Grumpelstiltskin

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Fundamental Objectives

Many objects in our everyday environment are inanimate, leaving little room for creative interactions and social growth. A major contributor to this lifeless world is furniture: it is present in virtually every home and building, yet provides no more than a place to relax. The objective of this project is to produce interactive furniture, seeing the potential to increase human cognition. With furniture which now has personality, people will no longer take them for granted. Users will have to consider the emotions of the furniture, rather than assuming it is specifically for their use. Besides having fun, this project would benefit people in that users will become more courteous towards others and increase awareness of their environment.

Current Rendition

The concept of interactive furniture is manifested in this report as a prankster's chair. This chair does not want to be sat upon: when someone is about to rest upon it, the chair will scoot out of the way. Users must consider the grumpy nature of this chair before automatically assuming the chair, Grumpelstiltskin, is theirs to take advantage of.

Construction

The main advantages of this project are the low-cost material selection and its fabrication from easily accessible materials. Any novice is capable of acquiring the supplies from their basement.

Materials Needed

- Chair (x1)
- Screws (x15)
- Scrap Wood
- 2x3 Wood (8')
- ½" PVC Piping (6")
- 8" Wheels (x2)
- 1" Roller Wheels (x2)
- 30" Circumference Drive belt (x1)
- 2.5" Pulley with an Axle Diameter of 3/8" (x2)
- 3/8" Aluminum Dial Rod (12")
- 3/8" Electric Drill (x1)
- ¼"-20 Threaded Rod 3/8" Diameter (12")
- ¼"-20 3/8" Nuts (x4)
- Arduino (x1)
- IR Sensor (x1)
- Relay- Switch: 4.5V/ 38mA Load: <6 Amps (x1)
- 22 Gauge Wire (10')
- 10' Extension Cord (x1)
- Duct Tape

The initial step in producing a Grumpelstiltskin chair is to construct a motor mount for the electric drill. Since the shape and design of each drill differs from company to company, this step can only be described qualitatively. To start, a piece of scrap wood, which is the same size as the electric drill, needs to be chosen and will serve as the base of the mount. Supporting scrap wood needs to be cut to the length of the drill's width. These pieces of wood will bridge the motor mount base to the underside of the chair's seat. The supporting scrap wood needs to be strategically placed as to secure the drill in one location, while also jamming the trigger into the 'on' position.

An additional piece of scrap wood is to be mounted to the base of the chair. This piece has 3/8" diameter hole drilled into it, a hole which lines up with the drill's axle. The purpose of this attachment is to allow the drive belt axle to have another support. A 3" long section of the aluminum dial rod should now be cut and tightened into the electric drill's chuck. Mount one of the pulleys onto this aluminum rod.

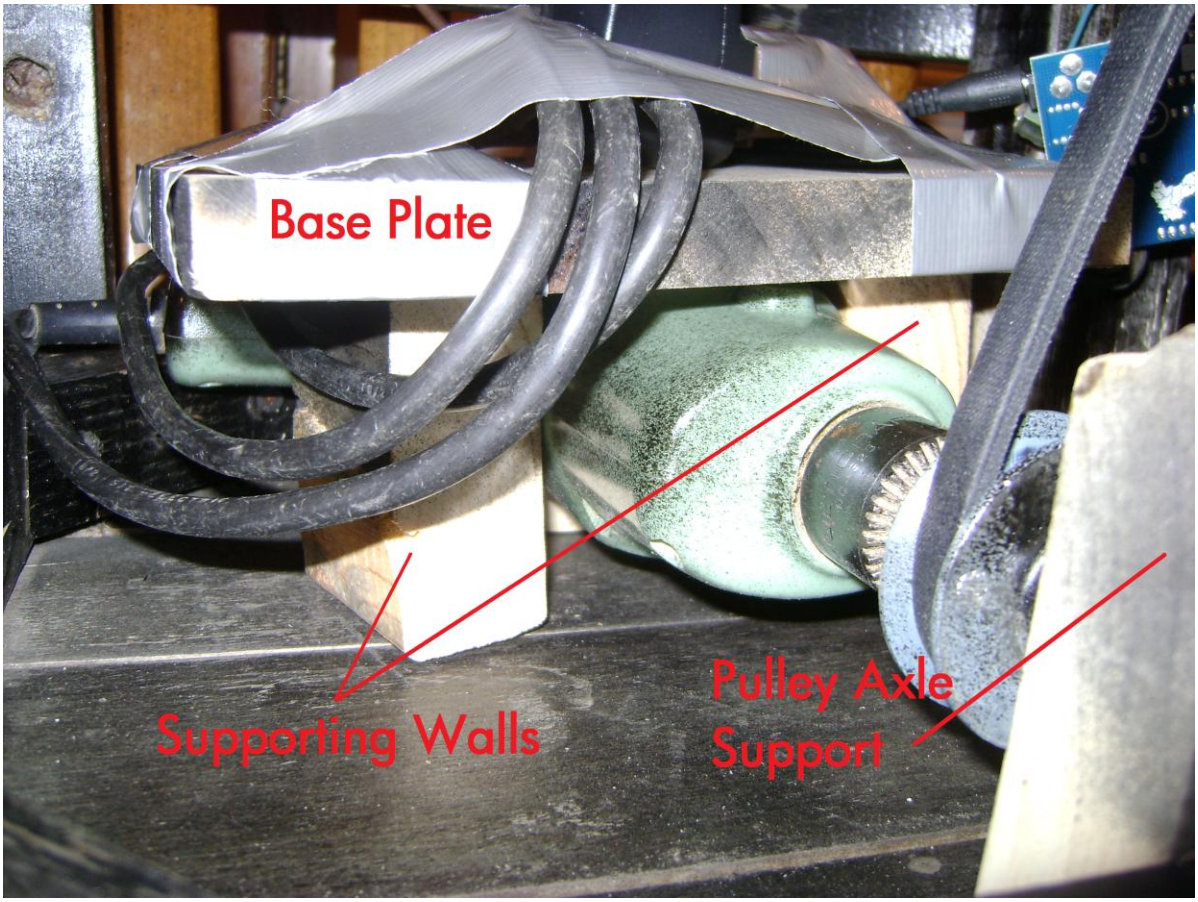

Figure 1: Base Plate Assembly

Now we are ready to attach the drive wheel support. Cut two equal size strips of 2x3 to the length of about an inch less than that of the chair's back legs. Drill a ¾" hole into each support, about 1" from the bottom. This will be the location where the wheel axle will be placed. Screw in these two supports into the base of the chair, about three inches from the very back of the seat. Since the drive belt will place tension on the wheel supports (pulling them forward), two small pieces of wood need to be attached from the supports to the chair's back two legs. These supporting shims will resist the belt from pulling the wheel supports forward.

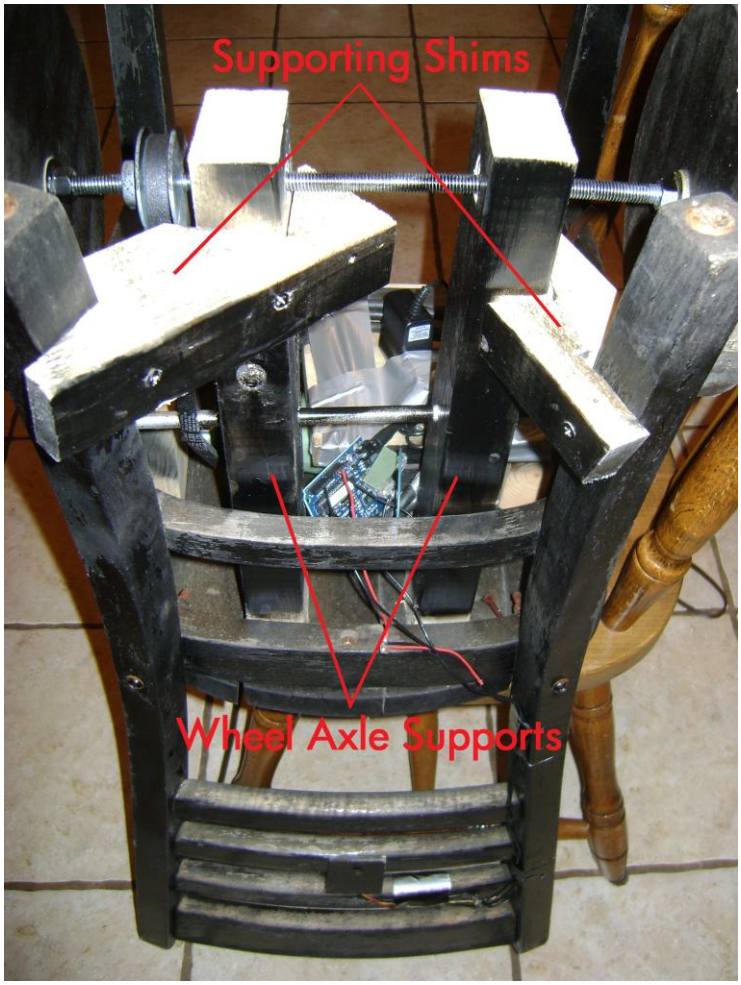

Figure 2: Wheel Axle Support Assembly

Cut off two 3” pieces of PVC pipe and place these into the two axle holes in the wheel supports. The PVC pipe serves as a bearing for the wheel axle.

Being the support structure of the chair is now complete, we will mount the wheels. This is completed by first putting the threaded rod through the PVC pipe. Attach the remaining pulley onto the threaded rod in such a manner that it aligns with the electric drill’s pulley. Now is the time when the drive belt is mounted to the drill’s pulley and looped around the threaded rod’s pulley. Screw on a single nut to each side of the threaded rod, tighten the wheels onto each side, and then cap each end of the rod with another nut.

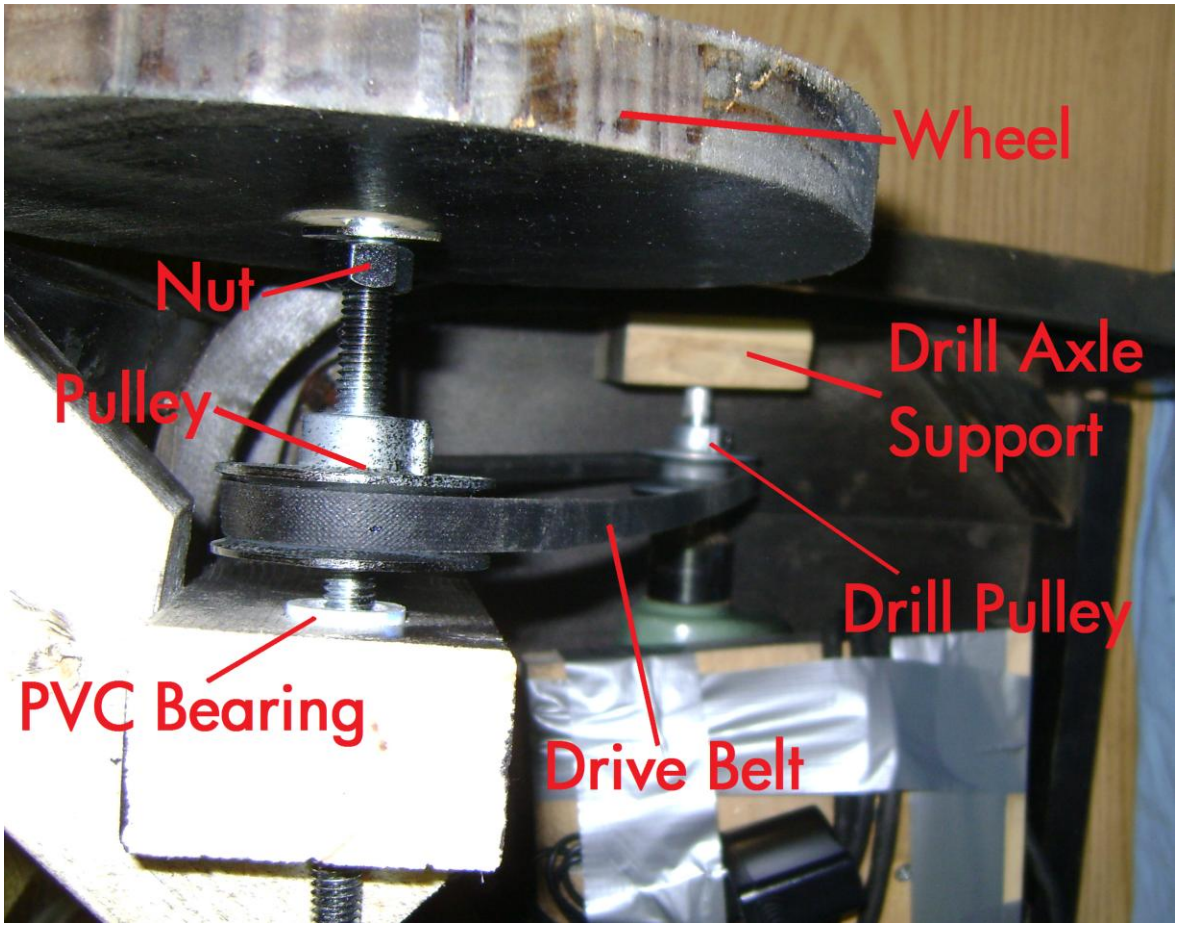

Figure 3: Belt Drive Assembly

The rest of the construction deals with the electronic components. Starting off, two inches of red wire and two inches of black wire were stripped and connected to their respective +5V terminal and the ground on the Arduino. These two wires will serve as connection hubs to attach the IR sensor and the relay.

The IR sensor needs to be mounted to the back of the chair. This step should be done in such a fashion that the sensor is aimed at the position where the user's hips will be when he is about to sit down. The IR sensor requires a two foot wire extension to each of its leads; this is done so that it can be attached to the Arduino (soon to be mounted on the bottom of the chair). Attach the IR's positive end to the red extension terminal, the IR's black end to the ground terminal, and the yellow IR wire to any analog pin on the Arduino.

Figure 4: IR Sensor Attachment

Before inserting the relay into the circuit, we first must cut into a portion of the drill's power cord to gain access to one of the power lines. Cut the black wire, and pull out about an inch on each side. Strip the ends of the black wire and then solder them to the two thicker leads on the Relay. The specific direction which the black wire is soldered to the relay does not matter (you may solder black wire 1 to relay lead 1, or relay lead 2). Cut two more jumper wires; solder both jumper wires to the smaller leads on the relay. Connect one of the wires to a digital pin on the Arduino, and solder the other jumper wire to the black ground terminal.

The physical components of the chair are now complete! The last step to finish your chair is to develop a program and upload the sketch to the Arduino. The sketch to run the Arduino is very simple; however, there is a specific issue with regards to the IR sensor which will be addressed in the Technical Difficulties section.

Electric Diagram

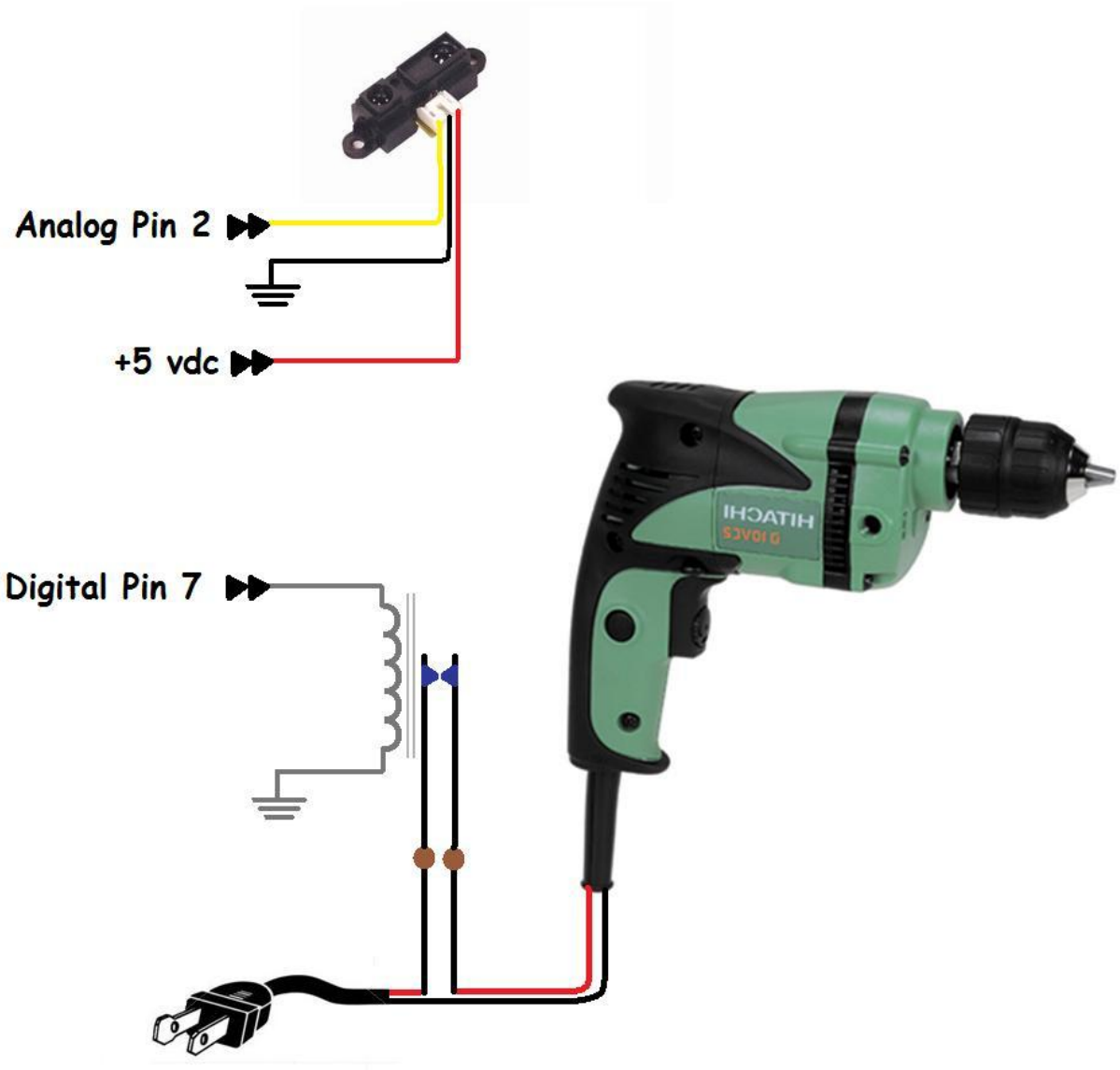

Figure 5: Grumpelstiltskin Schematic Diagram

Arduino Sketch

```
//Matt Kuhn
//This Program will read the value produced by an IR resistor
//If the IR resistor value is consistently over a certain value,
//then the program turns a motor on

int analogInPin; // IR Sensor Pin Number
int sensorValue; // Value Returned by IR Sensor
int motorPin;    // Pin Number connected to the motor's Relay switch
int count;       // Used to negate false positives
int detectionValue; // Value to determine whether someone is about to sit

void setup(){
        // Assigns Proper Pin Connections
        analogInPin=2;
        motorPin=7;

        // Initializes program with appropriate starting Values
        sensorValue=0;
        count=0;
        detectionValue=100;  //  Determined by Trial and Error

        // Sets up IR and Relay ports
        pinMode(analogInPin,INPUT);
        pinMode(motorPin,OUTPUT);

        // initialize serial communications at 9600 bps:
        // Serial communications are used for debugging purposes
        Serial.begin(9600);
}// End of setup( )

void loop(){
        // read the analog in value:
        sensorValue = analogRead(analogInPin);

        // Resets the motor to off and makes sure the motor
        // continues to stay off
        digitalWrite(motorPin, LOW);

        // Use Serial.println to determine optimal detectionValue
        Serial.println(sensorValue);

        // This loop is to determine whether a person is actually
        // in front of the chair, or whether the IR sensor is
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```
        // just producing noise
        if(sensorValue > detectionValue)
                count=count+1;
        else
                count=0;

        // If the IR sensor consistantly sees above the detectionValue
        // (sees the value ten times in a row), then turn on the relay
        // which switches the motor on
         if(count==10){
                // Turn the motor on for .75 seconds
                digitalWrite(motorPin, HIGH);
                delay(750);
                digitalWrite(motorPin, LOW);

                // Reset the noise mitigating count to zero
                count=0;
        }// End of if
}// End of loop( )
```

Technical Obstacles

One of the major obstacles to overcome was finding a strong enough motor to drive the heavy chair. Shopping for an appropriate motor online proved more difficult than expected: either the motors where too expensive and overqualified for the job, or they were small electric hobby motors. After an inconclusive online search, I realized that I could slightly modify an electric drill to fit my desired specifications.

Playing around with a drill from my house was enough to convince me that it was capable of doing the job. However, my next major concern was how exactly to attach the drill to the chair and have it turn the wheels. Initially I was toying with the idea of directly mounting a wheel to the drill's chuck; the drill would be attached to the base of the chair's supporting leg. Two concerns immediately came to mind: with this set up, the load (the person sitting on the chair) would be directly applied perpendicular to the drill's axle. I was unsure if the drill's bearing could handle the immense weight of a human. Secondly, the drill being mounted to the base of the chair would be very obvious. It would be hard for the victim to miss the drill's large profile.

The second conceptual design was to mount the motor to the bottom of the seat and have a driving mechanism of some sort to transfer rotation to the wheels. This was deemed the better model being that it mitigated the problems previously mentioned with the first design. The ideal method to transfer power would be to use a chain and sprocket (since it won't slip and allows some slack within the chain). Ultimately I settled to use belts and pulleys because I could not find an appropriate chain and sprocket package.

The belt eventually proved to be a successful design; however it put up a good fight before working properly. The difficulty with belts is that they need to be tight to cause enough

friction needed to spin the wheels. When the belt is too loose, it will slip right past the pulley. Originally the belt wasn't tight, and the drill was unable to drive the chair. Since all of the chair's components had already been built, I did not want to remake some of the structural elements. Eventually I solved the problem by adding an extra aluminum bar to the wheel supports. The bar was placed in such a fashion as to stretch the belt tighter and cut the slack. This proved enough to solve the problem!

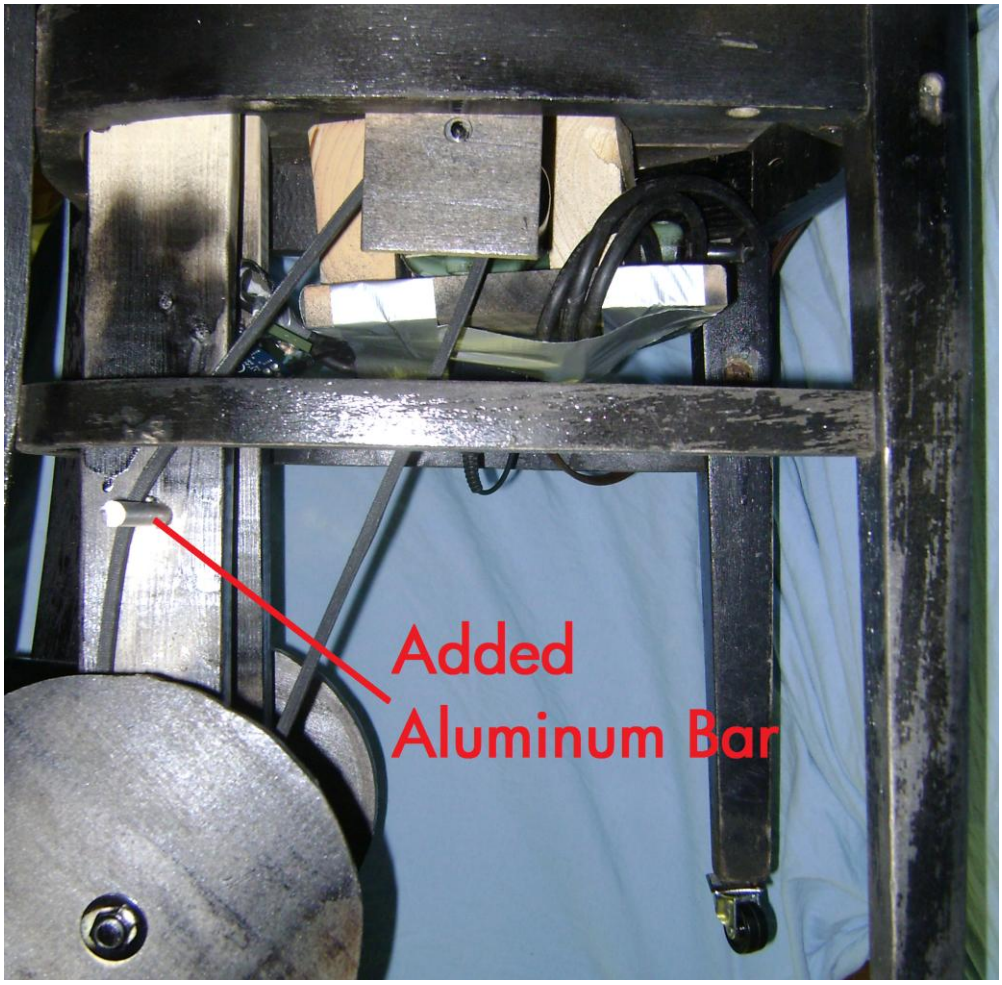

Figure 6: Belt Tightening Solution

The last major technical difficulty was from the electronic noise which the IR sensor produced. The drill's relay is tripped when the sensor reads above a value of 100. However, the sensor would randomly spike above 100 about once every second, causing the chair to move when no one was present. The solution to negate these false-positives is to add a counter to the main sketch loop. When the IR sensor sees above 100, instead of immediately turning on the relay, it adds '1' to the counter. After ten loops of seeing about 100, then we can be confident that it is not noise, but actually a person about to sit down.

Future Endeavors

In the future, I hope to make the chair appear to be more lifelike. Instead of just being a prankster's chair, I want to give my creation personality. If you approach the chair too quickly, it will be 'scared' away and scoot backwards; if you approach the chair slowly, it will 'warm' up to you and cautiously move toward you. To accomplish this goal, the current set-up would need to be modified in order to allow for the drill to spin both directions. At present, the drill can only spin backwards.

Additionally, I would like to add extra IR sensors to the sides of the chair. This way, users cannot sneak around the chair's main front IR sensor. To top off the project, I want to place an on/ off switch on the chair in case someone actually wants to just sit down.