Solar Powered Tracking and Gaming Device

Diijon Gumbs, James Lillie, and Kaniel Martin

School of Electrical Engineering and Computer Science, University of Central Florida, Orlando, Florida, 32816-2450

***Abstract* — The Solar Powered Tracking Device is a solar powered generation unit that will be used to generate enough power to run a television and Nintendo Wii console. The energy is sent from the solar panels through a AC/DC inverter and converted to energy to power our desired devices. The microcontroller will be the main hub of this project that will run the LCD Display, motor drivers, and the sensors through the use of the Arduino programming language. This device also tracks the sunlight progress through the use of photovoltaic cells which is the reason for our naming the device the solar powered tracker. The sunlight progress is used for tracking the panel voltage as well as the use of photoresistors to actuate and move the stepper motor to the right position to receive solar energy. The voltage measurement supply is provided through the use of the Arduino Mega 2560 as well as a 12V battery which will be used to power the actuator, stepper motor and some of the devices on our circuit.**

***Index Terms* — inverter, solar powered generation, microcontroller, sensors, programming, photovoltaic cells, solar energy, battery, actuator, voltage measurement**

I. Introduction

The solar powered tracking device is equipped with features that allow the regulation of voltage and power through the usage of a voltage regulator, sunlight sensor, solar panels, as well as an actuator. Mainly, the reason why our focus is on a solar powered tracking device is because of the emergence of solar power in the world as of today. Mainly, solar power is becoming dominant not only with households and vehicles but with charging devices as well as smaller components like batteries. The uses of solar power are also endless which is another reason why we are investing our time into building a solar powered tracking device because it incorporates features of linear controls, power electronics, and computer software into one. This device is used to charge a console as well as a television through the use of solar energy and a AC/DC converter.

The other focus in the design of this device is that it is going to be able to make a conversion of solar energy from photovoltaic cells to regular stored energy to be of use for making the console playable and enjoyable to all consumers. People cannot always depend on having power supplied to you at all times, in this we have decided that the use of an alternative source of power is needed to help out during those times of need thus the reason we have decided on building this. Our technical objective is to try and build a device that is not too bulky but will be able to maintain a good amount of energy to convert to normal power (conversion from AC to DC power). It also needs to be cost-efficient so that other people in the future will be able to purchase the device for their own need as well.

The main viewing ability for our consumer is through the use of a small LCD Display that will incorporate a backlight for viewable purposes whether in the sunlight or in bad weather conditions so that they will know if the system is working properly. This display will need to display the battery life in some form as well as the voltage through the panels and the amount of brightness the device is receiving to know when to turn on or off. This is incorporated through the use of a "sleep mode" which will help in conserving power and not using up excess energy that can be used for other purposes.

Our technical goal of this project is to be able to make the device withstand different types of weather conditions due to the fact that the battery will become damaged if there is too much of an overcharge to the system. If this happens then the whole solar powered device will be destroyed as a result and we need to prove that we can stabilize the system as a whole so that the device remains in tact. However, we also need to try and gather as much sunlight as possible to be able to have enough charge to power this console. Another objective towards this project is to be able to actuate the device so that it will be able to follow the sunlight as it rises from the east and sets in the west. In doing this, the solar powered tracking device will be able to experience the full effects of the sun during the entire day excluding the fact of rain or other weather conditions that may hinder exposure to the sun during the day. This will need to be incorporated through a bunch of sensors mounted on the device to tell the device whether to turn or actuate the frame.

The way this project will work is that the converted sunlight will pass through the photovoltaic cells on the frame of the device. Then this energy will be converted through a DC/DC converter and sent into the television and Nintendo Wii console to be used. At the same time, the battery will be needed to be able to be charged so that the device will still run in the long run. Therefore, a simple battery charging circuit will be implemented. These components will be helped through the use of a programming archetype and through a microcontroller. This microcontroller environment will help the project run smoothly provided with enough memory storage for data input for the LCD Display. The movement will be done through a usage of a few photoresistors in order to sense the sunlight and move in the desired direction based on where the sun is located.

The best strategy for this project design will be to be as cost efficient as possible. The Nintendo Wii is an excellent choice for the console to be charged with the television because it takes in the least amount of wattage, so the inverter will be able to handle the capacity of both devices running at the same time.

The main contributor for our project will be Progress Energy as we will be registered for the 3rd Annual Senior Design Symposium on April, 8 2011. Progress Energy has helped out in the past for Senior Design students to be able to receive funding for projects that deal with alternative sources including solar power. They are a well noticed company that has been around for years due to their diversity in different forms of power and engineering. Through the usage of the funding of Progress Energy as well as ourselves, we hope to be able to produce a monumental design for our presentation in Senior Design.

II. Components

A. LCD Display

The LCD display that is incorporated into our project is the Hitachi HD44780 LCD Display that was purchased from Gravitech US. We chose this display because it has many of the essential materials needed to show the viewer the important criterion that is implemented in this project such as showing the battery life, panel voltage and the direction of the sunlight. This display has many items such as a 16-bit male header, data pins for I/O travel, Read/Write memory, a 5V backlight, and the fact that it operates on 5V as well made this display worth our time. Figure 1 shows a picture of this HD44780 display below.

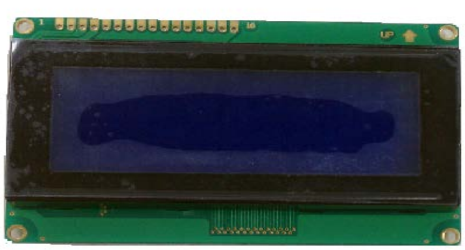

Fig. 1 HD44780 LCD Display from Gravitech

B. Microcontroller

The Microcontroller utilized in this project is the Arduino Mega2560 with the main Atmel component chip embedded in the main center of this microcontroller. This device was purchased from Sparkfun Electronics for a reasonable price. This microcontroller has 54 digital I/O pins, a Bootheader that allows for software uploading to the device without having to update the coding software, Pulse Width Modulation ports which are included in the pin count for sending and receiving data, as well as 256kB of Flash memory and 4kB of EEPROM, and lastly it has USB serial capabilities and a reset button. This device is the main hub of the frame which consists of the circuits, LCD Display, and the sensors. This device also deals with the main programming architecture that will be controlling the movement of the device such as the actuators and the stepper motor.

We chose the Arduino Mega2560 due to its huge amount of pin layout and space storage that would be able to accompany the use of many devices at one time. This device also saves on the amount of voltage power needed which is either a 3.3V or 5V input which is a normal amount within the range of microcontrollers. The programming archetype is very important to us as well which is the good part about the Arduino device because it supports a similar fashion to C programming. Through the use of the programming environment we can implement how to calculate the amount of voltage going into our 12V battery as well as to keep track of how the battery is doing also. Figure 2 shows a picture of the microcontroller in its actuality below.

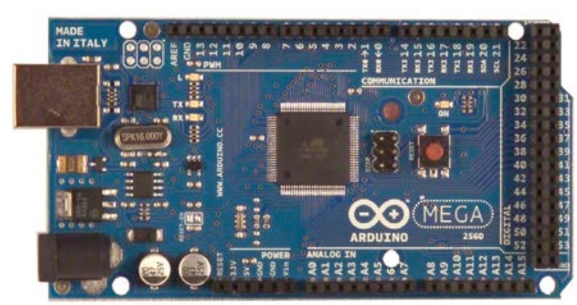

Fig. 2 Arduino Mega2560 from Sparkfun Electronics

C. Stepper Motor

The stepper motor driver that is implemented in our project is the EasyDriver Version 4.3 which is a small device used to be able to move the main stepper motor attached to the frame so that the solar panels can move left to right. This motor driver is very small and was bought on Trossen Robotics at a reasonable price of about $15. This motor driver takes in different coils mounted into a motor and loads these coils into two ports on the driver which is powered by our 12V battery to move the motor in the direction that we need it to move in through our coding archetype.

The reason why this stepper motor driver was integral in our project is due to the different amount of ports that are able to be used to power the device. You can either use the 5V input port or you can use the other input port that takes from a 7V to 30V input source. In our project we ended up connecting the step portion to pin 2 on the Arduino board and the direction portion to pin 3 on the board as shown in Figure 3 below.

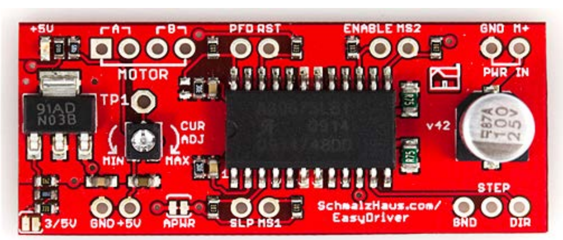

Fig. 3 EasyDriver Version 4.3 from Trossen Robotics

D. Solar Panels

The Solar Panels integrated into our project is the UPG 10 watt Solar Module. This solar panel was purchased from WholeSale Solar for an extremely affordable amount. This solar panel is a mono-crystalline panel with a power rating of 10 watts. The open circuit voltage for this panel is 21.6 V and also has a short circuit current of .59 amps ISC. The maximum power voltage is 18V while the maximum power current is .51 amps. The primary responsibility of the solar panel is to gain the energy which we will then channel to power the different components of the project.

There were many important features that appealed to us when selecting the correct solar panel. We had wanted a good quality solar panel, but did not want to have to spend an excessive amount of money. The price of the panel especially seeing as how it is a mono crystalline panel, this type of panel has the greatest efficiency and is considered to be a high caliber panel in terms of its grade. Another important factor that we considered was its physical dimensions as well as weight. The panel was not too large, or too small, it is also very light weight weighing in at only 3.3lbs! Above all, the last important consideration for this panel is the output and ratings. Upon calculating the amount of power we would need for our project, this panel's voltage, and power ratings seemed optimal. The current rating did seem to be a bit low, but by combining two of these panels together in a parallel fashion, we were able to achieve an acceptable amount of current. The picture of the solar panel used is displayed below in Figure 4.

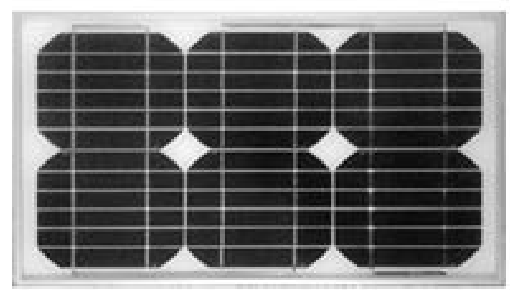

Fig. 4 Solar Panel from WholeSale Solar

E. Actuator

The linear actuator implemented in the project is the 6 inch stroke 110 lb linear actuator. This linear actuator was purchased from Trossen Robotics. This actuator features a solid steel stroke capable of sustaining 110 lbs. It also can extend its stroke up to 6 inches. The primary reason we chose this actuator is because of its reliability. We did not want to get an actuator that may not be strong enough to sustain our panels, and we also wanted to get an actuator that was simple to control, and was sturdy to endure force from not only the panel, but even the forces of nature. Another positive thing about the physical aspect of this actuator is its size. For our project we want to attain a 120 degree angle of tilt motion as part of the tracking. With this actuator, there was no need for external props or platforms so that we could be able to attain such a vast range. We will also be employing the use of the L298 H-Bridge driver which will move the actuator. Figure 5 shows a picture of the linear actuator used in the project.

Fig. 5 Linear Actuator from Trossen Robotics

F. Photoresistor (sensor)

The photoresistor used in our design is the cadmium sulfide photoresistor from adafruit.com. The purpose of this photoresistor in regards to our project is that it will essentially detect the area of most light while outside, and send the corresponding information to the microcontroller where it can be further processed. There are many advantages and specifications we were interested in when selecting this component. Apart from its extremely small size, this photoresistor is able to detect varying amounts of light to an accurate degree. This cadmium sulfide material is also a popular material in photoresistors therefore making it cheap as well. For use in our project, we used four photoresistors which are positioned in a square fashion. There are walls that go in between each resistor to essentially section the resistor off so that when light hits a resistor, the margin of error is greatly reduced when determining the direction of the sunlight. There is also a roof, or shader which is applied to this arrangement, used to limit the light even more so that we are able to achieve an even higher degree of accuracy. This item was purchased from Adafruit Industries for around $12 for a pack of ten as you can see in Figure 6 below.

Fig. 6 Photoresistor from Adafruit Industries

G. Battery

In our project there are many components which require power in order to function. This makes the battery an integral part of the design because everything other than the panels will essentially depend on this battery. The battery which we are using is a 12 volt deep cycle lead acid battery. This battery was purchased from SkyCraft Surplus inc. There are two significant purposes of the battery in our design. The battery will be used as a power source to power the Arduino mega 2560 microcontroller, stepper motors, linear actuator and even power the gaming system. The second purpose of the battery is to fulfill a significant goal of our project, and that goal is to be able to harness the sun’s energy in order to charge a battery. Essentially the battery is used to power the project as well as to demonstrate the project.

We chose a 12 volt deep cycle lead acid battery for many reasons. Firstly, we calculated the amount of volts that each component of our design would consume, and 12 volts is an amount where we would utilize most of the battery’s resource without wasting too much or not having enough for our use. Lead acid batteries are also widely used in a vast array of devices today making this type of battery easily accessible and cost efficient. We realize that there is quite a demand on the battery so by taking this into consideration; we chose a deep cycle battery so that we could really get the most use out of the battery. Lead acid batteries are also amongst the most commonly used type of battery when it comes to rechargeable batteries. The observation that this battery is also rechargeable helps to cut down on cost and is also a contribution to the green state of mind of which we are achieving. Figure 7 shows a picture of a 12 V lead-acid battery we used in our project.

Fig. 7 12V Lead acid battery from SkyCraft

H. Frame

The frame is a vital portion of the project used to tie all of the different components of the project together. We designed a frame which would be able to not only house all of our components, but it would be efficient to be able to support and withstand every little detail our project encompassed. The frame has multiple components to it in order to accommodate for these little details. The bottom of the frame is essentially that of a chair swivel. This allows portability, because it is on wheels. Another positive aspect when having this structure at the base of our project is the assurance that weight will not be an issue, not only because of the wheels, but because it is designed from a chair, it would be able to withstand a human’s weight, so it is quite durable for our use seeing as how the project is around 30 lbs. From the chair base, there is a wooden platform which is used to mount the structure which holds the solar panels themselves. The structure which the solar panels are housed in is comprised of a cold rolled steel frame with a rod in the middle so that it will be able to swivel. On the side of the wooden platform which the panel sits on, there is also an L shaped cold rolled steel shaped bracket which is where one of the servo motor controllers sits. This motor controller is fitted with a rubber wheel that is placed on the side of the wooden structure allowing the wooden platform to spin horizontally 360 degrees, like how a chair would be able to.

The reason we designed the frame in this manner is because it was cheap, most parts could be found around the house so to speak. The parts are also light weight and as a result of us constructing the design instead of purchasing a design, we were able to achieve a level of custom ability to perfectly suit our needs. Most of the materials used in the design of the frame itself was done through the mechanical use of team building as well as through the use of do it yourself places such as Home Depot, Lowe's and other types of hobby shops as you can see in Figure 8 below.

Fig. 8 Frame for the Solar Powered Device

III. Design and Implementation

In the design and implementation portion of the project, we used many aspects to make sure that our accuracy with the components was as little as possible whether it was using a more precise resistor value or even changing where to read an analog pin. These aspects not only shaped how our project was to be defined but which direction to take it as well due to the fact that this project will take in a source and convert that energy into usable renewable energy for a gaming console environment.

A. Microcontroller Implementation

With the microcontroller that we have used in the project which is the Arduino Mega 2560, this board is the main data center of the project as well as the frame. Through our coding, we were able to figure out which problems would occur within our measurements. The microcontroller takes care of our battery voltage, battery life, panel voltage and the movement of the actuator and stepper motor as well. Our design definitely took into consideration the microcontroller due to its portability and amount of space. In order to implement the code that we wanted to display to the LCD screen, we first had to figure out a way to measure the 12V battery from the Arduino. This method took some time to figure out because we did not want to fry the Arduino board since it can't take in 12V directly. One formula stated below shows how we determined the percentage battery life from the readings in which Batt(max) is the maximum voltage in the battery, and NewBatt is the next reading on the battery voltage which turns into a life percentage (1).

$$\frac{Batt(\max) - [Batt(\max) - NewBatt]}{Batt(\max)} \quad . \qquad (1)$$

Another portion that dealt with microcontroller implementation was the portion of the project dealing with the actuation and motor movement. Since our goal was to have a 120 degree vertical and 360 degree horizontal movement for both the actuator and stepper motor, some precaution had to be made in order to make it such that the code would be able to turn in those desired positions without overstepping its boundary. We didn't want to overstep the boundary due to the fact that the wires would tangle and mess up the frame. The code helped to determine which of the photoresistors got enough sunlight and then would move in the direction of that photoresistor in order to receive the desired amount of sunlight to power the device. To help better the microcontroller's in dealing with this issue, we used a switch to keep the stepper motor from moving the solar panels too far and thus in the code we have a set of data that will tell the frame to reset itself to the center in order to gather the direction of sunlight.

B. Frame Design

In the design of the frame of the project, much care had to be taken into consideration such as where will the actuator go or where will the wiring be placed for all the materials. This was intimidating at first, but once we had an idea of certain ways to design a solar tracking device, then the rest was mechanical work that took some days of work to accomplish. We wanted the frame to be portable as well as not too bulky so that the consumer will be able to bring it with him/her. This is the reason why we have put wheels on the bottom of the frame so that it is mobile when needed to go to far places. Wiring had to be done by placing a hole within the center where the actuator is located so that we can send the wires from the solar panels, linear actuator and from the stepper motor all in one place. These wires were taped together using painter's tape so that the wire would be easily accessible and not tangle with one another.

In addition to the wiring portion of the frame, lots of consideration had to be done in determining where the stepper motor would be located as well as the portion that would be the mounting of the solar panel. Holes had to be drilled into the frame to mount the solar panel and then the actuator would hold it in so that it would not swing around and break. Luckily, the chair used for the frame had a small detachable part that would be able to house the stepper motor which proved to be the best position for it since it turns the chair swivel easily depending on how much current is being supplied to the stepper motor driver and the linear actuator.

Lastly, a plastic toolbox to house the other components such as the breadboard, 12V battery, and the AC/DC converter is incorporated into the structure of the frame as well. The wiring will be put into a box so that there won't be too many wires moving around on the ground. The LCD Display will be placed inside the device so that when the consumer looks into the box, they will be able to see the display criteria which are the panel voltage, battery life, and battery voltage. We want this toolbox to be weather proof so that when the weather conditions persist as in when storms come, we will be able to protect all the circuitry and battery so that they won't get destroyed.

C. Console Implementation

In the decision to implement a Nintendo Wii game console in trying to maximize the use of solar renewable energy, we decided to use a 500 Watt Power converter which will convert our AC power source to a manageable DC power source. This power converter is ideal and more than enough to maintain the use of the Nintendo Wii, a television and any other devices hooked up to it. As we did research on the topic of power consumption through gaming consoles, we realized that we would need double the power emitted by the Nintendo Wii in order to not overload the power inverter. We ended up trying a previous low wattage power inverter through the testing of one of the group mates vehicles but it was an old type power inverter and couldn't handle all the power of the two components combined, which is why we had to switch to a better type of power inverter for our use.

The inverter will also be another important power supply for the gaming console since the wires from the solar panels will aid in the transferring of energy to the console. We ended up testing the 500 Watt power inverter to see if it would work and it was definitely successful in its efforts. The reason why we want to implement a console version of a solar tracking device is due to the fact that we are all interested in gaming consoles and this would be another way of looking into the future of gaming through less consuming ways of energy which will save people money in the long run. As we all know, consoles are one type of device that does consume a lot of power due to the heightened usage of it. Different consoles have different power consumptions. The Nintendo Wii has an average power consumption of about 19 watts, the Xbox 360 has a power consumption of 187 watts, and the PS3 has a power consumption of 197 watts [1]. Through our sense of seeing the amount of power used, we came to a decision of using the Nintendo Wii instead of the other systems since the inverter will require twice the amount of power that it consumes in order to run efficiently.

D. Programming Testing

With this project, programming had to be taken into consideration as well. We had to figure out a way to turn the stepper motor, actuator, and take in the battery voltage and panel voltage at the same time. We had for one of our portions a code implementing the movement of the actuator and stepper motor through the use of four photoresistors mounted into the top of the frame with the use of a shader to keep the light from hitting more than one photoresistor at a time. The most important thing we had to do was to initialize the stepper motor using the function myStepper.setSpeed(), where the number on the inside will indicate the rate per minute (RPM). Based on the photoresistor hit, there will be a reading using the function analogRead() within the Arduino programming environment which will take in a value from 0 to 1024 with 1024 being the highest amount of sunlight. Then, based on that reading it will turn the stepper motor either to the right or to the left and the same is true for the up and down photoresistors which will be responsible for moving the linear actuator in a clockwise fashion or anti-clockwise fashion based on a comparison of the sensor pins. Below you will see some of the code used to realize the movement.

```
sensorValue = analogRead(sensorPin);
sensorValue1 = analogRead(sensorPin1);
sensorValue2 = analogRead(sensorPin2);
sensorValue3 = analogRead(sensorPin3);
if ((sensorValue - sensorValue1)  > 100) {
   Serial.println(" - Right"); //print to the serial port
     while ((sensorValue - sensorValue1) > 100) {
     // Step forward 1600 steps:
     Serial.println("Forward"); //right
     myStepper.step(1600);
     //delay(100);
     break;
   }
 }
```

```
else if ((sensorValue3 - sensorValue2) >= 100) {
  analogWrite(speedpin,100);// value to set the speed
  digitalWrite(pinI1,LOW);// DC motor clockwise
  digitalWrite(pinI2,HIGH);
  analogWrite(speedpin,100);
  delay(100);
}
```

Continuing on with the explanation of other functions in the code include the fact that for the actuator, the pins must be set in a fashion that will make it so that it will go in one direction. This is done with the function digitalWrite() which will write to the microcontroller the instruction that it needs to execute. So when one pin1 is set for high and pin2 is set for low then the motor will rotate clockwise. If pin 1 and pin2 are reversed then the actuator will go in the opposite direction. Lastly, when the two pins are both high, then the actuator will be in the "Equal" position and will stay still. This will be done when the sun is directly above the shader or when there is no sunlight. With the function myStepper.step(), this will move the stepper motor to the right or left based on the sign polarity based on the amount of revolutions set, with 1600 being the amount of one revolution.

E. LCD Implementation

With the LCD Display that we are using, this is the Hitachi HD44780 display. We have decided to implement and connect our implementation in four-bit mode operation since it was an easier and more efficient method for transferring our data to the display. As you can see below in Figure 9, there is the picture of how four bit mode works in connection.

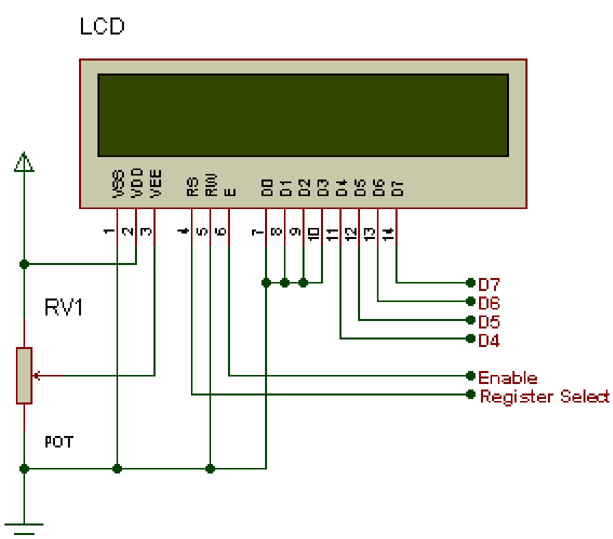

Fig. 9 Four bit mode operation for the HD44780 LCD [2]

As you can see, this format for the LCD Display will be the main control hub of our solar tracking gaming console due to the fact that it will keep us up to date with whether the system is working in a normal fashion or is depleted of power due to the amount of voltage the battery is giving off. From there this will be able to show the battery life as well so we know when the device will need to turn off as to not consume any more power.

The reason why we chose to display the three types of criteria that are battery life, battery voltage, and panel voltage are because those components are the most pivotal components of the project. The three components which are the battery,

This finalized design of the LCD will be conjunct within the circuit and the microcontroller as well for interpreting the data provided.

F. Sensor Testing

With the testing of the sensor design of our project, we employed the use of photoresistors in the form of connecting them to an analog voltage which is one of the ports on the Arduino board, as well as connecting the other port to the ground and a 5V source. When we connected the photoresistors together, they were connected in a fashion of being as a voltage divider. We employed the use of a 2.2k resistor due to the fact that at that level of resistor, the photoresistor will be able to pick up light readings in an easier manner. At first we were aiming for a 10k resistor, but this type would be too high of a resistance value to pick up light readings, but it will pick up dark readings easier even though that is not what we want in the first place. We were aiming for our solar powered gaming console to pick up the light and dark readings in a timely manner through our code as well as through the resistance.

The testing with our resistance values showed that depending on our code, it would pick up the light readings to move the frame. We tried to have different resistance values for each of the photoresistors, but this proved to be useless due to the fact that each of the photoresistors would pick up the light at a slower rate depending on how high or low the resistance value was chosen. In the end, we used all of the same values which showed to be effective because of the way the sensors would pick up the amount of sun flashed upon them. Once this was fixed, then it was all in the hands of the programming code to make sure the movement of the motors were exactly precise.

In this case, we used four photoresistors mounted on the front of the frame, but we also have two photoresistors also mounted on the back of the four sensors to detect when the sun sets as well as the sun rises.

V. Conclusion

In conclusion, through the implementation and design of our solar tracking gaming device, we can see that the amount of power needed and supplied from the Nintendo Wii as well as the inverter will be enough for us to realize the full power of what we have accomplished. As we started out in the beginning of Senior Design I, we decided on just having our device charge batteries which seemed kind of vague to begin with, but through long research and understanding of the goal that we wanted to achieve through the process of this class we realized that we must cater the project not only to the consumer's interests but also to the interests of ourselves. We later on figured out where it was that we wanted to go with this project when we realized that we are all gamers with an intention of using the power of solar energy to help reduce the energy consumption but help increase the amount of interaction with gaming in general. It helped us to move forward with a more positive outlook once we knew exactly where to go with this project

Through our participation in the 3rd Annual Progress Energy Senior Design Symposium, we also learned about the potential of creating a project and demoing it to the main public as well as practicing for engaging the public. This procedure of showing the people our project helped us to show what we are made of as future engineers as well as to help in our efforts to try and make solar power the next biggest source of energy in the future.

With the increase in solar power and other renewable sources in the future, it is a good thing to look into the ways to improve our mentality of being dependent on fossil fuels. As we have seen in the past years with the new inventions of the solar powered car or even the electric powered car as well as different generation procedures to propel vehicles and devices, this process is proving to the world that it is time to change our form of energy usage.

With our efforts invested into this project, we hope to one day see that the idea we came up with utilized more within the gaming and electronics industry. The research and formulas from different sources has helped us to use all the knowledge from all of our previous courses like Linear Controls, Embedded Systems, or even Electronics. These classes were the fundamental backgrounds for helping us to reach our goal of picking this project design. As was stated before, the reason for choosing this product was not to just design it for a limited time use but to design it for consumers to use in future developments.

With each of us trying to look into the fields of Power Electronics, Power Generation, as well as Digital Signal Processing, this project was a big precursor for us in learning more about these fundamental challenges we will face later on in life. Our experience with this project will definitely help us for job opportunities.

ACKNOWLEDGEMENT

We would like to acknowledge gratitude to Progress Energy and Bob Rich for sponsoring us throughout the design process of our project. We would also like to thank our review committee for taking the time out to critique our project. Lastly, we would also like to thank our advisor, Dr. Samuel Richie for helping our group through these two semesters of Senior Design.

PROJECT ENGINEERS

Diijon Gumbs is a senior at the University of Central Florida. He will be graduating with a B.S. in Electrical Engineering in May 2011. His interests include anime/manga, video games, and watching basketball. He plans on pursuing a master's degree in Electrical Engineering in Fall 2011 with a focus in studying Power Electronics.

Kaniel Martin is a senior at the University of Central Florida. He will be graduating with a B.S. in Electrical Engineering in May 2011. His interests include soccer, running, and commuter games. He plans on pursuing Digital Signal Processing as well as looking into a master's degree in business in the future.

James Lillie is a senior at the University of Central Florida. He will be graduating with a B.S. in Electrical Engineering in May 2011. His interests include bicycling, windsurfing, fishing, and wood/metal fabrication. He plans to pursue design and implementation within power generation.

REFERENCES

[1] Katzmaier, David and Moskovciak, Matthew. The basics of TV power. CNET/CBS Interactive 2011. 21 April, 2010. <reviews.cnet.com/green-tech/tv-power-efficiency/>.

[2] LCD interfacing with Microcontrollers tutorial. Rickey's World, World of Microcontrollers and Microprocessors, 2010.<www.8501projects.net/lcdinterfacing/introduction.php>.