GNG2101 C Deliverable I

Sensory Chair Project

Submitted by

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Abstract:

This deliverable outlines the current status of our final prototype, along with descriptions of its key components. These components include the rocking mechanism, code and electrical circuit. Below are the documented prototypes, as well as what would have been done should we have been able to continue to work as a team within the proper facilities. This includes detailed instructions of the plans for the final prototype, and a realistic plan for how our final prototype would have been completed.

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1.0 Final Prototype Status Update:

In an unexpected turn of events, the prototype at its current stage would become the final prototype. The current status of the prototype was the key aspects of the chair individually. The function of these prototype partitions include: the overall design, the mechanism to allow rocking, the code, and the electrical wiring between batteries, motor and arduino. The client would be able to interact with the different prototypes to have a better understanding of the core functionalities of the different mechanisms of the chair, as well, to communicate any changes or opinions on the current design. For these reasons, the prototypes were not only functional but also communicational.

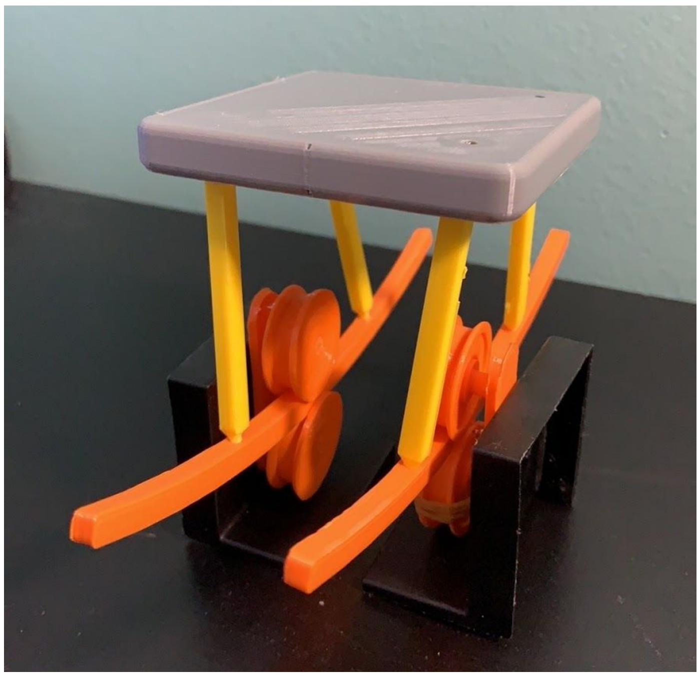

Figure 1.1: Prototype Design

The first prototype made was for the core design of the rocking chair. This design shows how the traditional rocking chair would be repurposed into one that could be automatic, as well as stationary. Originally, the rocking motion of this chair would have been powered by pulling a wheel along a chain track on one of the rockers. However, this design choice was modified. The above prototype was 3D-printed so it could be interacted with by the user, and see how the chair would rock while staying in place. A notable aspect of this design is how the wheels surround the rockers of the chair. This would allow the chair to rock back and forth, without displacing on the platform. Furthermore, the wheels would allow steady, consistent rocking along with making the overall design much more stable. Not pictured in the design is the backrest, which would be sloped to allow a variety of resting positions for the user.

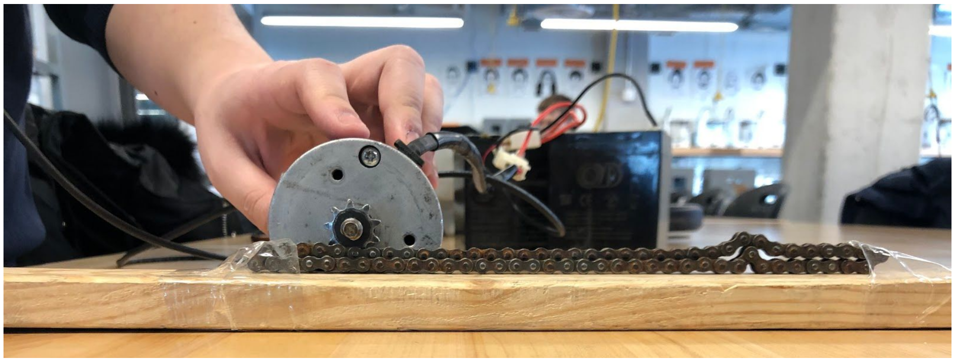

Figure 1.2: Rocking Mechanism

The next prototype focused on how the chain and the gear would interact. As can be seen above, the chain is attached to the wood board, which on the final design would have originally been the rocker. This would pull the rocker back and forth, causing the chair to rock. To ensure stability while rocking, wheels would be used on either side of the rocker, similarly to how a roller coaster rides along its rails (but inverted). The motor would be mounted alongside one rocker by a metal plate, secured to the base of the overall product.

As the COVID-19 pandemic came quickly, we were unable to complete final prototype testing to compare our prototype to our original specifications. Should everything have gone to the original plan, the project would have been completed as outlined below. Certain metrics of the chair that include rocking speed and rocking duration have been incorporated into the arduino code, and allow the user to determine their ideal rocking speed, and how long they want the chair to rock on a button press. This duration can be any amount of time, or, at the repress of the button.

2.0 Planned Execution Under Normal Conditions

Due to these unforeseen circumstances, we were unable to move forward with the completion of the project. This section will describe what we had planned to do to finish the project. After having bought all the required material, we were to split into two groups to work on building the prototype. The first group would work on building the chair and platform while the second team would work on finishing the circuit and the Arduino code. Both of these tasks were not completed.

In order to build the final prototype we needed to cut pieces from the sheet of plywood using the bandsaw. These pieces would be used to make the box under the chair. The pieces would be cut into two 2 x 2.5 ft. for the top and bottom, two 1 x 2.5 ft. for the sides, and two 2 x 1 ft. to complete the box. The front panel would have a hole cut from it to allow access to the inside of the box. This hole would be covered by a hinged door held down by a pin. When the pin is removed, the user would be able to access the Arduino chip to make changes to the code and charge the batteries. The inside of the box would be supported by cut pieces of 2x4 wood for structural support and to hold the components in place.

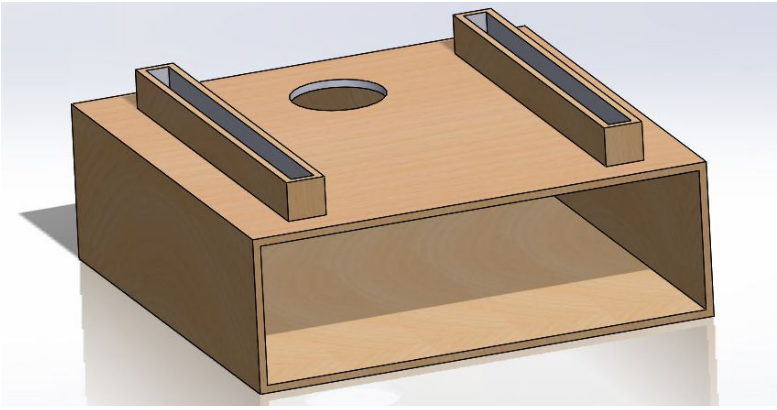

Figure 2.1 Box where the chair will rest.

To complete the box, two casters would be installed on the back side of the box and two slots on the front as handles. The box will be able to roll using a tilt n'roll system. This works as the box sits flat on the ground the wheels are not touching the floor. When the user wishes to move the chair assembly, they simply lift by the front slots tilting the box back and thus the wheels would then be the only point of contact with the floor (figure 2.1).

Figure 2.2 Tilt n'roll ladder

Next, we would have to install the motor mechanism in the box with all its components. The motor would be installed in the box under the top sheet, held by the motor mount. Then, once the location of the motor is known, a hole would be cut in the top sheet where the chain will be moving up and down. On the free end of the chain in the box, the spring would be installed to a support piece to make sure the chain remains in tension on the motor sprocket (figure 2.3). Once the box is finished, the chair would be placed on top in the neutral position and the chain would be attached to the front crossbeam between the rockers. To ensure the chair doesn't slip on the top of the box, a frame would be installed around the rockers. This frame would be made of 2x4 pieces fitted to the size of the rockers so that there is no room for the chair to slip forwards or backwards. There would also be a screw eye installed on the front piece of the frame with a cable attached to the bottom of the seat. This would be installed so that the chair does not fall off the base when the system is being moved with the tilt n'roll. It is better to have the cable holding the chair rather than putting unnecessary force on the chain and motor while the chair is being moved. Once the chair is in its resting position, the cable can be detached to allow the chair to rock.

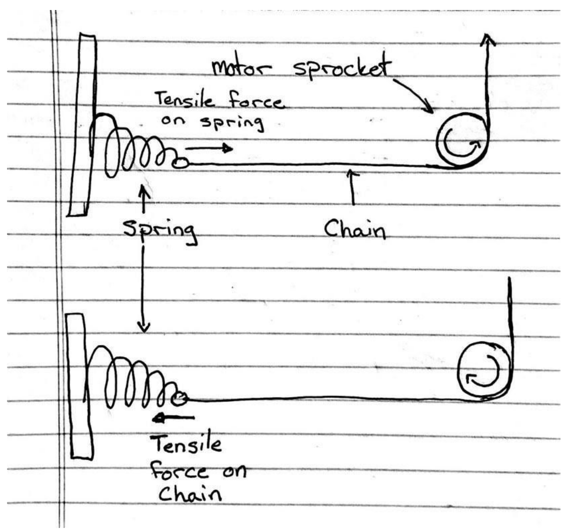

Figure 2.3 Spring mechanism to keep motor chain in tension

This mechanism is displayed in figure 2.3 to show how the chain and motor in combination will produce a rocking motion. The chain connects to the back bar on the chair and as the motor rotates clockwise and counterclockwise the chair will rock back and forth respectively. The spring (not shown in figure 2.4) will maintain tension in the chain.

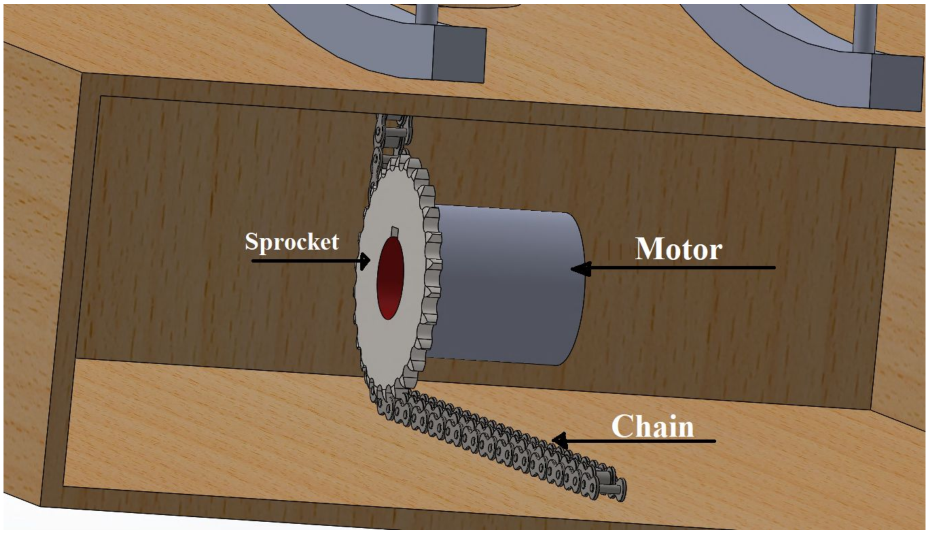

Figure 2.4 motor chain set up inside box

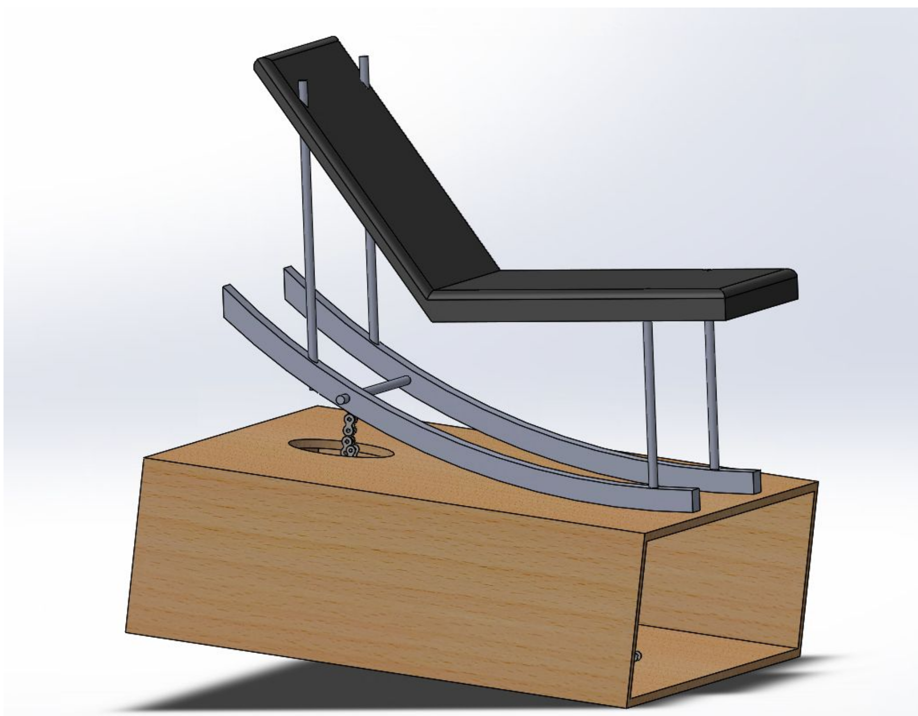
Figure 2.5 Overview of chair assembly

Finally, the last thing for construction would be to make the new backrest and fix it to the existing seat. The customer requested in our last meeting that the chair remain in a desired position for optimal comfort. To do this we had planned to cut a new backrest out of the remaining plywood from the box. Six strips would be cut from the plywood to make the backrest resemble the backrest of a muskoka chair (figure 2.3). The backrest would be attached to the seat at the desired angle using the brackets. Next the seat would have to be attached to the rocker legs at a position where the center of gravity is in the middle of the rockers. Due to the user wishing to be on his belly or back, the backrest will have to be well supported.

Figure 2.6 Muskoka chair backrest

As mentioned above, the second team would be working on fixing the Arduino code to make sure the motor functions as desired. The code would be formatted to make the motor rotate slower and change direction. In order to make the design work the chain would have to pull the chair down making it rock forward. Then the motor would spin in the reverse direction making the chair fall back on its rockers due gravity. This motion would have to repeat itself over and over, as a loop function. The customer also wanted the rocking motion to be on a timer, so the code would include a thirty minute timer to automatically turn off. Finally, the motion would have to be at a steady slow speed to make sure the user is comfortable in the chair.

After everything is set up, we would move on to testing the motor and motion of the chair. The tests would include setting up the motor and uploading the code to the arduino. A fifteen kilogram weight would be placed on the chair to simulate the weight of the user.

The circuitry of the system is shown in figure 2.7 below. The picture shows the motor connected to the motor shield. And the shield is supplied with 24Volts from the 2 12V batteries. The arduino is powered by one battery. The circuit works and moves the motor backwards and forwards with the help of a motor open source shield test code obtained from Cytron Technologies . The next steps would have included adjusting the speed of the motor and dampening the abrupt stopping motion using a PID controller in the arduino code. However after trying to recreate this circuit, the arduino seemed to not work anymore and further tests and adjustments to the code could not be completed.

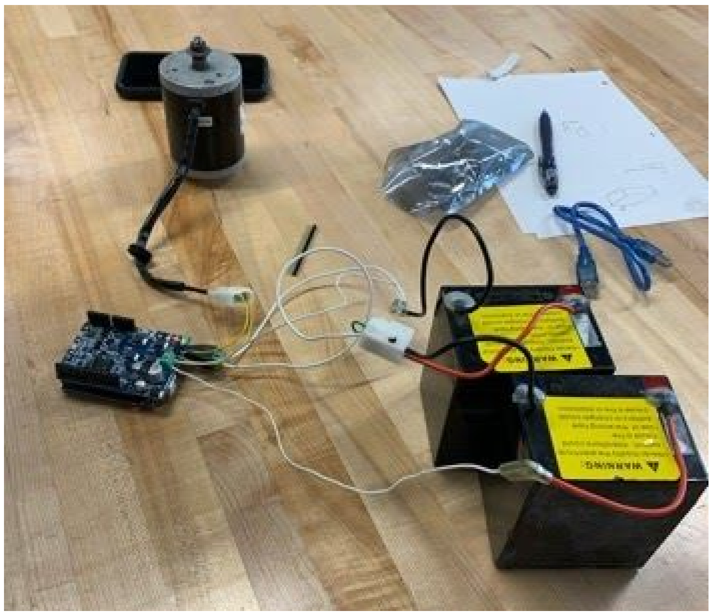

Figure 2.7 Motor arduino circuit

The tests would include turning the rocking motion on and off to test for speed and stability. Then the motor would be left on to make sure the timer function works as well. This test would not need to include the entire setup as we would simply be testing if the motor turns off after thirty minutes. Finally, we would test the tilt n'roll system by trying to move the system. This would simply include attaching the cable to the screw eye and making sure the chair does not fall off in the process.

3.0 Conclusion

Hardly any project goes to plan, however such circumstances are very difficult to predict. While these events mean we can no longer proceed as planned, this deliverable outlines what we have managed to accomplish before the pandemic. Additionally, the further steps we would have taken are described in detail to explain what would have been done should everything have gone according to plan.

Source code (obtained from Cytron Technologies)

```
 * AUTHOR   : Kong Wai Weng
 * COMPANY  : Cytron Technologies Sdn Bhd
 * REVISION : 1.0
 * DATE     : 22/10/2012

// PWM is connected to pin 3.
const int pinPwm = 3;

// DIR is connected to pin 2.
const int pinDir = 2;


// Speed of the motor.
static int iSpeed = 0;

// Acceleration of the motor.
static int iAcc = 1;



// The setup routine runs once when you press reset.
void setup() {
  // Initialize the PWM and DIR pins as digital outputs.
  pinMode(pinPwm, OUTPUT);
  pinMode(pinDir, OUTPUT);
}

// The loop routine runs over and over again forever.
void loop() {

  // Control the motor according to the speed value.
  // Positive speed value = CW,
  // Negative speed value = CCW.
```

```
  if (iSpeed >= 0) {
    analogWrite(pinPwm, iSpeed);
    digitalWrite(pinDir, LOW);
  }
  else {
    analogWrite(pinPwm, -iSpeed);
    digitalWrite(pinDir, HIGH);
  }

  // Increase/Decrease the speed according to the acceleration.
  iSpeed += iAcc;

  // Change the acceleration sign when full speed is reached.
  if ((iSpeed >= 255) || (iSpeed <= -255)) {
    iAcc = -iAcc;
  }
  delay(10);
}
```

Gantt Chart

Purchase Materials	1 day	Sun 20-03-15	Sun 20-03-15	
Build Prototype	5 days	Mon 20-03-16	Fri 20-03-20	
Prepare pieces	2 days	Mon 20-03-16	Tue 20-03-17	
Cut materials to size	1 day	Mon 20-03-16	Mon 20-03-16	
Drill screw holes	1 day	Tue 20-03-17	Tue 20-03-17	
Cut holes	1 day	Tue 20-03-17	Tue 20-03-17	
Assemble Box	2 days	Wed 20-03-18	Thu 20-03-19	
Add supports	1 day	Thu 20-03-19	Thu 20-03-19	
Build frame	1 day	Wed 20-03-18	Wed 20-03-18	
Build backrest	3 days	Wed 20-03-18	Fri 20-03-20	
Attach casters	1 day	Thu 20-03-19	Thu 20-03-19	
Install acess door	1 day	Fri 20-03-20	Fri 20-03-20	
Install screw eye	1 day	Fri 20-03-20	Fri 20-03-20	
Testing	5 days?	Tue 20-03-17	Sun 20-03-22	
Program Arduino	3 days	Tue 20-03-17	Thu 20-03-19	
Test tilt n'roll	2 days	Fri 20-03-20	Sat 20-03-21	
Test motion	2 days	Fri 20-03-20	Sat 20-03-21	
Test timer	1 day	Sun 20-03-22	Sun 20-03-22	
Design Day	4 days?	Sun 20-03-22	Wed 20-03-25	
Make presentation	2 days	Sun 20-03-22	Mon 20-03-23	
Practice	3 days	Mon 20-03-23	Wed 20-03-25