Self-Cleaning Table

ECE 445 Design Document

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2/27/20

1 Introduction

1.1 Objective

When people go out to eat at a restaurant, there are high expectations for the safety of the preparation of their food. In the US, we have the FDA to set and enforce standards related to food preparation. However, the FDA does not currently have any standards regarding the hygiene of dining areas, as can be seen from reading through the 2017 FDA Food Code [1]. States can add additional rules to this, but many states, including Illinois, also fall short in this regard [2]. In such a wealthy and developed society, nobody should be negatively affected by a person who used the same table before them.

Our goal is to design a device which will automatically clean a table between uses. We will mount a moving arm to the table, which contains all of our cleaning utensils. In order to ensure that the cleaning process occurs after every use, we will have a method for reliably detecting when patrons are present. We will also include extra safeguards which prevent cleaning at the wrong times, such as when a patron goes to the bathroom and leaves their food on the table.

1.2 Background

While most or all restaurants are willing to clear tables, many fast-food establishments rely on their customers to clean up after themselves. By providing a tray with every order of food, restaurants help avoid direct contact between food and the table. This helps to contain messes and germs, but it does not fully protect the table. If a customer makes a mess and simply chooses to not clean up after themself, then the cleanliness of the restaurant suffers. Studies show that restaurant cleanliness is among the most important factors for repeat patronage [3], as well as for restaurant quality evaluations [4]. Thus, it should always be in a restaurant's best interest to keep their dining areas as visually clean as possible. If no employee comes around to disinfect the table between uses, which is very likely during peak hours, then this also leaves potential for the spread of disease between patrons. In a study of tabletop objects in bar and grill restaurants, E. Coli was found on the surface of 4% of ketchup bottles and 8% of menus[5]. Sick customers are not going to be returning customers, so it is in everybody's best interest for tables to be disinfected between uses.

Our device will be able to clean up any reasonably sized spills and messes. If piles of garbage or large ketchup spills are detected, then our system will indicate visually and audibly that it requires an employee to help clean up. Otherwise, the regular cleaning cycle will be able to wipe down the table, leaving it both visually clean and disinfected.

1.3 High-Level Requirements

- The microcontroller must be able to use the sensors to reliably determine when people use and then leave the table.
- All components must have little or no impediment to customer use of the table, relative to the usable surface of the table and the available legroom.
- After cleaning, the surface of the table should be clear of all crumbs and small spills.

2 Design

The main device will be a moving arm which spans the shorter width of the table. The arm will move across the length of the table via a pair of guide rails and a screw drive on the underside of the table. When not in use, the arm will retract into a housing unit on the end of the table, such that it does not impede the patrons' dining space. We will know when to begin cleaning by using a motion sensor on the underside of the table to detect patrons, as well as a sensor on the arm to detect items left on the table. If no people or items are present, then the arm will spray the table with a disinfectant solution, and then squeegee the table, and then dry the table. All of these cleaning utensils are mounted to the moving arm, so the entire process requires only one pass.

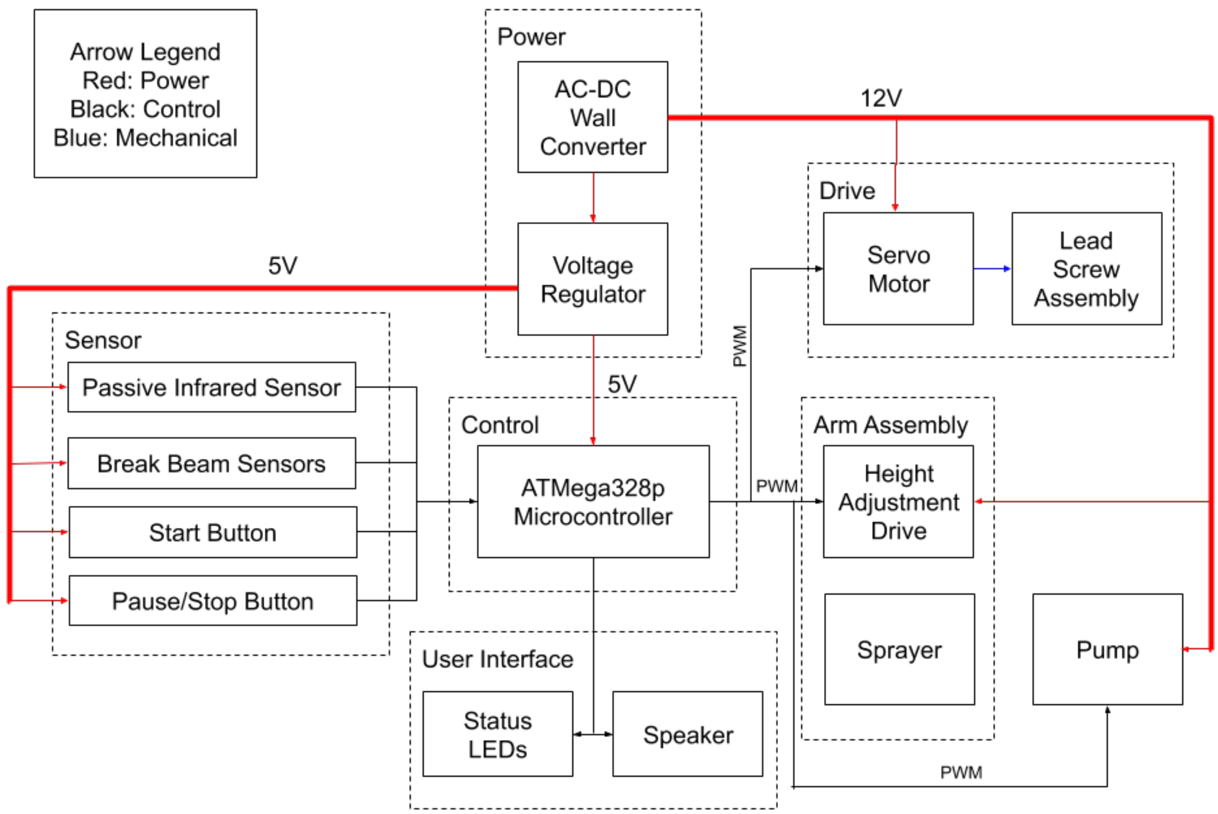

Fig 1. Block Diagram

All control signals in Fig 1 are digital signals. PWM signals are indicated where needed.

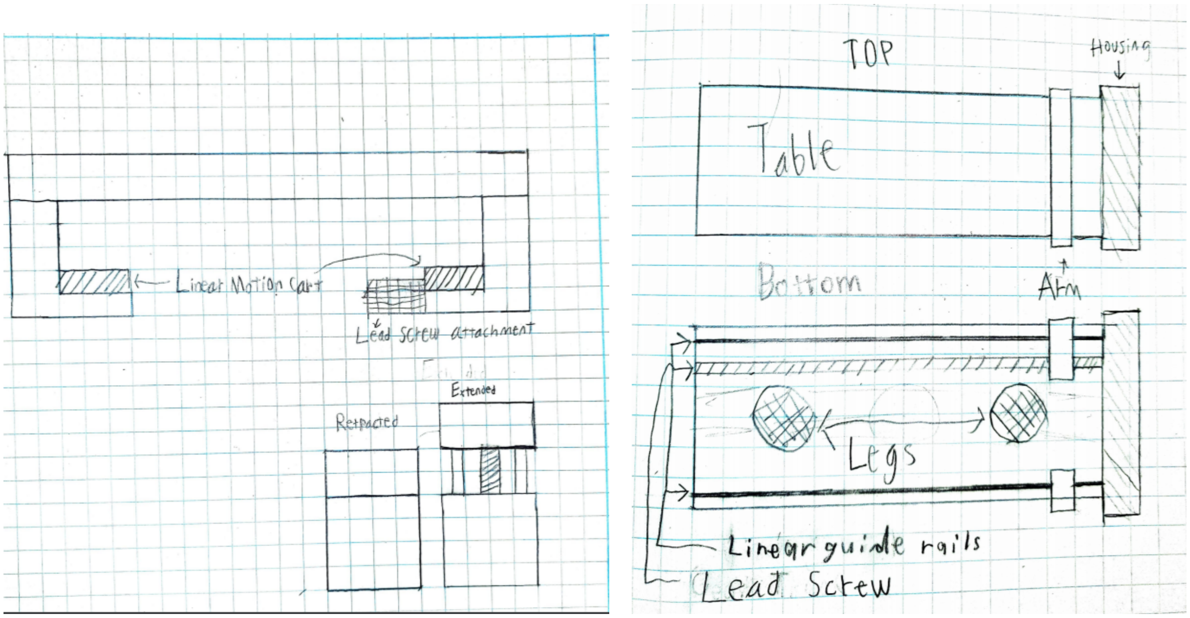

Fig. 2. Physical design sketches; Arm Assembly (left) and Arm Mounted to Table (right)

2.1 Power Supply

A Power supply is necessary to operate all subsystems. The motors, sensors and microcontrollers all need power. Power will come from a wall connection and will be regulated to power that each subsystem can use.

2.1.1 AC/DC wall converter

Will take in wall power and convert the AC signal to a usable DC voltage which will be further converted to usable voltages by the other power components. We need to step down the voltage to a reasonable level for our linear voltage regulator, but also provide enough current for powering our motor.

Requirement	Verification
1. Provides rated voltage to motor driver within the tolerances required by the motor 2. Provides enough power for voltage regulator and motors.	1, 2. a. Connect to power supply set to 12v to input b. Connect to wall outlet c. Connect electronic load to output d. Connect oscilloscope to output pin e. Monitor voltage across a range of currents up to 4A current draw to ensure voltage stabilities

2.1.2 Voltage Regulator

A 5v linear voltage regulator which will provide power to the microcontroller and sensors. We will be buying the regulator, and connecting it as shown in Fig. 4.

Requirement	Verification
1. Provides 5v +/- 5% to all low voltage* components. 2. Can provide rated power to each low voltage* component while all components are operating **low voltage = less than 5V*	1,2. a. Connect to power supply set to 12v to input b. Connect electronic load to output c. Connect oscilloscope to output pin d. Monitor voltage across a range of currents up to maximum current draw to ensure criteria are met. e. Will also need to be tested while connected to AC/DC converter to ensure the entire power system is accurate. f. The same procedure will occur

2.2 Control Unit

The control unit will take in sensor data and determine whether cleaning of the table can occur. This is also in charge of controlling the motion of the arms and cleaning operators, as well as providing status information for the user.

2.2.1 ATMega328p microcontroller

This controller takes in input from each sensor and determines if cleaning is safe to perform. This controller was chosen because it is one of the most popular microcontrollers for projects like this, and it is the same microcontroller as in the Arduino Uno. Because we plan to connect and monitor several devices at the same time, this seems like a great option for us.

Requirement	Verification
1. Must be able to power each LED with 10mA. 2. Must be able to provide adequate PWM to safely control the motor. 3. Must be able to power and communicate with all devices concurrently.	1. a. Wire the microcontroller on a breadboard in the same way as this tutorial: https://www.arduino.cc/en/Main/Standalone b. Flash the 'Blink LED' example onto the microcontroller, verify that the LED flashes. 2. a. Connect the drive pins of the motor to PWM pins on the

	Arduino b. Flash a basic PWM example onto the microcontroller, verify that motor turns in both directions. 3. a. Connect the PIR sensor, break beam sensor, speaker, LED's, and motor. b. Flash a program which activates all devices at the same time. c. Verify that all LED's light up, the motor spins, the speaker sounds, and the sensors are triggered correctly.

2.2.2 Status LEDs

LEDs that display the status of the table between: ready for use, waiting for clearing, and currently cleaning. We will use a green light to indicate that the cleaning operation is currently running, a yellow LED to indicate that the system has been paused, and we will blink the yellow LED if a problem has occured.

Requirement	Verification
Must be clearly visible from at least 3 meters away with drive current of 10mA.	A. Set the power supply to output 10 mA B. Connect the LED to the power supply C. Measure 3 meters distance from LED circuit D. Ensure that LED is clearly visible when pointed in the viewer's direction

2.2.3 Speaker

Will provide an audio response to items being on the table while attempting to clean in order to notify staff to bus the table. This is only a secondary method of alerting the users, so we are choosing to use a speaker that we already owned.

Requirement	Verification
1. Must be able to be loud enough to hear from 3 meters away for notification	1, 2. A. Connect the speaker to the ATMega328, with a simple speaker program flashed to the microcontroller. B. Measure 3 meters distance from speaker circuit C. Ensure that speaker is clearly audible

	when pointed in the observer's direction

2.3 Sensors Unit

2.3.1 Passive Infrared Sensor

PIR sensors are effective motion sensors. This sensor will be placed on the bottom of the table and determine whether or not people are sitting at the table by detecting movement of their legs and feet.

Requirement	Verification
Must be able to reliably tell when people are seated at the table.	A. Connect the sensor to an Arduino B. Mount the PIR sensor, aimed towards the floor C. Load the Arduino with a program that blinks an LED when the sensor is triggered. D. Verify that the LED blinks when a person sits next to the sensor. E. Verify that the LED is off when nothing

2.3.2 Break-Beam Sensor

This sensor will be attached to the cleaning arm in order to determine if cutlery, plates, or large messes are on the table that would obstruct the cleaning process.

Requirement	Verification
Must be able to detect objects protruding from the surface of a table, with a beam gap of 9.5"	A. Connect the sensor to an Arduino B. Mount the transmitter and receiver 9.5" apart. C. Load the Arduino with a program that blinks an LED when the sensor is triggered. D. Verify that the LED blinks when a hand is placed between the transmitter and receiver. E. Verify that the LED is off when nothing is between the transmitter and receiver.

2.4 Drive Unit

The drive unit is the module responsible for movement of the cleaning arm along the table, it must be able to support the weight of the arm, and provide sufficient torque to move the arm back and forth.

2.4.1 Servo Motor

Servo motors are high precision motors, suited for precise amounts of rotation. This will drive the lead screw, generating all linear motion of the arm. If necessary, we will build in a control system for the motor to keep it accurate enough for our needs. However, our speeds are low enough that we don't necessarily believe this is needed.

Requirement	Verification
Must be able to move the arm to within 1 inch of the desired position.	A. Load an Arduino with a PWM controller test program. B. Connect the motor Hall effect sensor pins to the arduino, and connect PWM pins to the motor inputs via power transistor C. Provide the arduino program with a given number of turns, and use the hall effect sensors to count the number of turns that actually happen. D. Verify that the number of turns is within 1 / (threads per inch of screw drive) full rotations of the motor.

2.4.2 Lead Screw Assembly

Has a lead screw shaft that drives the cleaning arm up and down the table. Consists of one lead screw and two linear guide rails that the arm is attached to. The linear guide rails with attached carts will guide the arm. The linear guides will be plastic sleeve bearing guides in order to limit cost and provide movement even in potentially dirt filled environments.

Requirement	Verification
1. Must be able to move the arm to within an inch of the desired position. 2. Must be able to move the arm all the way to the end of the table.	1. A. After attaching an arm we will run the arm control circuitry and measure with a ruler the distance the arm travels. B. Different lengths will be tested that will represent scale models of common table lengths

2.5 Arm Assembly

2.5.1 Height adjustment arm

Two pneumatic actuators will raise and lower the arm, in order to get the cleaning utensils off of the table surface. If we did not do this, then we would end up pushing everything onto the floor, instead of into our housing.

Requirement	Verification
Lift arm 1” to get the cleaning utensils off of the table surface.	A. Firmly mount the arm assembly, with all attachments, vertically. B. Measure the initial height of the arm. C. Actuate both pneumatics at the same time. D. Measure the new height of the arm. E. Verify that the difference in heights is at least 1 inch.

2.6 Water System

The lab is not designed to work with both water and electricity, so we will be foregoing this component for this project, unless time allows and we find a safe environment to work. We have filled out R&V specifications for these components and included them in the cost analysis, but it seems too hazardous for us to complete given the circumstances.

2.6.2 Water pump

The water pump will take the water and cleaning product solution and pump it up to the sprayer apparatus.

Requirement	Verification
Pumps liquids hard enough to push through 0.5 meters of tubing	A. Connect the output of the pump to 0.5 meters of tubing. B. Provide liquid to the intake of the pump. C. Connect the pump to power. D. Verify that the test liquid was pushed through to the output.

2.6.2 Sprayer

The sprayer will administer the cleaning solution from the cleaning arm onto the table. We are planning to use flat jet nozzles, in order to administer a small amount of liquid to cover a large area with a decent amount of pressure.

Requirement	Verification
1. Full coverage of table with liquid. 2. No spraying off the sides of the table.	1, 2. A. Mount the tubing and nozzles to the arm assembly. B. Connect the pump and test liquid to the sprayer assembly.

	C. Activate the pump for 1 second without moving the arm assembly. D. Verify that the cleaning liquid was dispersed from end-to-end of the table, along the arm. E. Verify that the liquid did not spill over the end of the table.

2.7 Schematics

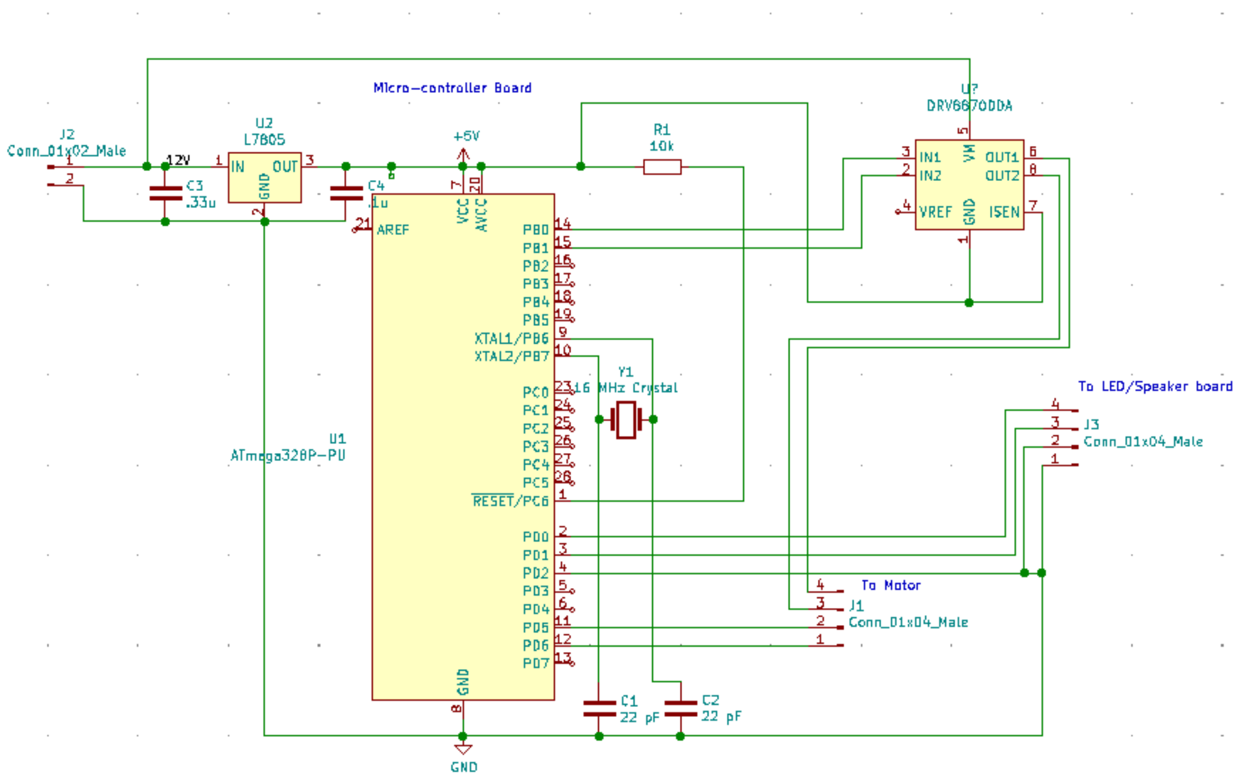

Fig. 3. ATMega328 Schematic

2.9 Software

The software written for the system will all need to run on the ATMega 328p microcontroller specified above. There are a few distinct and fairly simple submodules that the microcontroller will need to manage. We will use an Arduino Uno or equivalent to help debug the software and test out components, before we actually move to using the ATMega 328p.

2.9.1 State Diagram

The most fundamental thing that the software must do is keep track of the current state of our system. The expected control flow is shown in fig. 5 below, with a sub-control flow shown in fig. 6 for the cleaning cycle. A brief description of each control listed below, along with any corresponding status LED's.

Idle: Nobody has approached the table.

Waiting: People are present at the table. Waiting for them to leave.

Cleaning: All people have left the table. The arm moves and cleans the table. Green LED on.

Pause: Pause state is for customers who are leaving the table but do not want the arm to trigger. Yellow LED on.

Error: If the cleaning cycle is interrupted (break beam sensor triggered, the motor stalls, etc.). Yellow LED blinking and speaker chirping. Waiting for reset signal. When the reset is received, the arm will be raised and then moved back into the housing, before returning to the idle state.

Move Arm: Activate the drive motor to turn the screw drive. This movement could either be outward (away from the housing) or inward (toward the housing). When moving the arm back towards the housing during the regular cleaning cycle, we also want to activate the sprayers.

Raise/Lower Arm: The arm is equipped with two pneumatic actuators. We will initially move the arm with the actuators extended, in order to avoid pushing the mess onto the ground. We will lower the arm back onto the table before we move back towards the housing.

2.9.2 Motor Controller

The motor provides position data using built in Hall Effect sensors, which connect to the microcontroller through a pair of digital input pins. This section of code will be responsible for decoding the position data, and then keeping track of the total number of rotations that the motor has turned. It will be important to be able to differentiate between clockwise and counterclockwise motion, so that we can be careful to turn the motor only as far as necessary, and can correct for any extra turns of the motor. This code will also be responsible for controlling the speed and direction of the motor. We will control the motor using one of the PWM pins on the microcontroller, through a power transistor.

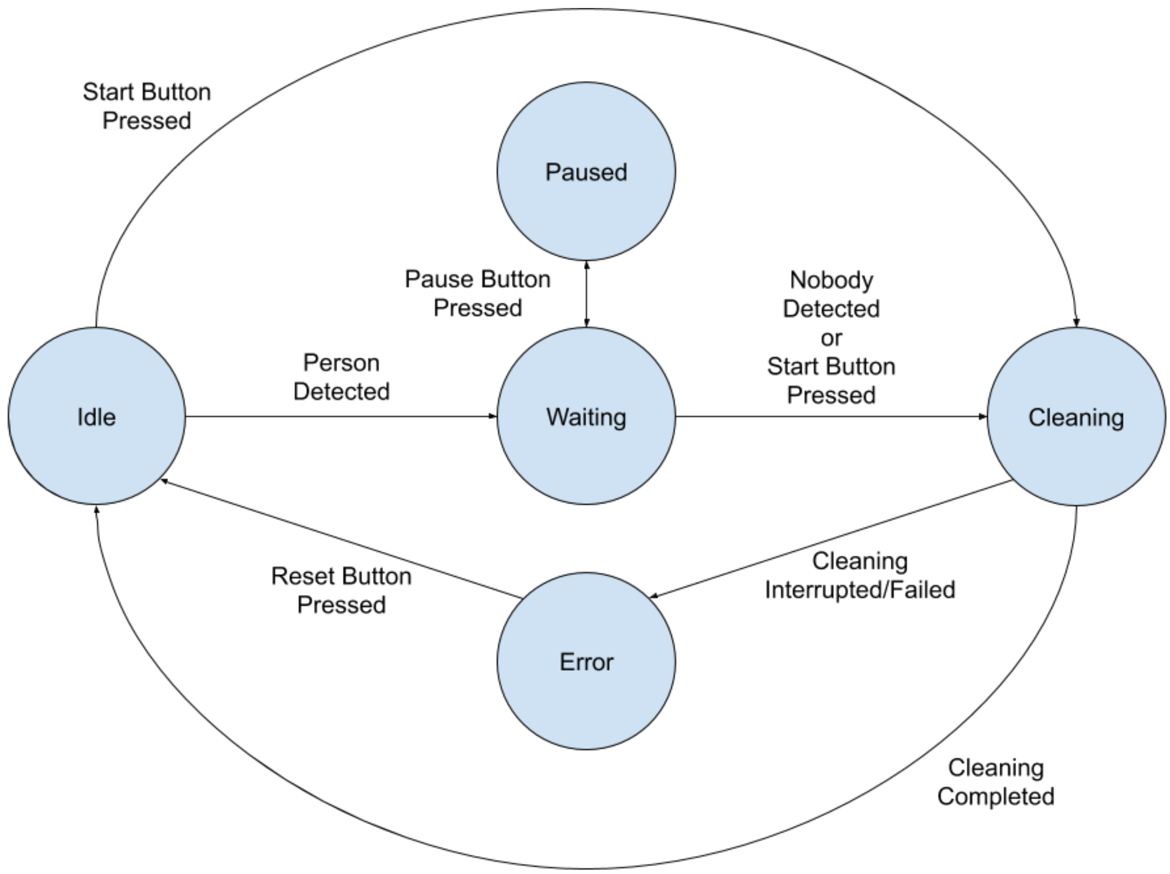

Fig. 5. Control Flow Diagram

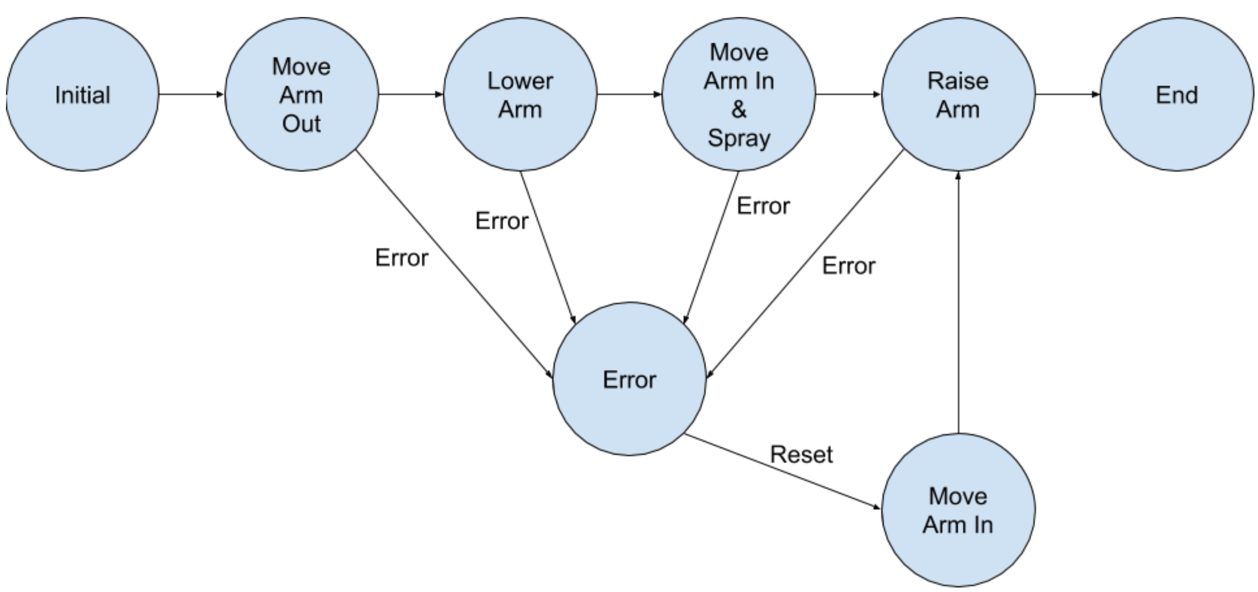

Fig. 6. Cleaning Stage Sub-Control Flow

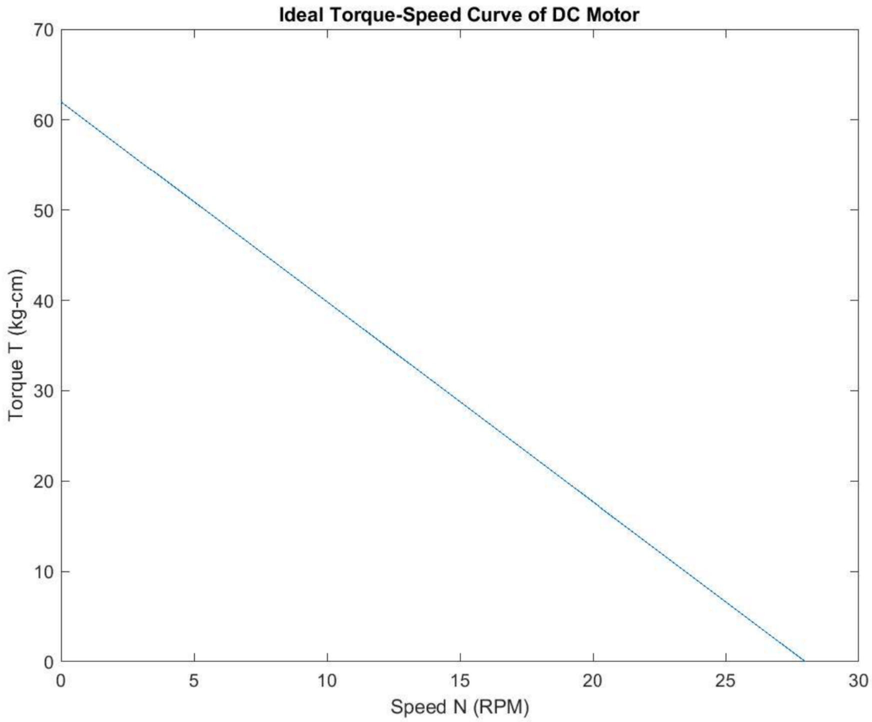

Fig. 6. Ideal Torque-Speed Curve Of Our DC Motor

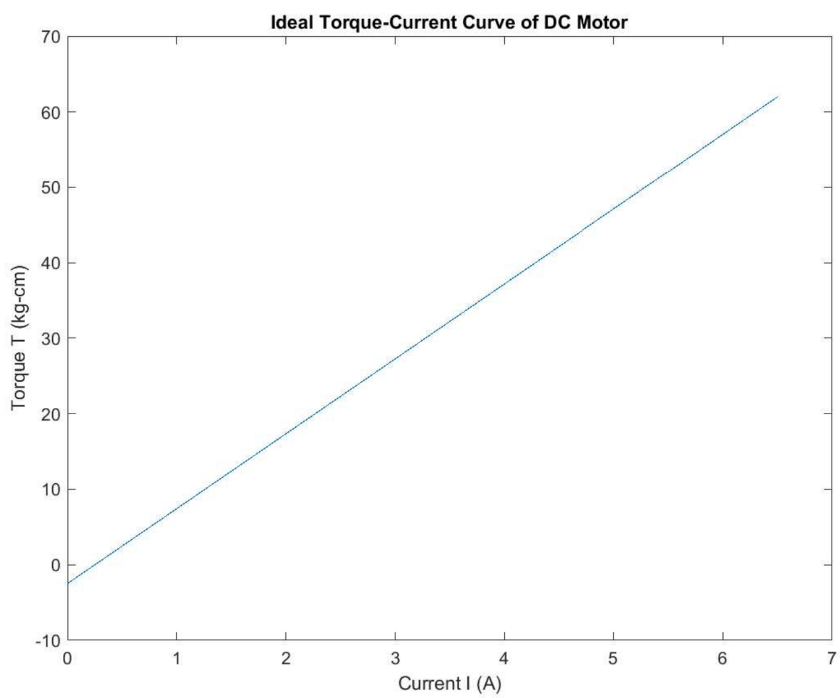

Fig. 7. Ideal Torque-Current Curve Of Our DC Motor

2.10 Tolerance Analysis

The lead screw drive is the most critical system in our project. Being able to safely and consistently drive the arm across the table is essential to the entire project's operation. Faulty operation of this system can damage the project and cause safety hazards.

Of this system, the part of greatest risk and impact on proper operation is the DC Servomotor. It has many tolerances to maintain to ensure any sort of proper operation. This motor must drive the load attached to the lead screw at a speed that isn't too fast, but can complete a full cycle within 1 minute. This means the linear velocity, v, must remain between 1 and 4 in/s. Our ideal range velocities are between 2 and 4 in/s. To see if our chosen motor can produce these results, we started by finding the required torque to move the predicted load, the arm assembly, at speeds within our ideal velocity range.

Calculating the torque requires a series of operating parameters from various parts of the system, listed in Table 1 below.

Table 1. Input Parameters to Torque Estimation

Input Variable	Value
v Linear Velocity of Load	$4\ \frac{in}{s} \geq v \geq 2\ \frac{in}{s}$
p Pitch of Lead Screw	$0.125\ \frac{in}{rev}$ [9]
ρ Density of Carbon Steel	$0.284\ \frac{lb}{in^3}$
R Radius of Lead Screw	$\frac{3}{8}\ in$ [9]
g Coefficient of Gravity	$386\ \frac{in}{s^2}$
μ Coefficient of Static Friction for Steel on Steel Without Lubrication	0.58
L Length of Lead Screw	$23.5\ in$
W Weight of Load	$3.5\ lb, 4\ lb, 4.5\ lb$
η Efficiency of Lead Screw	45% [8]
t Acceleration Time	$0.25\ s$
J_{Motor} Moment of Inertia of Motor	$126.567\ (lb)(ft)(s)$

We predicted that the weight of our load would be between 3.5 and 4.5 lb, so we ran simulations over multiple weights within that range. Since motor Torque and Speed can be approximated linearly, the motor will satisfy the entire range if it can satisfy the ends of the range. The rest of the parameters are by design, from the datasheet of our desired lead screw [9], or they are generally accepted values. We next calculate the required torque using the method found in a Parker Hannifin Reference Manual [8].

We start by finding the angular velocity is

$$\omega = 2\pi p v \qquad (1)$$

The Shaft speed is thus

$$N = \frac{\omega(60)}{2\pi} \qquad (2)$$

From this shaft speed, we can get an easier to use parameter in place of the linear velocity: the range of acceptable shaft speeds shown in Table 2.

Table 2. Shaft Speed Range

N Shaft Speed	$30\ RPM \geq N \geq 15\ RPM$

Continuing with our calculation, the force of friction for the load on the lead screw is

$$F_f = \mu_s W \qquad (3)$$

The required torque to overcome friction is

$$T_f = \frac{F_f}{2\pi p \eta} \qquad (4)$$

The Moment of inertia for the Load is

$$J_{load} = \frac{W}{(2\pi p)^2} \qquad (5)$$

The Moment of inertia for the Lead Screw is

$$J_{lead} = \pi L \rho R^4(.5) \qquad \textbf{(6)}$$

Combining previous equations, the torque required to accelerate the load to the desired linear velocity is

$$T_{Accel} = \frac{1}{gt}(J_{load} + J_{lead} + J_{motor})\omega \qquad \textbf{(7)}$$

The total required torque is

$$T = T_{Accel} + T_f \qquad \textbf{(8)}$$

We now have the required torque the motor must provide to drive our load at the desired velocity. We now must see if our motor can provide that torque while maintaining a speed within the desired range. This requires that we find the operating point of the DC motor at each predicted load. We do this by plotting the Torque-Speed curve of the motor with the load lines of our required torque, shown in Fig. 7 in kg-cm. You can see the operating points where the load line crosses the Motor curve. These points all fall within the acceptable range of shaft speed. These points can be provided safely by the motor since they are far away from the stall speed and are close to the No-Load speed of 28 RPM, shown in Fig. 8.

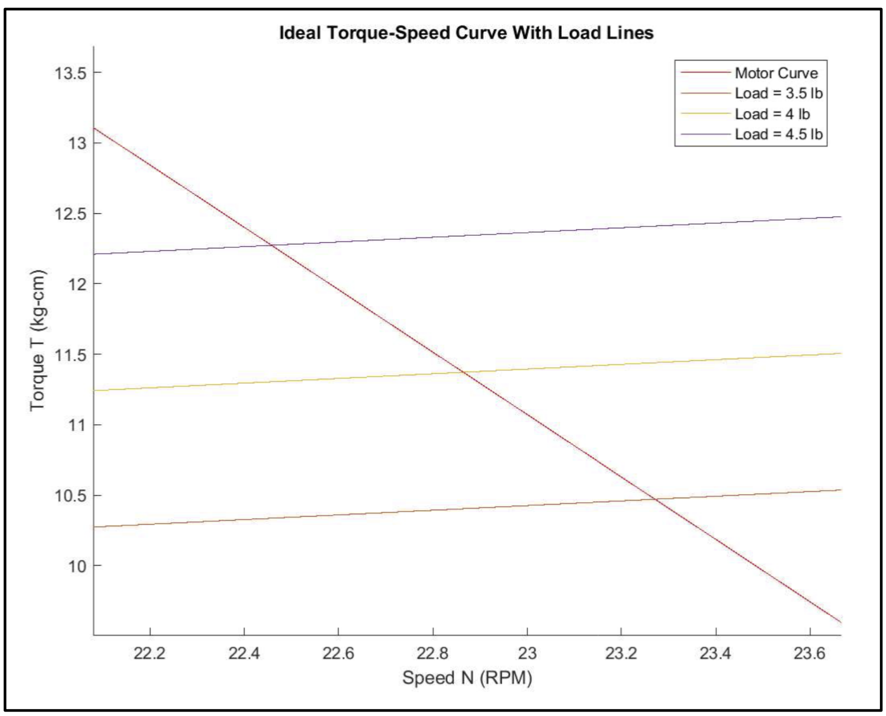

Fig. 7. Ideal Torque-Speed Curve With Load Lines Close-Up

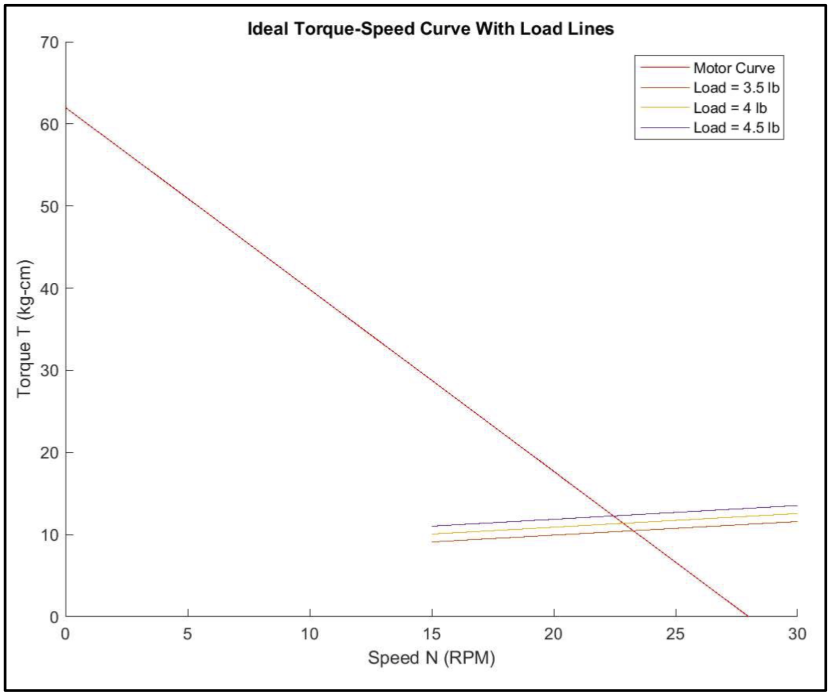

Fig. 8. Ideal Torque-Speed Curve With Load Lines

Now that we have the torque calculations, we can examine the tolerance of our system to variance in the motor parameters of Stall Torque and No-Load Speed. Variance of these parameters dramatically alter the operation of the motor, and vary the operating points of our system. Our system will only allow Torque-Speed characteristics that cross all three Load lines on the graph to ensure we can handle a range of weights. As you can see plotted in Fig. 9, we have a tolerance of +25%/-32% for the shaft speed, and a tolerance of +20%/-11% for the torque. This large tolerance can be attributed to the size of motor that we bought and its low No-Load speed and high torque. This means it can run at our range of speeds, while still providing a wide range of torque.

Table 3. Tolerance Ranges

$N_{No-Load}$ No-Load Shaft Speed	$35.2\ RPM \geq N_{No-Load} \geq 19\ RPM$ $+25.71\%/-32.14\%$
T_{Stall} Motor Stall Torque	$75\ kg.cm \geq T_{Stall} \geq 55\ kg.cm$ $+20.97\%/-11.29\%$

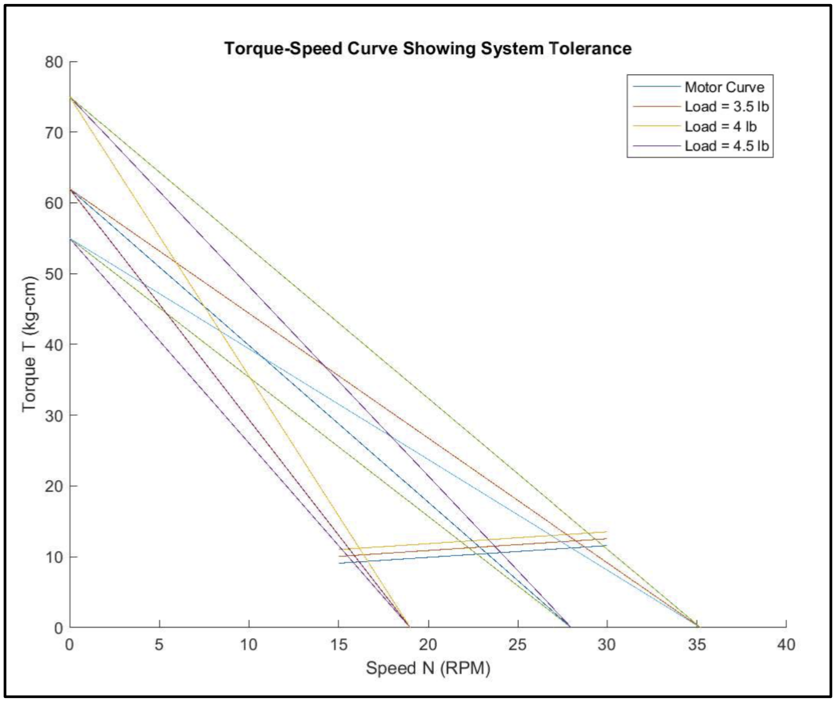

Fig. 9. Ideal Torque-Speed Curve With Lines Showing Tolerance

3 Costs

Our fixed development costs are estimated to be $40/hour, 10 hours/week for 3 people. We consider approximately 70% of our final design this semester (16 weeks), neglecting the water pump:

$$3 \cdot \frac{\$40}{hour} \cdot \frac{10\ hours}{week} \cdot \frac{16\ weeks}{0.7} \cdot 2.5 = \$68{,}571.43 \tag{8}$$

Part	Cost (prototype)	Cost (bulk)
Lead Screw	$16.58	$16.58
Fastening	$1.85	$1.85
Elbow brackets	$15.24	$15.24
Coupling	$11.93	$11.93
Sleeve bearing	$19.66	$19.66

Framing- T slot aluminum	$11.77	$11.77
AC/DC converter	$14.00	$12.40
PIR Sensor (Digikey; IRA-S410ST01)	$3.50	$1.50
Through-Beam Sensor (Adafruit; IR Break Beam Sensor - 3mm LEDs)	$1.95	$1.56
Microcontroller (Digikey; ATMega 328P-PU)	$2.08	$1.73
Assorted resistors, capacitors, ICs, crystals, sockets (Digikey;est.)	$10.00	$0.40
Water Pump (Adafruit; Peristaltic Liquid Pump with Silicone Tubing - 12V DC Power)	$24.95	$19.96
Motor (Amazon; CQRobot Metal DC Geared Motor w/Encoder)	$31.87	$31.87
2x Pneumatics (Amazon; Parker .75RSR01.0 Stainless Steel Air Cylinder)	$52.74	$52.74
Total	$218.12	$198.99

The estimated cost of our prototype is $218.12, so the estimated development cost is $68,789. If we were to produce a large number of such devices, the bulk pricing options we could find would bring this down to $198.99 per unit. Many of the hardware components did not offer bulk pricing options, so we believe that this cost could be brought down significantly lower.

4 Schedule

Week	Anders	Armando	Kevin
2/24/20	Research and pick out linear motion parts	Research and pick out motor and pneumatics	Research and pick out sensors and microcontrollers
3/2/20	First draft of PCB design	Talk to professors/TAs about water in labs	Begin collecting code for testing components
3/9/20	First draft of arm assembly	Investigate arm housing options	Write code for control flow
3/16/20	Assemble basic small-scale table for prototype	Assemble first prototype of housing	Write code for cleaning subsystem control flow
3/23/20	Verification of power system	Verification of motors	Verification of sensors and control systems
3/30/20	Verification of screw drive	Verification of pneumatics	Write code for motor control
4/6/20	Second draft of PCB design	Verification of all power systems	Full system test on breadboard
4/13/20	Verification of all mechanical systems	Second draft of arm assembly	Verification of all electrical systems
4/20/20	Assemble prototype on PCB	Verification of arm assembly	Begin collating data for Final Report
4/27/20	Verification that high level requirements were all met	Generate plots for final report and presentation	Ensure that verification for all components was completed
5/4/20	Prepare final presentation	Prepare final presentation	Prepare final presentation

5 Ethics and Safety

5.1 Safety

Our project has multiple potential safety hazards. This project is only a prototype of a product that would be used in Food service establishments and would operate near the general public. We will only address safety hazards having to do with the prototype, although more would be present in the actual product.

This product would be in close contact with water during cleaning and the general use of the table. This can lead to short circuits and electrical fires if water leaks onto electrical connections. The lab we would be working in is an electrical lab where water is not permitted. We will thus not use water to test any part of our equipment when in the lab since we are only proving a concept with our prototype. We will only construct the hose assembly and set up a control scheme. If we end up ahead of schedule and want to begin testing with water, we will consult the TA’s and lab safety coordinator before proceeding. We will waterproof connections as we build and test with adequate circuit protections when water testing.

This project uses a connection to a wall outlet for power. This brings up multiple hazards that are made more serious by the possible power from a wall connection. We can have potential shock hazards from a variety of sources including accidental shorts to the housing of our project and accidental human contact with live electrical equipment. We will avoid this by following the safety recommendations listed in the electrical safety portion of the University of Illinois Division of Research Safety[6]. We will ensure that all exposed metal parts are properly grounded to the ground pin on our outlet connection. We will also ensure that we are always wearing non-conductive, long sleeve clothing to reduce accidental human contact with electrical components. The main safeguard we will have is a shutoff button near the machine in case of an emergency.

As a project with spinning drives and moving parts, there are several mechanical hazards to consider. People near the operating project could get hair or loose clothing caught in the spinning drives or moving rails of the machine. We will ensure that we are 1 foot away from the device when testing moving parts. We will also avoid loose clothing and jewelry. The shutoff button also helps with this issue as well. We are also designing the project to move at slow speed and sense if anything is in the way of a moving part. A final safeguard is wearing safety glasses when testing the actual machine.

5.2 Ethics

This project also has ethical considerations. It is heavily mechanical, and requires a broad scope of electrical engineering knowledge. This can lead to violations of 2 different IEEE codes of ethics, #6: “to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;” [7], and #7: “to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;” [7]. To address #6, we will first review the relevant course material in power, control systems, circuits, and other fields of study in order to ensure the highest technical competence. We will also consult the machine shop to assist us with the manufacturing of components. Finally, we have a diverse group that has expertise in various areas, making us qualified to undertake this task. To address #7, we will seek guidance from the TA's and other course staff on mechanical issues, and accept any criticism to improve on our project.

As a machine built for automating a job done by humans, this may displace certain employees who currently work as table bussers in the restaurant industry. This displacement may cause issues between labor unions and employers, as well as eliminate jobs for the public. This may violate #2 of the IEEE code of ethics: "to avoid real or perceived conflicts of interest whenever possible" [7]. Although our device automates a job, it doesn't fully eliminate the need for bussers. This job takes little time to perform, and cannot automate the clearing of dining ware and trash. We also see that our project is suited for fast food restaurants and establishments where there aren't dedicated bussers. These facts lead to a low amount of overall job displacement. Some small displacement is inevitable, but we feel overall cleanliness and public health are of higher priority.

References

[1] *Food Code, 2017 Recommendations of the United States Public Health Service Food and Drug Administration*, 9th ed. College Park, MD: National Technical Publication Service, 2017.

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