sonar and bump sensors into account.

Results

The hardest aspect of the project, by far, was designing the navigation algorithm to control the robot. After much testing, however, I was able to create a working obstacle avoidance navigation algorithm. In testing the robot, I realized the limitations of sonar due to the many variables that affect the sonar signals. CESAR proved to be very capable on all sorts of terrain and despite occasional errors, the sonar never completely failed resulting in a collision.

Conclusions/Discussion

After seeing the limitations of full-autonomy, especially when the purpose of the robot comes into account, I concluded that semi-autonomy is the best choice when it comes to mobile robots going into unknown territory and conducting a specific task. Overall, the sonar worked well and the robot was able to successfully navigate around obstacles.

Summary Statement

CESAR is a mobile semi-autonomous robot designed for reconnaissance-type missions, rescue work, and as a safer powered wheelchair for the handicapped.

Help Received

A friend helped me program the robot and a neighbor welded part of the steering system.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Krystele D. Campbell

Project Number
S0702

Project Title
A Comparative Study of the Reception of Different Cell Phone Companies at Locations in Tuolumne County

Abstract

Objectives/Goals
The hypothesis for this study is that Golden State Cellular will perform better in Tuolumne county than AT&T Wireless.

Methods/Materials
Materials: One Motorola Timeport phone with Golden State Cellular, one Nokia 1260 with AT&T Wireless; clipboard, pen.
Methods: The experimenter was driven mainly along Highway 108 to different towns in Tuolumne County. At each stop the number of reception bars showing on the phones was checked and recorded. Calls to local numbers were attempted and whether or not the calls went through was recorded.

Results
Golden State Cellular performed better overall but in some locations AT&T Wireless was better. At higher elevations on the mountain, Golden State Cellular was far superior to AT&T Wireless. In Jamestown, at lower elevations, AT&T Wireless performed better. For locations in between, performance between the two companies was about the same.

Conclusions/Discussion
Some support for the hypothesis was found. Golden State Cellular did perform better than AT&T Wireless in completing calls overall. Choice of cell phone company really depends on the area calls are placed from. People living at higher elevations up the mountain would probably want to use Golden State Cellular, but for those living down the hill, AT&T Wireless might be the better choice. For areas in between, both companies performed about the same.

Summary Statement
Comparing the reception of two cell phone companies in Tuolumne County.

Help Received
I thank my science teacher, Mrs. Skutches for her inspiration and my Mom for making sure I did my experiment.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Nate Deleney-Busch; Sean Moore

Project Number
S0703

Project Title
A New Generation of Efficiency

Abstract

Objectives/Goals
The goal of our final project (this science fair spurred a number of experiments, many of which failed)is to determine the efficiency of a hand-built AC generator in relation to the angular velocity of the magnets.

Methods/Materials
My procedure is 5k over limit, short version:
1 Drill holes in baby bottle
2 Wrap the wire around bottle
3 Sandpaper the ends of the wires and wrap each around of the plugs of the DC micro-amp meter
4 fashion magnet structure using tape and toothpick bracers
5 put magnets on nail and run nail through holes
6 get drill, grip the point of the nail as you would a drill bit
7 #1 turns drill crank, counting exact rotations; #2 records the number of needle fluxuations.
9) Repeat step 8 as many times as necessary using different speeds.

Results
Assuming that our instruments are accurate, our data showed amazing irregularities and loss in efficiency at higher rates of spin. When the speed of the magnet is lower, the gap between perfection (a 1:1 ratio between a single rotation of the magnet and a single transition from + to - and back) and the actual measurement of the fluxuations is much smaller. When the magnet speeds up, the flux per 10 seconds goes up with it, but the gap (difference between perfection and actual flux) grows much larger. Based off this data, we calculated the inefficiency coefficient ([Cranks per 10 seconds x magnet rotations per crank] - flux per 10 seconds, or Cr-a). The greater the value of inefficiency, the more alternations missed (basically the bigger the "gap" that appears in the graphs).

Conclusions/Discussion
Things we could have fixed in the experiment:
Firstly, we could have had more control of the experiment equipment in general. We should have had a more sensitive or more accurate meter to read the flux's in the AC current (speaking with some of the professionals at the science fair, we were led to realize our data came from flawed instruments). We should have also had another person to read the stop watch while the magnets were spinning. Third, we could have made a better generator that would have put out a more powerful current that would have been easier to read and make better calculations on the project.

Summary Statement
Calculating the inefficiency of a handmade generator in relation to the angular velocity of the magnets.

Help Received
My father bought the materials that we listed; Sean's father provided us with the AC/DC, amp/volt meter; my grandpa helped me understand the units of measurements for electricity

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Douglas S. Duchon

Project Number
S0704

Project Title
The Effects of Dimensional Variations in a Resistor on an Electric Current

Abstract

Objectives/Goals
My goals were to find out the properties of electric currents: volts, amperes, etc, and how their values are affected by different amounts of resistance. I sought to find out how metal rods varying in dimensions(variables A and L in R=PL/A) but not in substance or temperature(varyable P in R=PL/A) resisted electricity differntly. Overal i sought to find out if shoret wires and wires with larger cross sections resisted current more and those with smaller dimensions.

Methods/Materials
I sought to find metal rods varying in dimensions(variables A and L in R=PL/A) but not in substance or temperature(varyable P in R=PL/A). I got these in three different groups varing in the P variable: alluminum, iron, copper. I then took each rod and placed it in a current and messured the loss from the current via the metal rod. I messured the loss by percent change from the originol current. I compared the percent change of each rod to the messurements made with the other rods in its group.

Results
Eeach group showed a pattern. The longer the rod/wire the more current lost. The smaller its cross section the more current lost

Conclusions/Discussion
The results were found because the dimension variations directly change the metal's proportion of volume to surface area. The surface contains atoms carrying the current and exposing them to give off heat, via vibration, to the surounding air. Rods with larger cross sections have less surface compared with volume. Longer wires have more atoms in them subject to give off energy to the surounding air.

Summary Statement
The ways in which wire surfaces loose energy based on dimenional proportions.

Help Received
Dad bought materials needed, used given format for referring to soarces in my research report

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Evangeline J. Fleischaker

Project Number
S0705

Project Title
Using Capacitance to Distinguish between Living and Dead Cells

Abstract

Objectives/Goals
To analyze capacitance as a rapid means to estimate viable cell numbers in culture and to apply this method to the evaluation of several frequently used cryoprotective agents by measuring the viability of cells post freezing.

Methods/Materials
The instrument for these measurements consisted of a capacitance probe and an impedance meter. The probe was constructed using stainless steel wires held in place with silicone rubber in a glass tube. The wires are connected to the instrument using small coax cables. The construction of a bridge circuit to measure capacitance was attempted. Most of the capacitance measurements were obtained using commercial LCR meters (HP 4275 and HP 4285). CHO cells used were grown in a serum-free medium, in a humidified CO(2) incubator at 37 deg C. The cells were concentrated using centrifugation (15' at 1000 x g). Actively growing cells were used for the freezing experiments. The cells were then centrifuged and re-suspended in the freezing solution and cooled to -80 deg C using Nalgene's "Mr. Frosty" to control the rate of cooling.

Results
Measurements of the capacitance of the media with and without CHO cells at different frequencies showed that measurements at 75KHz gave the best signal to the media background ratio. At this frequency the measured capacitance was shown to be a linear function of cell number. Additionally using this method, a solution of dimethylsulfoxide (DMSO) and carboxymethylcellulose was shown to protect CHO cells better than the other formulations examined.

Conclusions/Discussion
Capacitance was capable of measuring viable cell number of CHO cells in the range of 0.5 to 7 x 10^6 cells per mL. It is possible that improvements in the probe design could allow the measurement of fewer numbers of cells. Additionally, the results indicate that the use of capacitance to measure viable cell number is useful in screening cryoprotective agents and conditions for the viable freezing of cells, as I was able to predict the viability of the cultures at 48 hours after their recovery from the freezer.

Summary Statement
By measuring the impedance of cell suspensions I was able to indirectly measure viable cell density and apply this technique to the rapid screening of cryoprotective agents for use in freezing cells.

Help Received
Used electronics equipment at Vista Biologicals Corporation

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Sarah Guillen; Skylar Shephard

Project Number
S0706

Project Title
Can You Hear Me Now?

Abstract

Objectives/Goals
The purpose of this project was to determine which carrier received the best cell phone reception in Simi Valley, determining which transmission worked the best. It also tested which areas of Simi Valley get the most and least reception, and if the model of cell phone used affects the reception.

Methods/Materials
To perform the experiment, divide the city into half-kilometer squares and drive through each one, reading the cell phone reception for each phone in each square. Record areas of no reception, partial reception, and full reception by marking them on the map, each carrier in a specific color. After all the data has been obtained, transfer the information for each carrier to its individual map. Compare the maps and make conclusions.

Results
Nextel, which uses IDEN transmission, performed the best in the experiment. T-Mobile, Verizon, and AT&T followed behind, with Cingular producing the least amount of reception. The size of the phone had no noticeable effect on the amount of reception received.

Conclusions/Discussion
The conclusions of the project did not support the hypothesis, but the prediction was correct in that the southwest corner of Simi Valley had the lowest reception, and the central areas had the greatest amount of reception. If this project was to be redone it would be expanded to include larger areas of Ventura County, more phones, and 1 or 2 minor cell phone carriers with further research into the exact technicalities of how the type of transmission affects the reception. This project is very valuable to the person looking to purchase a cell phone who spends a lot of time in or lives in Simi Valley by letting them know what areas of Simi Valley get reception, which carrier would give them the best reception, and not to consider reception as a factor when choosing which phone model of a specific carrier to use.

Summary Statement
This project is about testing cell phone reception of different carriers in SImi Valley.

Help Received
Skylar Shephard's father drove throughout the city while we read the cell phones.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Nicholas A. Hosein

Project Number
S0707

Project Title
The Utilization of Nitinol in an Artificial Limb

Abstract

Objectives/Goals
To develop an artificial finger using Nitinol.The main problem faced with creating an artificial limb using Nitinol is the unpredictable nature of the wire under non-ideal conditions. Slight air currents, exposure to light, and variations in room temperature affect the amount of current needed to alter the length of the wire. My main goal is to control the Nitinol for use in an artificial limb.

Methods/Materials
This problem was solved by using a microcontroller to measure the angle of each joint and changing the current through the wire to compensate for any environmental variations. Another problem was deciding between using an active bias (Nitinol contracts freely) or a constant bias (constant force opposing the contraction) in the artificial limb. Three tests were conducted on the Nitinol. Test one and two were used with an active bias system while test three was used with a constant bias system. The first test determined the percent contraction of the wire as a function of the current. It also determined the superelastic current range, which is used to maintain the limb at a set position. The second test determined how the force of the Nitinol varied with current and therefore the stress range under which the Nitinol safely operates. The third test determined how the bias force affected the percent contraction of the Nitinol. It was also used to predict the results of test one for a constant bias system. Each set of results contributed the data required by the microcontroller to control the Nitinol.

Results
The artificial finger worked as intended.

Conclusions/Discussion
Using the microcontroller to change the current sent to the wire was the best solution to the initial problem.

Summary Statement
Developing an artificial limb using a shape memory alloy

Help Received

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
James P. Hynes, III

Project Number
S0708

Project Title
DRSSTC: A Double Resonant Solid-State Tesla Coil

Abstract

Objectives/Goals
Tesla Coils have been used for over 100 years to study high voltage, high frequency discharge (1,000,000+ volts!), but over half of the input power is lost in the simple spark gap switch. Recently, high power semiconductor switches and microcontrollers have made possible solid-state Tesla coils but these cannot match the (>Megawatt) peak power of a spark gap so they are limited to brush type CW discharge.

My objective is to demonstrate a new topology which will create long streamers by greatly increasing the power factor as seen by the IGBT switches (average watts transferred per peak volt amp).

Methods/Materials
My innovation is to drive a primary LC resonator for exactly half the beat period (a dozen cycles or so) while the loosely coupled secondary mode extracts all of the energy and then discharges, producing long arcs more efficiently than either "spark gap" or existing solid state tesla coils.

Results
I've cycled over 1000 amps through an IGBT rated for 160 amps peak by overdriving the gate to maintain saturation. This was a critical test which demonstrated the peak power capability. The dual H-bridge drive has soft switched up to 400 amps at 280 volts and 57 Khz, which would generate a 5-joule burst and 500 kilovolts in the presence of the secondary.

Conclusions/Discussion
Though successful, my DRSSTC implementation is under continual revision. During a test last week, EMI caused a catastrophic shoot-through. I've designed a fix and ordered replacement parts and expect to have it running at again at even higher levels before the State Fair.

Summary Statement
I designed and built a uniquely efficient solid-state multi-resonant pulse transformer circuit for Tesla Coils

Help Received
My parents helped with the typing, and family, friends and Tesla Coil Mailing List peers have listened to my "transfunctionator jibberish" all winter

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Tarang Luthra

Project Number
S0709

Project Title
Reducing Interference in High Speed Home Networking using Signal Processing

Abstract

Objectives/Goals
The IEEE 802.11b (Wi-Fi) is currently the most commonly used technology for high-speed wireless home networking to connect various electronic devices. Both, noise and the unwanted sources interfere with wireless communication by adding errors in the received information. The purpose of this project is to show how to use multiple antennae and advanced signal processing to significantly reduce the interference. Also, I want to find out what the relation between the number of antennae elements and the amount of reduction in the interference is. This would allow me to figure out roughly how many elements one should use in a practical system.

Methods/Materials
I used the mathematical models of antennae array, electromagnetic waves captured by the array, noise being added to signal, radiation from an unwanted source and the signal processing to be done by the array in wireless home networking environment.
First, I wrote a C++ program which measures the effect of number of antennae on signal to noise ratio. Then, I moved the interfering source around to study how the angular distance from the wanted source impacts the capability of my antennae to reject the unwanted signal. My third program deals with the effect of number of antennae on signal to interference ratio. I collected and plotted the data to see the effect of number of elements on the interference reduction. Lastly, by properly phase shifting the signals at each antennae element, before adding them up, I was able to automatically scan and find the direction of the source.

Results
see (graphs)

Conclusions/Discussion
My hypothesis that the noise will reduce N times by using N antennae elements was correct. It can be concluded that in an 802.11b system about five antennae elements should be used to reduce noise by about 80%.
However, my hypothesis that the strength of the undesired signal will also reduce N times by using N antennae elements was not correct. It can be concluded that to significantly reduce the interference from the unwanted source at an angle of twenty degrees or larger, away from the signal source, five antennae elements should be used.
Based on this work I also conclude that as, in a typical home networking environment, the unwanted sources are generally farther away than twenty degrees and 80% noise reduction is a good target, a five

Summary Statement
I processed signals coming from multiple antennae, in a receiver, together to reduce interference in a wireless home networking environment

Help Received
Advisor helped with ideas; Mother helped with the board

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Bruno Maranhao

Project Number
S0710

Project Title
The Signal Attenuation Coefficient of Fiber Optic Cable

Abstract

Objectives/Goals
To calculate the signal attenuation coefficient of a particular fiber optic cable, and demonstrate why it is that red light of a wavelength between 650 and 660 nm is used to transmit signals along industrial fiber optic networks.

Methods/Materials
Using: one, two, three, and five meter Industrial Fiber Optics Super Eska SH4001 cable I calculated the attenuation coefficient for three different wavelengths emitted from a green, red, and infrared light emitting diode (LED).

Results
The infrared wavelength signal showed the greatest attenuation, while the green wavelength signal showed the least attenuation. However, the red wavelength signal had the highest optical power at the signal termination.

Conclusions/Discussion
When transmitting signals across large distance a red light of wavelength between 650 and 660 nm is most frequently used because though red light may not have the lowest attenuation coefficient, it has a significantly greater launch power and hence greater optical power at the signal's termination.

Summary Statement
My project deals with calculating the signal attenuation coeffiecient for a particular fiber optic cable.

Help Received
I would like to thank my mother for helping me put my project backboard together, and my father for financially supporting my project.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Linnea L. Motts

Project Number
S0711

Project Title
The Effect of Temperature Regulation on the Power Output of Solar Cells

Abstract

Objectives/Goals
How does temperature regulation affect the power output of various solar cells (photovoltaic cells) in a concentrator system? The six photovoltaic cells - single-crystal silicon, polycrystalline silicon, gallium arsenide, thin film amorphous on steel, thin film amorphous on glass, and thin film amorphous silicon - were tested at 20°C, 25°C, 30°C, and 35°C. It was hypothesized that in a concentrator module the gallium arsenide solar cell at 20°C would produce the greatest power output of the cells tested.

Methods/Materials
1 IR (infrared) temperature probe
4 digital multi-meters
2 DC power supplies
1 Fresnel magnifying lens
75-watt halogen spotlight
6 various solar cells

A solar cell module was constructed, consisting mainly of a solar cell, heat sink, thermoelectric module, and a DC brushless fan. At each temperature voltage, current, and resistance were recorded, and overall power output was calculated for each individual cell. Furthermore, voltage and current were recorded for the power supplies of the thermoelectric module and fan.

Results
Although each solar cell varied in individual measurements for voltage, current, power output, and resistance; the solar cells generally had a negative temperature coefficient, meaning that as temperature increased resistance decreased. However, power output decreased as temperature rose.

Conclusions/Discussion
The data supports earlier findings that as temperature rises, cell materials overall lose efficiency. Additionally, the initial hypothesis supported the data in that solar cells perform more efficiently at lower temperatures. In the hypothesis, gallium arsenide at 20°C was predicted to have the highest power output; however, the thin film amorphous on glass cell at 20°C had the greatest power output.

Summary Statement
The experiment investigated the effect of temperature regulation on various solar cells.

Help Received
Father provided equipment and materials, including solar cells.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Sarav S. Patel

Project Number
S0712

Project Title
The Effect of Load Resistance on the Amount of Power Delivery

Abstract

Objectives/Goals
The objective of this study is to determine the optimum load resistance in a circuit that yields the most power delivery possible to an electrical component. Research suggests that if the load resistance is decreased, then the amount of power delivery will increase proportionately.

Methods/Materials
A condensed electrical circuit consisting of a 10 volt regulated DC power source, a 1000 ohm internal resistor, and a variable load resistor was constructed. An ammeter was used to measure the current (in milliamps) in the entire circuit, and a voltmeter was used to measure the potential difference across the load resistor. These two values were multiplied in order to calculate the amount of power delivery (in milliwatts) to an electrical component that would be placed in series with the load resistor.

Results
Power delivery peaked at a load resistance of 1000 ohms, which, incidentally, was also the value of the internal resistance. When the load resistance was set to 0 ohms, no power delivery occurred. Between load resistances of 0 ohms and 1000 ohms, power delivery increased very rapidly. Then, after peaking at a load resistance equal to the internal resistance, power delivery dropped off considerably. Eventually, the rate of decrease tapered off and power delivery did not reach 0 milliwatts within the range of testing.

Conclusions/Discussion
The results of this study were not fully consistent with the hypothesis. In fact, the relation between load resistance and power delivery was not even linear. However, these data do show that power delivery to an electrical component peaks when the load resistance of the circuit is 1000 ohms. This was also the value of the internal resistance in this investigation. Therefore, further study is needed to determine whether maximum power delivery is always achieved at a load resistance of 1000 ohms, or if the load resistance needs to be equal to the internal resistance to attain that goal.

Summary Statement
This project focuses on varying the load resistance in a circuit to maximize the amount of power delivered to a given component, thereby increasing its performance.

Help Received
Over the course of this study, I received education and assistance from my dad. He helped set up the electrical circuit and position the meters properly.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Keerthi K. Prabhala

Project Number
S0713

Project Title
Brainwave Derived Electronic Control

Abstract

Objectives/Goals
The main goal of this project is to demonstrate the feasibility of building a low-cost Brain Computer Interface (BCI) for electronic control of devices using Electroencephalographic (EEG) techniques. I hypothesize that it is possible to achieve enough control for people with neuromuscular disorders to gain independence, and for normal people to gain improved efficiencies in their daily lives.

Methods/Materials
I pasted passive electrodes on my scalp using 10-20 Conductive Paste in bipolar configuration to sense the Mu-Rhythm of a single channel EEG. Imagining pressing a button was used for forward control and computing an intensive math problem was used for backward control in several epochs. I amplified these signals using AD620 instrumentation amplifier and OP90 Operational Amplifier, and digitized them using a 12-bit ADS7806P Analog-to-Digital converter. I used mathematical techniques like linear regression, Hamming Window, and computed FFT to acquire 7.5-12 Hz frequency components. Then I trained a 3-layer Artificial Neural Network and used test samples to recognize forward and backward commands. Finally, I modified the remote control of a R/C car, and applied the forward and backward electronic commands to move the car. In subsequent sessions, I used the trained Neural Net of previous session to retrain for improving recognition rates.

Results
At the end of my first session, I obtained 40% successful recognition rate. Using this trained Neural Net, I achieved 72% success rate on my second session, and 74% success rate on my third session. It's noteworthy to observe the dramatic improvement on the second, and third sessions compared to the first.

Conclusions/Discussion
The results prove that it is possible to achieve the BCI control to a useful degree. By carefully controlling the quality of materials, processes, and processing, I believe more than 95% success rate is possible. Compared to the subjects used in the research community above 21 years of age, I am only 16. My first trial success rate of 40% was way above the 20-30% reported in the research community probably because of better intuition. Also, I haven't used any active feedback. I think this technology is critically important even for ordinary people to improve their working efficiency just like a cell phone!

Summary Statement
Brain to Computer Interface for controlling electronic devices is a very important technology for handicapped and ordinary people.

Help Received
Faith Medical Inc, and Texas Instruments donated materials and components. Dr. Metherate helped discuss many concepts. My father supervised for safety, and mother helped with transportation. My mentors Dr. Shugarman, and Dr. Allali encouraged throughout.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Conrad L. Salinas, Jr.

Project Number
S0714

Project Title
Underclocking: For Fun and Profit

Abstract

Objectives/Goals
Computers are getting faster, more powerful and more capable everyday. Most of today's home and business desktop computers would have been considered a 'Supercomputer' just a few years ago. Since more power is required to run these faster CPU's is it practical and economical and even ecologically beneficial in today's world? Is there a way to effectively get work done, save money, and save precious natural resources? One idea is Under-clocking. Under-clocking is the technique to slow down a computer's CPU speed from its default factory setting. I propose to build a device to under-clock computers.

Methods/Materials
AMD Athlon XP Tbred "A" core 1800+ @1.533 GHz
WINDOWS XP SP 1
VISUAL BASIC C++
Variety of electronic components
Multi-meter and thermocouple
Soldering iron and wire-wrap wire

Results
The results of my data shows that clock speed greatly affects CPU power consumption and heat generation, but the overall power going into the computer did not change dramatically. According to my research CPU life would be increased with under-clocking because of reduce CPU temperatures. In addition my research shows that office applications operate well at lower clock speeds. This is because CPU speed tested in my project exceeded the minimum and recommended operating speeds listed by manufactures for those applications. The overall performance of the CPU decreases as the clock speed decreases and the CPU performance increases as clock speed increases; CPU performance is the measurement of its raw processing potential.

Conclusions/Discussion
Surprisingly, in business environments, under-clocked computers would emit significantly less waste heat, which reduces air-conditioning which reduces air-conditioning loads accordingly. For example, if (a) business had 400 computers all running at regular speed, air-conditioning required to overcome CPU heating would cost over $60,000 over the 3 year life of the computers. On the other hand, if the computers are under-clocked to the lowest level that energy drops to just over $7,000. The difference between the regular and under-clocked computers is $53,000. Huge difference!

Summary Statement
Under-clocking computers to save power!

Help Received
Dad and mom helped with money; Advisor helped type out report.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Benjamin C. Steele

Project Number
S0715

Project Title
Lights Out? Analyzing Break-Even Times for Home Lighting

Abstract

Objectives/Goals
A widespread belief is that household lights, especially fluorescent bulbs, use such large amounts of extra power when first turned on that they should be left on when leaving a room for a short time. It is a fact that some bulb types use extra energy starting up, but are the startup costs so high that lights should just be left on when not needed? If so, how long? To find out the break-even times, I tested incandescent, halogen, compact fluorescent, and tube fluorescent bulbs.

Methods/Materials
I constructed a measuring apparatus for the experiment. The first half of the circuit powered test bulbs at household AC voltage, in series with a one-Ohm resistor to allow measurement of a voltage proportional to the current through the bulbs. The second half of the circuit carried the signal to a laptop computer through an isolation transformer. The transformer and a potentiometer reduced the sample voltage down to a lower level, which was safe for the computer audio input. I then recorded the waveforms of the current on the computer using inexpensive audio software, and computed the power used at each 23-microsecond sample interval.

Results
All the tested lights used extra startup power for surprisingly short periods of time. The incandescent bulb had a break-even time of 0.04 seconds and the halogen bulb had a break-even time of 0.12 seconds. Both of the fluorescent types were temperature-dependent and so their break-even times varied, but were short. For example, the compact fluorescent had a cold break-even time of about one-fifth of a second.

Conclusions/Discussion
All bulbs tested had break-even times of fractions of a second. Contrary to popular belief, home lighting should be turned off whenever unused to save energy.

Summary Statement
I found that, to save energy, home lighting should be turned off whenever unused.

Help Received
My dad helped photograph the setup for my display board and provided the laptop computer.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Josh R. Taylor

Project Number
S0716

Project Title
The Accuracy of a Handy Board Barcode Reader as a Function of Sampling Frequency per Bit of Data

Abstract

Objectives/Goals
The purpose of this project was to build a bar code reader using a handy board and an infrared device and determine how many readings per bit were necessary to accurately read a bar code.

Methods/Materials
Using Legos, a platform was built for a motorized wheel and an infrared sensor. A barcode was attached to the wheel, and the motor and sensor were attached to the handy board. Software was written to read the bar code and convert it into zeros and ones. The zeros and ones were then tested to see if they matched the expected values and the results were recorded. This process was repeated eight hundred times at nine different motor speeds. The results for each motor speed were recorded and then graphed.

Results
At frequencies of greater than 3 readings per bit the accuracy was 98.3 percent, while it dropped down to 90 percent at frequencies of 2.39 to 2.48 readings per bit and then jumped back to 97 to 98 percent at around 2.3 readings per bit. A significant decrease occurred at around 2.16 readings per bit with accuracy levels ranging from 43.5 to 58 percent. The standard deviation of the accuracy ranged from .46 percent at the high frequency readings to 1.75 percent at the low frequency readings which means that the two dips that occurred were greater than should be expected from experimental standard error.

Conclusions/Discussion
The results supported the hypothesis that the accuracy of the bar code reader would drop significantly as the frequency of the readings approached one per bit. A reader of uniform frequency that was perfectly able to discern black from white with an arbitrarily narrow infrared beam would be expected to plummet in accuracy as the frequency of the readings dropped below 1.5 readings per bit. With an infrared beam about one millimeter wide however, the reader is subject to error at the boundary between white and black stripes causing the error rate to dive at a frequency of about 2.2 readings per bit. Additional error was introduced due to the inaccuracy of the time stamp.

Summary Statement
This project is about exploring the limiting factors of data retreival from a storage device.

Help Received
I received help from my neighbour Marc Leavit who taught me how to use a handy board, as well as the basics of IC.

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Daniel K. Trubey

Project Number
S0717

Project Title
Listening to Lightning

Abstract

Objectives/Goals
The objective of my project is to find out how well a homemade whistler receiver does compared to one made by a professional.

Methods/Materials
A receiver was built using directions from a magazine article and used Radio Shack parts. The other professionaly made receiver was gotton from a personel at NASA. Sensitivity and durability were tested using several groups of tests, like the power line test for sensitivity, and were then analyzed using many different instruments including an oscilloscope and spectrometer.

Results
The receiver made by a professional came on top in all of the tests that were done for instance it proved more sensitive in the power line test. The homemade one had many more malfunctions and had a problem in its amplification part of its circuit which made it very hard to hear with the human ear.

Conclusions/Discussion
There is a part of the circuit that amplifies the sound coming out of the receiver which does not seem to work on my receiver. In the one made by a professional that part of the circuit is put into an integrated circuit which makes it more likely to work while in the homemade one it is made up of many different parts meaning that there are many places to go wrong. I have gone as far as to replacing all the parts of the circuit that could be causing the problem and still have not fixed it.

Summary Statement
I am comparing a homemade whistler radio receiver to one made by a professional.

Help Received

CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Daniel R. Zimardi

Project Number
S0718

Project Title
Optical Correlation of Digital Data Using Volume Holograms: The Impact of the Photodetector

Abstract

Objectives/Goals
Holographic data storage allows for storage capabilities within the volume of the recording medium, unlike CD-ROMs or DVD-ROMs which limit storage to the surface. With the ability to store 1000's of record on one medium, it becomes neccesary to develop a method of search to correlate the stored records to one search record one wishes to find. This search method is called associative retrieval. Because holographic data storage is an optical system, implmenting associative retrieval is difficult due to the errors that come with optics. I set out to study these errors and engineer an optimal system.

Methods/Materials
To study the the errors and problems with optical correlation and associative retrieval I had to first simulate a system using MATLAB to allow for studying the effect of certain system parameters without having to worry about experimental error in lab. By varying the parameters to certain components I was able to engineer a system that would be optimal in lab and real life. I then had to experiment with the same parameters in the lab to obtain and confirm the results I got in the simulation.

Results
The photodetector is CCD camera. The light it detects comes from the output of the associative search. Once all records are correlated with the search record, the photodetector measures the similarities by measuring the intensity of the light as it leaves the medium. The higher the intensity of the light, the more matching the record is to the search pattern. I found that what causes the search to be innaccurate is optical noise and the fact that the pixels on the CCD camera are spaced apart. This means that the optical noise changes the intensity of light detected by disrupting the signal that was meant to be read by the photodetector. The pixel spacing on the detector also causes some light to be lost because it hits the inactive parts of the photodetector, causing an incorrect reading.

Conclusions/Discussion
In simulation, I was able to lower the effects of noise by having the system run the same search over and over about 1000 times, each with a random amount of noise, this way an average detection can occur which allows the noise to only affect the search minimally. To account for the pixel dead space I changed the focus position of the photodetector. Now there was greater area to read the light and dead space had lost its effect.

Summary Statement
Optimizing the associative retrieval aspect of volume holographic data storage.

Help Received
Used lab equipment and simulation computers at IBM Almaden Research Center under the supervision of Dr. Geoffrey Burr.