Operation Manual

EML 4551C – Senior Design – Spring 2013 Deliverable

Team 13: Smart Materials Museum Exhibit Design

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1. Function Analysis

The flow of our prototype components is described in the following diagram. The diagram states how each component is utilized in the grand scheme of our project and how the function of one is directly related to the other. The statements for each component are brief but they capture their respective main purpose and task.

Again, this flow diagram incorporates all of our components and their relationship to one another. There are actually two flow diagrams. The design was divided into two phases: user interface (Figure 1) and satellite structure (Figure 2). The reasoning for dividing the design into two flow diagrams is simply for the sake of clarity. The user performs a series a functions and the satellite workings are a direct result of it.

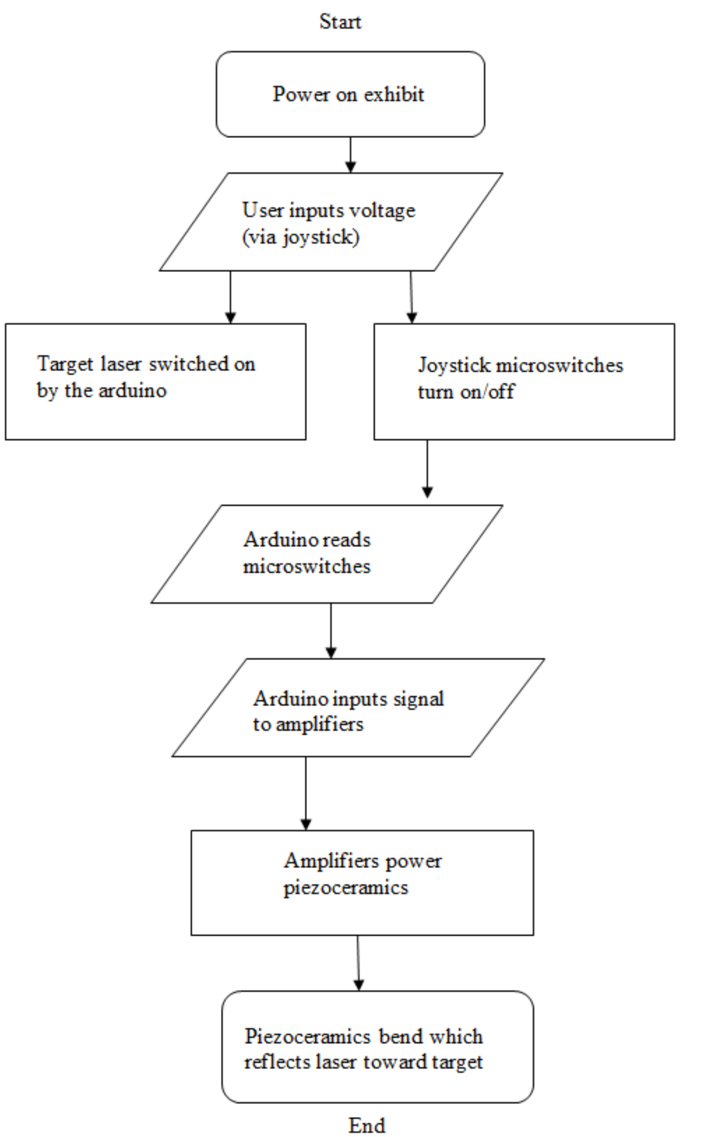

Figure 1: User Interface Flow Diagram

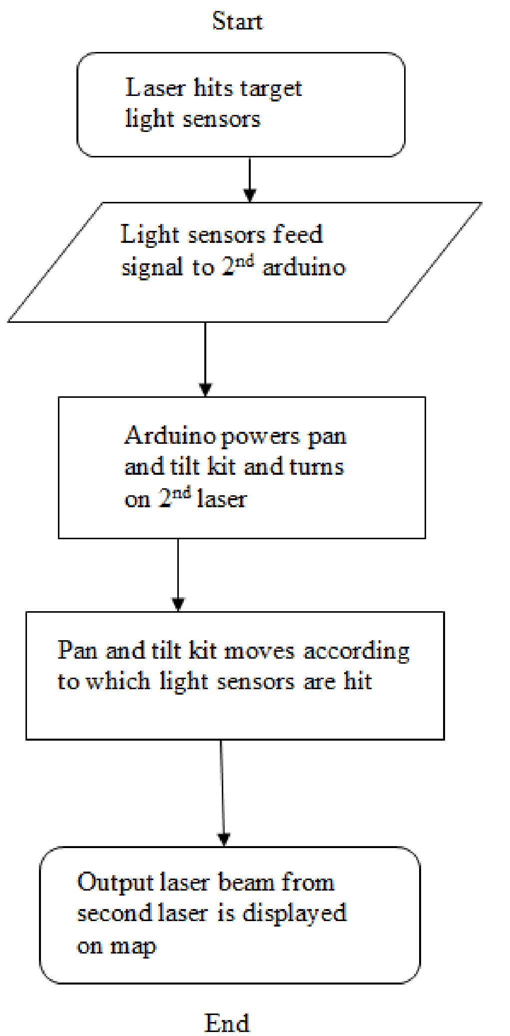

Figure 2: Satellite Structure Flow Diagram

2. Product Specifications

Piezoelectric Ceramic: Microfiber Composite

Product Number: MFC P1 #M4010

Operating Voltage: -500 to +1500 V

Capacitance: 1.00 nF

Lifetime:

Actuator: 10E+8 cycles

Sensor: 10E+11 cycles

Harvestor: 10E+10 cycles

Microcontroller: Arduino Uno

Product Number: DEV-09950 (or DEV-11021)

Input Voltage: 7 to 12 V
System Voltage: 5V
Clock Speed: 16 MHz

Amplifier:
Product Number: EMCO C10
Output Voltage: 1 to 1000 V
Maximum Output Current: 0 to 1 mA
Frequency: 200 to 250 kHz

Joystick: Arcade Joystick- Short Handle
Product Number: COM-09182
Rated: 5A @ 125V, 3A @ 250 V

Pan/Tilt Kit: Pan/Tilt Bracket
Product Number: ROB-10335

Servo Motors:
Product Number: ROB-09065
Operating Voltage: 4.8 to 6.0V
Operating Range: ~170 deg

Photocell: Jameco Photocell
Product Number: 120299
Maximum Power: 250 mW
Maximum Voltage: 250 V
Resistance: Max-1000kohms, Min-12 kohms

Power Source:
Voltage: 12V
Current: 2A DC

Lasers: Green and Red
Requirements: Low power

Piezoelectric Stand: Helping Hands
Product Number: SE MZ101B

3. Operation Instructions

Our operation instructions are very unique in the sense that the instructions are a bit open ended. There are clear ways to go about starting our design but after that, the way in which the user operates it is simply up to the student. That is the unique aspect that our project allows for. We designed the operation with the mind state of it being reflective of how piezoceramics are used in satellite communication today. They are attached to the fender of a satellite and when voltage is provided, the satellite fender bends slightly which improves the satellite communication. Our design provides the means for the piezoceramics to bend slightly but the way it does so and the direction in which the mock satellite adjusts is completely up to the user or student.

The instructions for operating the system are as follows:

1) The exhibit is first powered on. This is to be done by an adult before the student attempts to use it.
2) The student is explained the concept and objective briefly. The objective will be to improve satellite communication with a certain Florida city. Depending on which city is said, the student will adjust the satellite accordingly so that laser from mock satellite projects onto the city. Satellite will be adjusted by hitting one of four photoresistors stationed above.
3) Student uses joystick at stand to apply voltage to piezoceramics.
4) Joystick also controls where the laser, which is reflected from small mirrors, hits the target above.
5) Student, using the joystick, hits one of the photoresistors. This induces a reaction in the pan and tilt kit placed inside the mock satellite. Another laser is attached to the pan and tilt kit and is turned on once a photoresistor is hit.
6) Once a photoresistor is hit, the projection of the laser from the pan and tilt kit is adjusted as will be seen on the map of Florida against the wall.
7) If the proper city which the student was told to improve satellite communication with is not hit, step 5 is repeated again until the laser from mock satellite projects beam onto proper city.
8) Once proper city is hit, the student has successfully completed his objective.
9) The exhibit is then to be turned off to preserve battery and components power life.

Apart from our interactive design that was just explained, our exhibit also allows for an additional demonstration. Since our initial problem statement included demonstrating how smart material works, a bonus feature was added to our exhibit. Apart from the joystick, the user can press any of the 4 colored buttons surrounding it. When pressed, these buttons will make the piezoceramics bend in a certain matter and the laser will reflect off them in a specific manner. Each one will be different. This will show how different voltage affects the piezos differently and since they only bend slightly, the laser reflection will enhance the demonstration. All the user has to do is select a button and watch.

4. Additional Required Assembly

In addition to the electronic components an exhibit stand must be built to encase the project. The laser, piezoelectric ceramics, and amplifiers will be inside an acrylic case on top of the stand. The joystick is mounted outside of the acrylic case so the user can operate the system. Inside the stand is an area where all wiring and other electrical components will be stored. This will be enclosed by a vented sheet to prevent overheating. The dimensions of the acrylic case and stand are shown in Figures 4 and 5 respectively.

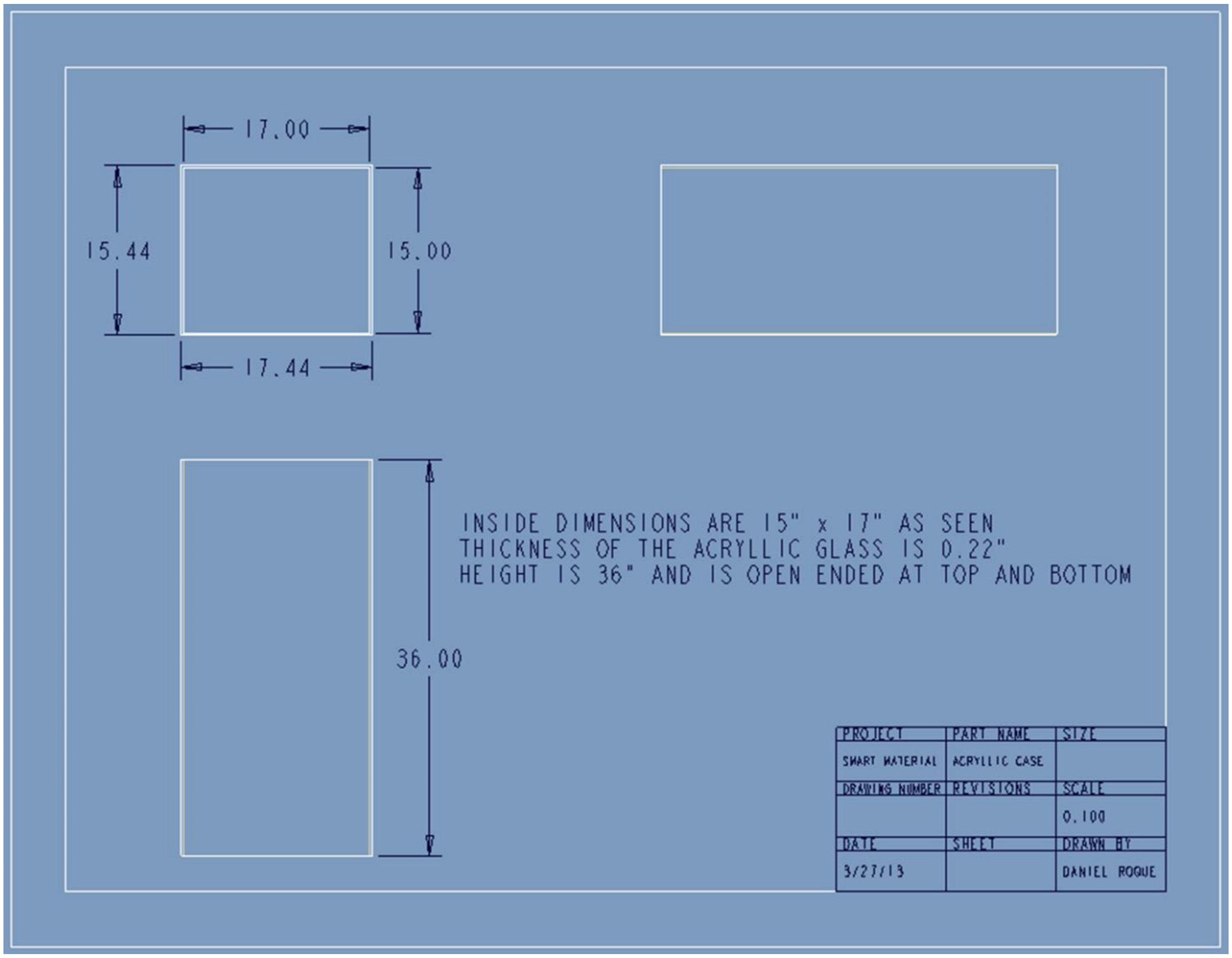

Figure 3: Acrylic Case Dimensions

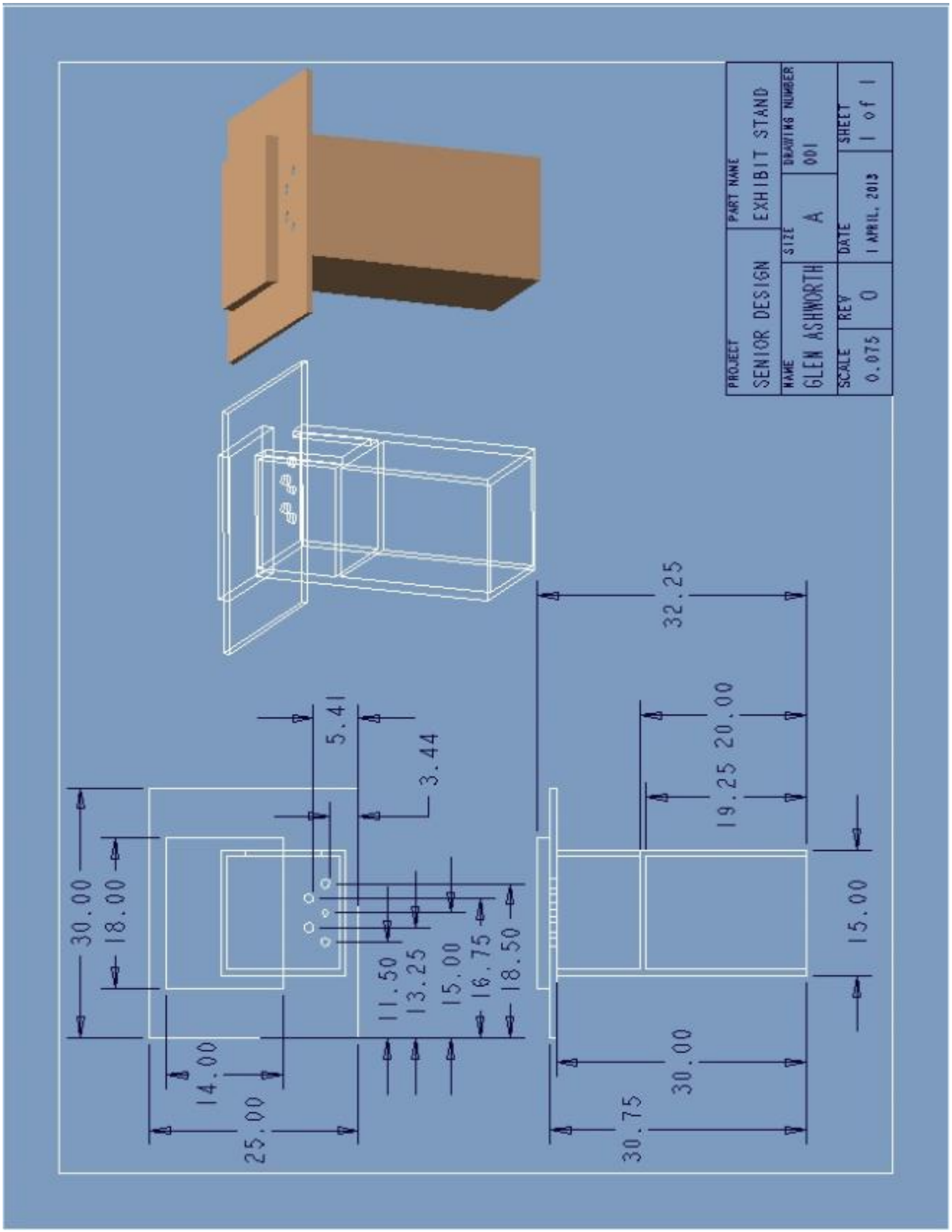

Figure 5: Exhibit Stand Dimensions

5. *Troubleshooting*

Problem	Cause	Remedy
No response from exhibit	Power switch turned off	Turn switch on.
	AC power not plugged in	Ensure exhibit is plugged in to a working outlet.
	Power supply failure	Check to see if green light on power supply is on. If red light or no light is present, replace power supply with a 120V AC to 12V DC power supply capable of 10W of output.
	Microcontroller failure	Check to see if green light on microcontroller is on. If light is not on and the microcontroller is receiving power, replace with Arduino Uno microcontroller.
Smart material moves, but red laser does not come on.	Red laser has failed	Test voltage when laser should be powered on. Voltage should read 3V. If laser is being powered and still not working, replace with a 5V laser which draws less than 40 mA current. (Recommended Digital Energy 8 LED flashlight with laser from Radioshack)
Laser comes on, but smart material does not move.	Amplifier has failed	Test programming voltage going in to amplifier. Should read from 0-5V depending upon joystick movement. Replace with EMCO C10.
	Smart material has failed	Replace with Smart Material M 4010 P1 bonded to aluminum sheet.
Nothing happens when the laser hits the photoresistors on target	Upper station not receiving power	Check to make sure upper station is plugged in to a working outlet.
	Microcontroller failure	Check to see if green light on microcontroller is on. If light is not on and the microcontroller is receiving power, replace with Arduino Uno microcontroller.
	Green laser failure	Test voltage when laser should be powered on. Voltage should read 3V. If laser is being powered and still not working, replace with a green laser that operates at 3V.
	Photoresistor failure	If arduino is functioning properly, test to see if resistance of the photoresistor changes with light conditions.
	Servo motor failure	If arduino is functioning properly, test to see if motors are receiving power.

Figure 4: Troubleshooting Instructions

6. Regular/Routine Maintenance

There is minimum maintenance to be done on our project since it is mostly hardware that was bought and it is all subject to the computer code that we implemented. The code that goes to each microcontroller will obviously not ever be changed once installed so that does not need to be checked. As said, there is no major maintenance upkeep on our project. The following are simple repairs that may be required and they are of no technical difficulty so they may be accomplished by any adult.

- After a while, the laser beam from the laser might dim in appearance signaling it losing a bit of power. A replacement in batteries may be needed.
- Wires connecting piezoceramics may become loose. In this case, they are to be soldered carefully back.
- Piezoceramics may become loose from metal sheet (though it should not happen unless by a freak accident). In this rare case, they are to be glued back to the metal sheet carefully with specific glue.
- Pan and tilt kit assembly can also be checked periodically just for precautionary purposes. Tightening of screws and bolts may be needed just to make sure all small pieces are secure.

7. Spare Parts

Alligator Clips (Jameco Part no. 104440): In the case of damage to wiring, alligator clips can be used to connect wires until the wires are properly repaired/ replaced.

Soldering Equipment: If electrical components are damaged, soldering equipment will be needed to install new electrical wiring between components.