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The Useless Machine

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ABSTRACT

For this project, The Useless Machine, the purpose was to design and build a machine that that turned itself off whenever turned on. By utilizing an Arduino Uno to control a SPDT switch and servomotor, a useless machine was created.

NOMENCLATURE

SPDT – *Single Pole Double Throw*

Servomotor – *rotary actuator that allows for precise control of angular position, velocity, and acceleration*

INTRODUCTION

To study how the combination of electrical and mechanical parts affect the overall usefulness of a machine. Machines come in many different forms and are used all over today's modern world. Simple machines such as the one created for this project for education purposes, to more complicated machines used in industry to do a plethora of different tasks. The way machines are build and designed to perform is a critical aspect of engineering that every mechanical engineer should understand. The purpose of this project is to gain a greater understanding of how the different components of a machine work together to either be useful or useless.

METHODS AND APPROACH

The Useless Machine Project ultimately consists of a wooden box, an on/off switch, and a wooden finger that rotates in and out of the box to activate the on/off switch. The completed box can be seen below in Figure 1.

Figure 1 – Useless Machine

The completed useless machine is made up of several different components. Table 1 below shows the components required to complete the project.

Table 1 - Parts List

Part	Quantity	Cost
5.25”x0.25”x36” Wood Plank	1	$7.99
1”x0.5”x24” Wood Strip	1	$2.99
Scrap Wood	1	$0
10k Ohm Resistor	1	$0
SPDT Switch	1	$2.99
Servomotor	1	$9.99
22 Gage Wire	1	$0
9V Battery	1	$0
Arduino Uno	1	$0
Breadboard	1	$0
Wood Glue	1	$0
Wood Screws	24	$0
Hinges	2	$1.99
	Total	$25.95

After acquiring all required parts, the box is constructed with dimensions 9”x5.5”x5.5”. Using the wood plank, the bottom and sides of the box are cut and glued together. The wood strip is cut into four 5” pieces. These pieces are then glued vertically into the corners of the box as seen below in Figure 2. Wooden screws were used to reinforce the useless machine.

Figure 2 - Top View of Box

The top of the box is cut into 2 pieces. One that is 3” long and another that is 6” long. The shorter piece is attached to the box via a pair of hinges as seen in Figure 2. A half inch diameter hole is drilled into the longer of the two top pieces. The hole is located on one end, in the middle, 1” from the short edge. The SPDT switch is inserted into this hole.

A frame is built next to house the servomotor. The inner dimensions of the frame are 1.5”x0.75”. Scraps of wood were used to build the housing. The scraps were cut and glued together using wood glue. Figure 3 below shows the finished frame.

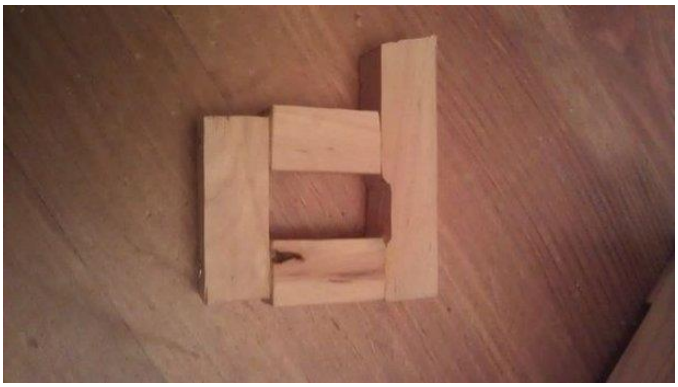

Figure 3 - Servomotor Housing

After completing the servomotor housing, it was attached to the underside of the 6” box lid so that when the servomotor activates it in line with the SPDT switch. Finally, small wood strips were attached to the lid along the sides of the box. These pieces of wood were offset a quarter inch to account for the thickness of the walls. This holds the lid in place when it is on the box but allows it to be removed for easy access to the electrical components inside. Figure 4 below shows the offset wood pieces attached to the underside of the lid.

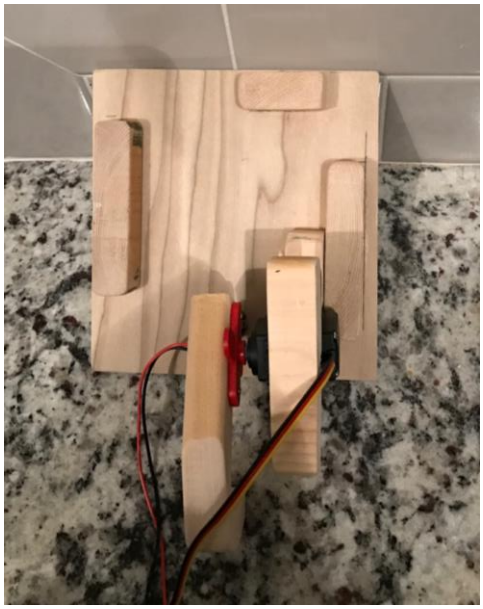

Figure 4 - 6" Lid

In order to have the servomotor interact with the SPDT switch, a "J-shaped" wooden finger was cut out of scrap wood, seen below in Figure 5. This finger is attached to the servo motor with wood screws.

Figure 5 - Wooden Finger

Inside the completed box is where the electronic components of the useless machine are housed. Figure 6 shows the wiring diagram used to complete the project. Not shown in the wiring diagram is the positive lead of the 9V battery which is connected to the Vin port and the negative lead connected to the Gnd on the Arudino board.

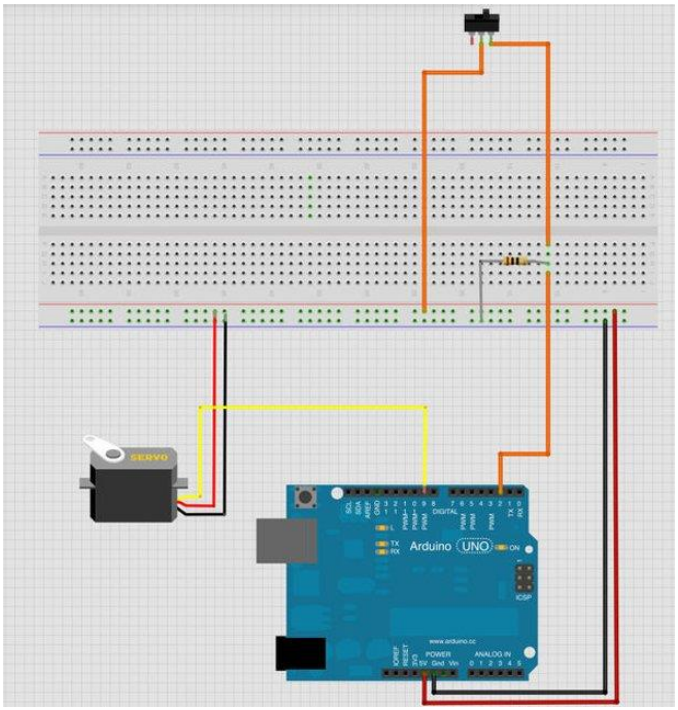

Figure 6 - Wiring Diagram

All electronic components were connected and placed inside the useless machine. A code was written and loaded onto the Arduino board that controlled the system. The code instructed the servomotor, with the finger attached, to rotate a certain amount of degrees when the SPDT switch was in the "On" position. It also told the servomotor to return to its starting position when the SPDT switch was in the "Off" position.

RESULTS AND DISCUSSION

DATA ANALYSIS

Using the Arduino software, a code was written to control the useless machine. The goal of the code was to have the machine turn itself off whenever turned on. To do this, an "if else" loop was written. The code in its entirety can be found in the Appendix.

The code was designed so that initially the state of the SPDT switch was read. If the switch was in the HIGH or On position, the servomotor would then rotate clockwise 70 degrees in 1 smooth motion. A time delay was also inserted into the code to randomize the rate at which the servomotor rotated.

If the switch was read to not be in the HIGH position, then the servomotor was programmed to return to its

initial starting position. Figure 7 below shows the servomotor having rotated 70 degrees after reading the SPDT switch in the On position. It shows the machine completing its useless task of turning itself off successfully as the switch in the Figure is now in the Off position.

Figure 7 - Useless Machine Turning Itself Off

DISCUSSION

While working on this project, a greater understanding of the process of designing and manufacturing a useless machine was acquired but not easily. It took several days to completely design and build the useless machine. The greatest challenge was finding a middle ground in developing the code to have the servomotor rotate the correct amount of degrees and creating a "J finger" that would reach the SPDT switch perfectly. Through much trial and error I was able to successfully find the correct size J finger and perfect amount of servomotor rotation to allow the useless machine to turn itself off.

I broke down the project into 2 individual parts to be tackled separately; Designing and building the box and wiring and coding the electrical components. The total amount of time I spent on the project was 22 hours. The breakdown of how that time was utilized is shown in the table below.

Table 2 - Time Management

Activity	**Time Spent (hrs)**
Part Acquisition	2
Manufacturing Box	6
Manufacturing Servo Housing & J Finger	2
Coding & Wiring	3
Testing & Troubleshooting	3
Report	6
Total	22

Designing and building the box was a greater challenge than expected. Cutting and sanding each piece of wood to the proper length was a very time consuming process. This could have been alleviated with the use proper tools and access to a better work space. Also, building a box using quarter inch thick wood was a great test of patience as the flimsy nature of the wood made for a difficult task to properly assemble the box with limited tools. After the box was assembled, more sanding was required to ensure that all corners were square and did not overlap.

As stated before, the biggest challenged I faced was in designing the mechanism that turned off the SPDT switch. I had to design a J shaped finger that would hide inside the box when off but that could maneuver around the lip of the lid and reach the switch to turn it off when activated. Since the switch was in a fixed location, there were only two variables that could change. The size of the finger and the amount of degrees the servomotor rotated.

My first attempt at solving this problem was to guess the correct size of the J shaped finger and to alter the amount of rotation provided by the servomotor. This was an unsuccessful method as there was not enough clearance by the J finger to get around the lip of the lid and I could tell that the servo was over rotating. To correct this I started by shaving down the finger and making the curve of the J thinner, thus giving me the correct amount of clearance to navigate the lip of the box. Next I began to alter the code to change the amount of rotation provided by the servo motor. Table 3 below shows the results of my different trials.

Table 3 - Testing

Trial	Rotational Degrees	Observation
1	90	Fail; over rotated
2	50	Fail; under rotated
3	80	Fail; over rotated
4	60	Fail; under rotated
5	65	Fail; under rotated
6	70	Pass; reached switch

After a series of trial and errors I discovered that the ideal amount of rotation was 70 degrees. This would allow the J shaped finger to travel out of the box, over the lip of the lid, and push the SPDT switch into the off position.

After the box was completely assembled with electrical components turned on and in place I came upon another unexpected issue. The SPDT switch provided too much resistance for the servomotor to overcome to flip the switch into the off position. This could have been easily fixed by purchasing a more powerful and expensive servomotor. However, I wanted to try and work with the components I had already acquired.

It was clear that the resistance provided by the SPDT switch needed to be reduced. I started by disassembling the switch. The internal mechanism of the switch can be seen below in Figure 8.

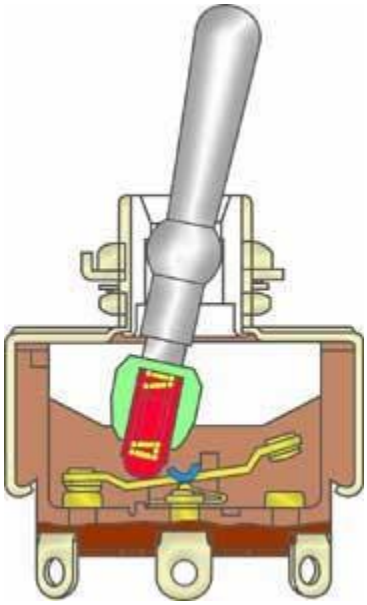

Figure 8 - Internal Switch Components

To reduce the amount of force it takes to throw the switch, I reduced the length of the red pin shown in the figure. I only cut approximately 1 millimeter each time and utilized the trial and error method to get the right length. Each trial I would shave a little off the tip of the contact pin and reassembly everything and test the useless machine. It took 3 iterations to get the useless machine working properly.

Ultimately, I was able to design and build a machine that would turn itself off whenever turned on. Thus, making it a useless machine.

CONCLUSION

This project demonstrated how the combination of electrical and mechanical parts effect the overall usefulness of a machine. Upon completing this project, a clear understanding of how the different components of a machine work together to either be useful or useless was gained.

FUTURE WORK

I intend to further expand on this useless machine by adding another servo motor that will control the hinged part of the lid. I will be able to build onto my already existing code to incorporate a new servomotor. This servomotor will lift and close the lid before and after the original servomotor has performed its function of turning off the useless machine.

APPENDIX

useless.robot

```
#include <Servo.h>

const int  buttonPin = 2;
int buttonState = 0;

Servo myservo;

int pos;
long timeDelay;

void setup()
{
  pinMode(buttonPin, INPUT);
  myservo.attach(9);
}

void loop()
{
  buttonState = digitalRead(buttonPin);
  if (buttonState == HIGH) {
     for(pos = myservo.read(); pos >=20; pos -= 1) {
       myservo.write(pos);
       timeDelay = random(15, 30);
       delay(15);
     }
  }
  else {
     timeDelay = random(1, 4);
     for(pos = myservo.read(); pos <=90; pos += timeDelay) {
       myservo.write(pos);
       delay(15);
     }
  }
}
```

Figure 9 - Useless Robot Code