Dawg Feeder

MECH 307: Mechatronics and Measurement Systems

Department of Mechanical Engineering, Colorado State University

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Lab Section L01, Mondays 4:00-6:50 pm

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Design Summary

The Dawg Feeder was designed to be a pet feeder that operates automatically or with a user-controlled remote. The Dawg Feeder had the sole intention of beating the animal feeders on the market through the integration of a system that can differentiate manual and automatic control and function reliably using cheap, "out of the kit" components.

The Dawg Feeder had working components for each of the six required categories. The listed components have a number corresponding to the labeled picture in *Figure 1*. The output display was represented by an LCD (3) and a LED light strip (11). The audio output used was a buzzer (13). The manual user input was from a remote connected to the IR-Sensor (2). The automatic sensor was the photoresistor (9). There were multiple actuators, mechanisms, and hardware: the water pumps (6), servo motors (5), 5-gallon buckets (1), and base. The logic, processing, and control were from the Arduino Mega (12).

All of the components listed above worked together to dispense food and water for pets. The design is intended for dogs, specifically large dogs. The IR remote is used to control the food dispensing and water dispensing and toggle from manual mode into automatic mode. The buzzer, LCD, and LEDs had different functions depending on the variety of functions. If the remote were to stop working, there is an emergency stop button that cuts power to the water pumps. In automatic mode, the photoresistor senses a light turning on and automatically dispenses food.

System Details

The Dawg Feeder was centered around a base, shown in *Figure 2*, made from plywood. Plywood was the choice material because of how inexpensive and easy to work with it was. There was a raised surface where the electronics were stored (2) *Figure 2*, and the supports were hollow to promote cable management (4) *Figure 2*. The base supported two five-gallon buckets (1) *Figure 2*. One of them was for the water, and the other was for the food. Five-gallon buckets were used because of their strength and volume. The goal of this product was to give dog owners a break when it comes to feeding their pets. The five-gallon buckets were adequate for the large amounts of kibble and water a large dog would eat.

The Arduino Mega (1) *Figure 5* is pictured in the center of the breadboards. Powered by a 9V battery, as the group's main and only board used, it is the heart of the system. The Arduino Mega was originally selected because of the number of pins. Two Arduino Unos could have been used but it was decided that using one Arduino would be far more simple than trying to use two.

Two five-volt pumps moved the water from the bucket to the water bowl, as shown in *Figure 3*. The pumps chosen were fully submersible and attached to the bucket's bottom with waterproof caulk. The pump output was two plastic lines that ran through a bracket to help "aim" the flow (2 & 3) *Figure 3*. The two proximal breadboards (2) *Figure 5* and (3) *Figure 5* were solely used to provide power to the pumps through the use of a flyback diode (4) *Figure 5* and npn transistor (5) *Figure 5* for each. Each of these boards has an external power supply (6) *Figure 5*, supplying separate power and current to the pumps through the use of two additional 9V batteries. This could not be done off of the Arduino Mega because of the magnitude of current the pumps draw when they are active. The pumps only required the soldering of a power and ground wire each, and these wires can be seen flowing up through the baseboard to the left.

The food was moved from the bucket to the bowl by two servos, (1) *Figure 4*, attached to a trap door, (3) *Figure 4*, and a ramp, (2) *Figure 4*, that guided the food. The servos used were the ones from the kit. Two servos were used for torque and symmetric purposes. All of the supporting parts and brackets for the food bucket were 3D printed. The servos were an integral part of the food dispensing. These wires can be seen on the distal breadboard connecting to power and ground. Two instances for the servos were created using the library Servo.h. These are written to and from 80 degrees. The servo wires flow through the baseboard to the right, opposite the pump wires.

The IR sensor was attached at the top right corner of the base, adjacent to the food bucket. The IR sensor interfaced with the IR remote included in the lab kits. Almost all of the functions of the Dawg Bowl could be controlled with an IR remote. The six main functions include food door open (volume up), food door close (volume down), water pumps on (up arrow), water pumps off (down arrow), autonomous mode on (number 1), and autonomous mode off (number 2).

In the autonomous mode, a photoresistor (8) *Figure 5* would sense when a light was turned on, simulating a dog owner turning on the lights in the morning. The photoresistor would sense the light turns on, open the food door for a defined amount of time, and then shut it. As the circuit's sole sensor and analog input, the photoresistor was connected to the board through a 1000 Ohm resistor to digital pin A0. In automatic control, when the desired analog input is reached, in this case available light, the food and water will dispense for 10 seconds before closing. The idea behind this was to have the consumer activate automatic control in the mornings.

A button on the top of the base acted as an emergency stop for the water system (4) *Figure 1*. The IR remote can be unpredictable, and the automatic control cannot fix itself without user input. With the emergency stop button, all pumps will be shut off, servos closed, and the LCD will read "E-Stop Engaged," letting the user know that the system was activated.

The group of wires soldered onto the RGB LED stripping purchased on Amazon, flows out of the back of the base, (6) *Figure 5*. Because of the power demands, three NPN transistors were used, with the digital pin running into the base, the emitter running to a common ground, and the collector flowing into either the red, the green, or the blue LED strip wiring (11), *Figure 1*.

The LCD, (3) *Figure 1,* displayed everything to let the user know what was happening with the system at any given moment. Integrated off of the V0 pin on the LCD, the potentiometer allows the user to adjust the contrast on the display. This can assist in viewing the display in different lighting conditions throughout the day.

Finally, it is important to note that strain gauges are included in the partial parts list as they were originally incorporated in the design. However, after integrating them into the mechanical design, the group found that the load cells were inoperable and produced inconsistent results. The strain gauges were then omitted from the circuit design but maintained as they were critical to mechanical stability for the five-gallon water and food buckets.

Figure 7 is a flowchart that describes the functionality of the code. At the start, all variables are defined and then initialized. Once in the main loop, the code reads the values of each button to determine whether it has been pressed or not. An important note is that the E-Stop button is a physical button on the device, while all other buttons are on an IR remote. The E-Stop button is on an interrupt, so when pressed, it will stop all actions that aren't within the E-Stop code. When any other button is pressed, it will perform its task until the button associated with that task is pressed, or the E-Stop is engaged. When the autofood is on, it is run within its own loop that detects the value of a photocell that determines when the servos activate and food is dispensed.

The functional diagram uses Figures and Icons to indicate the functions of the system. Arrows show the relationships and interactions between each part of the system. Our function diagram uses pictures of our specific dog feeder, as well as images of the parts used to allow the system to run together.

Design Evaluation

The Dawg Feeder performed well in all functional categories. When one of the buttons on the IR remote was pressed, the system worked without issues. The servos opened the food dispenser with ease. The water pumps held water and pumped water as desired until they were turned off. Once the food was manually dispensed, the buzzer sounded. Our LED light strip turned blue when the water pumps were on, blinked red when the food was dispensed, and turned green after the food was dispensed. When the E-Stop button was pushed, the system stopped whatever it was doing and flashed the LED strip red. The automatic feed setting used the photoresistor from the lab kit. When a flashlight was shined on the photoresistor, it dispensed food for 10 seconds. This allowed for an adequate amount of food to flow into the dog bowl. The code ran everything in the system as intended.

The product worked without issues throughout the first half of the demonstration. The pumps that were ordered were cheaper products that could not handle the pressure of the water on top of them. When the water was initially poured into the system, the pumps leaked onto the base. The wooden base was not waterproof and a lot of the wiring was exposed to the incoming water. The entire electrical system stopped working after being exposed to water. Waterproofing the electrical housing was an oversight in our design.

Overall, the Dawg Feeder met all six required categories. With a couple of simple design alterations, waterproofing the electrical housing, and mounting the pumps differently, the Dawg Feeder could have been reliable and robust enough to function through the spilled water.

Partial Parts List

Part	Cost	Vendor	Description
Arduino Mega	$25	Amazon	Mega 2560 R3
LED	$10.99	Amazon	4 ft long multi color LED light strip
Base	$25	Home Depot	Plywood
Dog Bowls	$13	PetSmart	Stainless Steel Mirror Finish Dog Bowl
5 Gallon Buckets (x2)	$9.96 (Both)	Home Depot	Standard Home Depot 5 gallon buckets
Wires	$16.99	Amazon	24 AWG Stranded Wire Kit – Silicone Coated Copper Wires 24 Gauge Pre-Tinned 30ft/9m Each Spool, 6 Colors (Black, Red, Yellow, Green, Blue, White), Electrical Jumper Wire Hook Up Wire Kit from Plusivo
Water Pumps with Tubing 2	$10.92	Amazon	AITIAO 6Pcs DC 3-5V Micro Submersible Low Noise Mini Water Pump with 2pcs Clear Vinyl Tubing Flexible Water Pipe(1M) Micro Motor Water Pump
Strain Gauges (x2)	$8.00 (Both)	Adafruit	Strain Gauge Load Cell - 4 Wires - 20Kg - Product ID: 4543

Table 1: Partial Parts List

Lesson Learned

Throughout any project there are many lessons that are learned. As always when the project is over, it feels like things could have gone better if a few changes were made. This project was no different. Even after the due date, there were several ideas about how to make the Dawg Feeder a better design. Looking back on the semester there were a few lessons that stuck out as important.

One of the big lessons learned was about waterproofing. The Dawg Feeder performed all intended functions consistently. During the presentation, there was water spilled on the base. Since there was no waterproofing separating the electronics, water seeped into the electronics compartment and soaked the breadboard. This caused the Dawg Feeder to short-circuit and break during the presentation. The lesson from this is whenever dealing with water and electronics, the electronics should be behind a waterproof, or at least water-resistant, barrier to prevent accidental leakage from interfering. If there had been even a bead of caulk separating the electronics from the rest of the board the Dawg Feeder would have performed all of its functions without issue throughout the presentation.

Another lesson learned, later than sooner, was that part sourcing and building should start as soon as possible. The Dawg Feeder started being assembled in late October, which left about one and a half months for part ordering, testing, and assembly. Although that is almost half a semester, it is not enough time. A well-known anecdote is if you give grade school kids foam building blocks and tell them to build the tallest tower they can, they will immediately start trying, failing, and re-trying. Give the same exercise to corporate executives, they will spend hours arguing about the best way to do it and accomplish nothing. This story paired with our experience explains a powerful lesson. The Dawg Feeder came together, but it felt rushed and there was not enough trial and error. There was a lot of time thinking about the best way to do things and not enough time trying various ideas and refining them. Granted being college students with lots going on outside of this class, having the time and money to iterate through designs is difficult, but starting the project earlier would have helped with that.

Had we started earlier, here are some of the problems that would have been solved:

1. Water leaking onto electronics - This is what broke the Dawg Feeder during the presentation.
2. Food flow while dispensing - Noticed that the food would get clogged in the latch while dispensing.
3. Strain gauges - The strain gauges were difficult to wire and code, once the first pair got figured they broke. With more time the strain gauges would have been wired correctly.

Although there were some difficulties, overall the Dawg Feeder was considered a success. There are some design elements that can be changed easily to make this product something that can stand up to the abuse of feeding pets. The lessons learned will provide a solid foundation as this group starts senior design, and moves on into industry.

Appendix

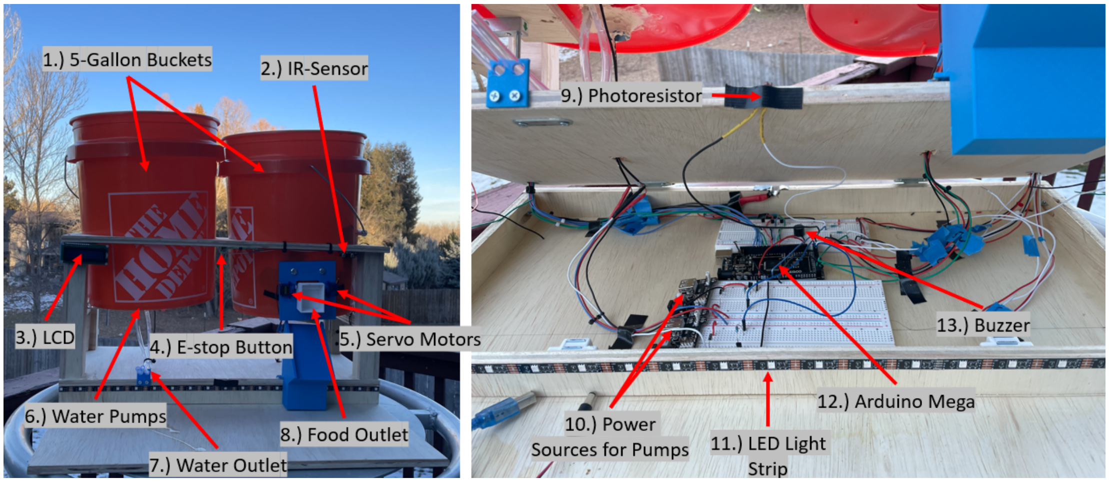

Figure 1: Labeled Design

The figure to the right shows the full wiring of all of the components connected to the Arduino boards and the Arduino Mega. The figure on the left shows both buckets and all components used for the Dawg Feeder.

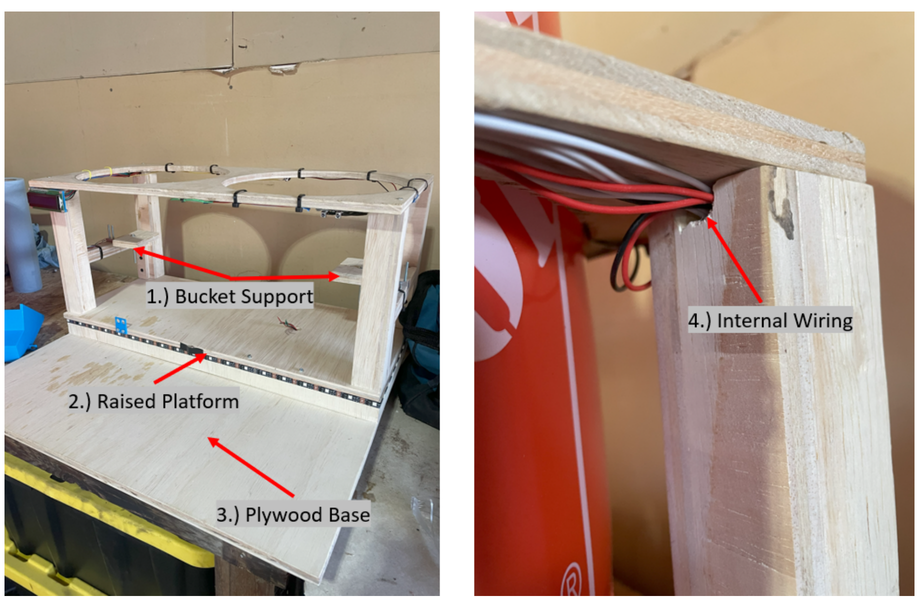

Figure 2: Labeled Base Design

Figure 2 shows our plywood base and how we hid all of the wiring for the Dawg Feeder. We used internal wiring up the vertical supports so it would look more neat. The plywood base lifts up with hinges in the back and magnets holding it down to hide the wiring to the Arduino and power supplies.

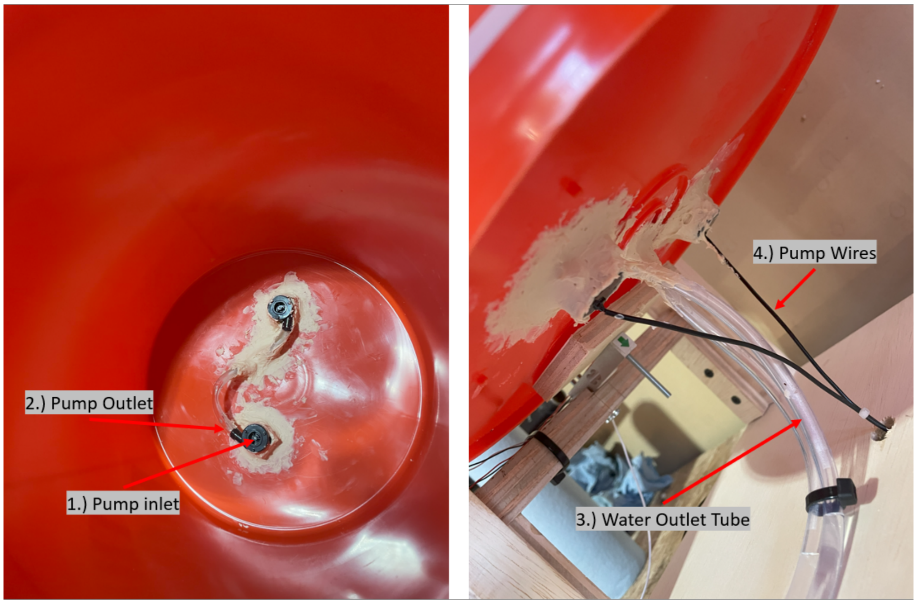

Figure 3: Labeled picture of the water system

The water system pumped water from the bucket through the outlet tubes (3) to dispense water into the dog's water bowl. In the figure on the left, we used lots of caulk to waterproof the pumps in order to keep the water in the bucket and prevent it from ruining the circuit.

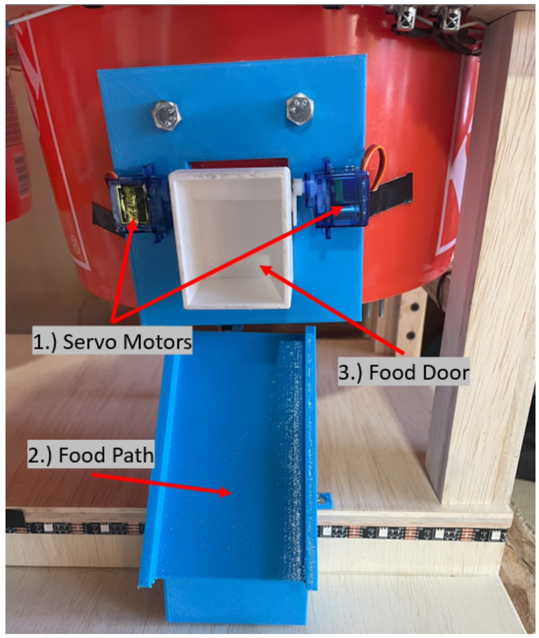

Figure 4: Labeled picture of the food system

The food system used 2 servo motors (1) to open and close the food door (3). It dispensed food down the food ramp (2) to let the dog food flow into the food bowl.

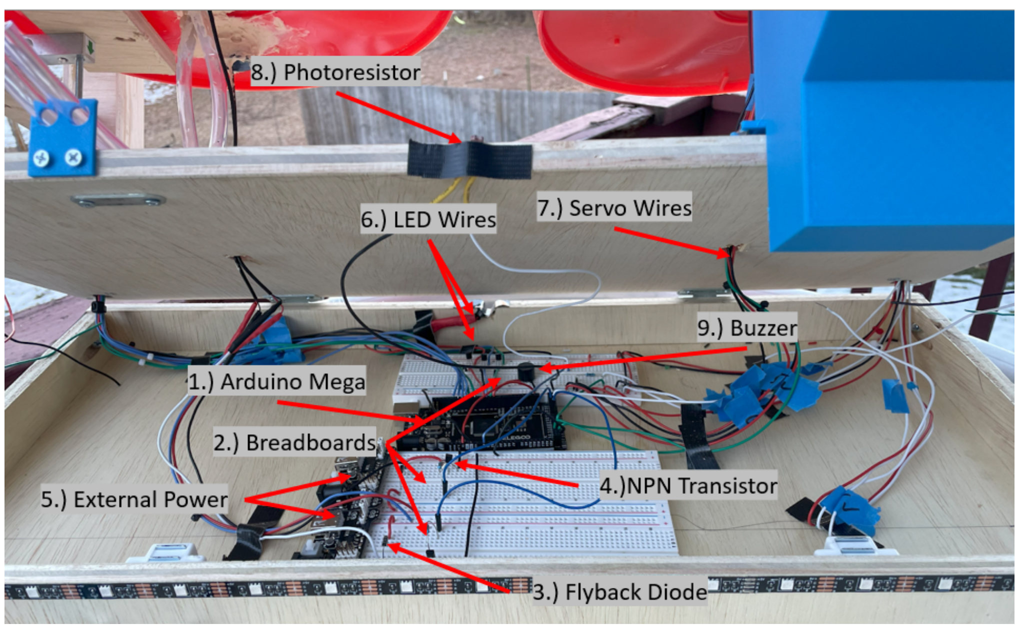

Figure 5: Labeled wiring components

This figure shows all of the wiring out of the breadboards and the Arduino Mega. Each component that is wired in the system is labeled with blue tape to keep them organized so it doesn't get mixed up with other wires if it gets unplugged.

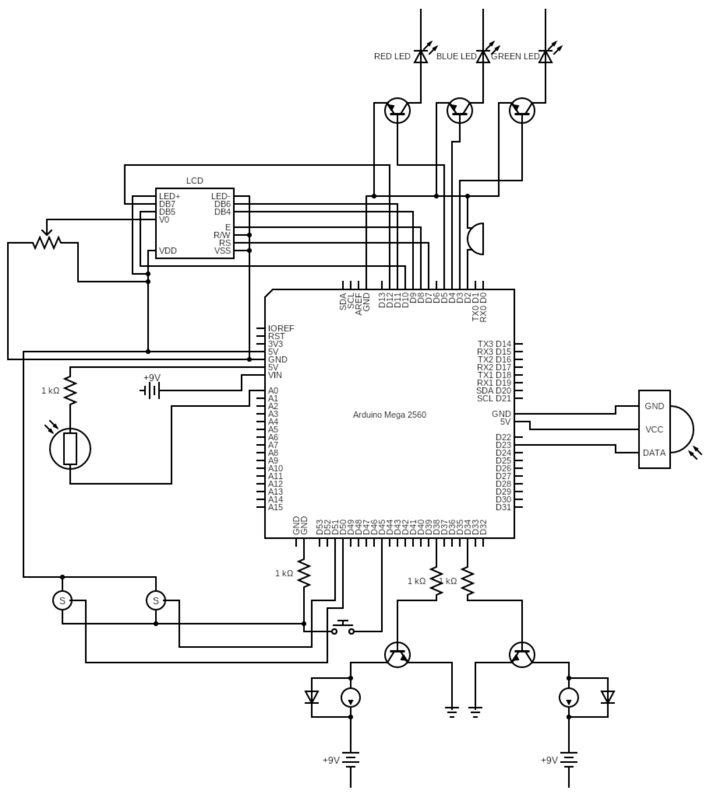

Figure 6: Wiring Diagram

The wiring diagram shows how each component is wired and what other components such as resistors, transistors, and power supplies. It is all connected to the Arduino Mega shown in the middle of the diagram.

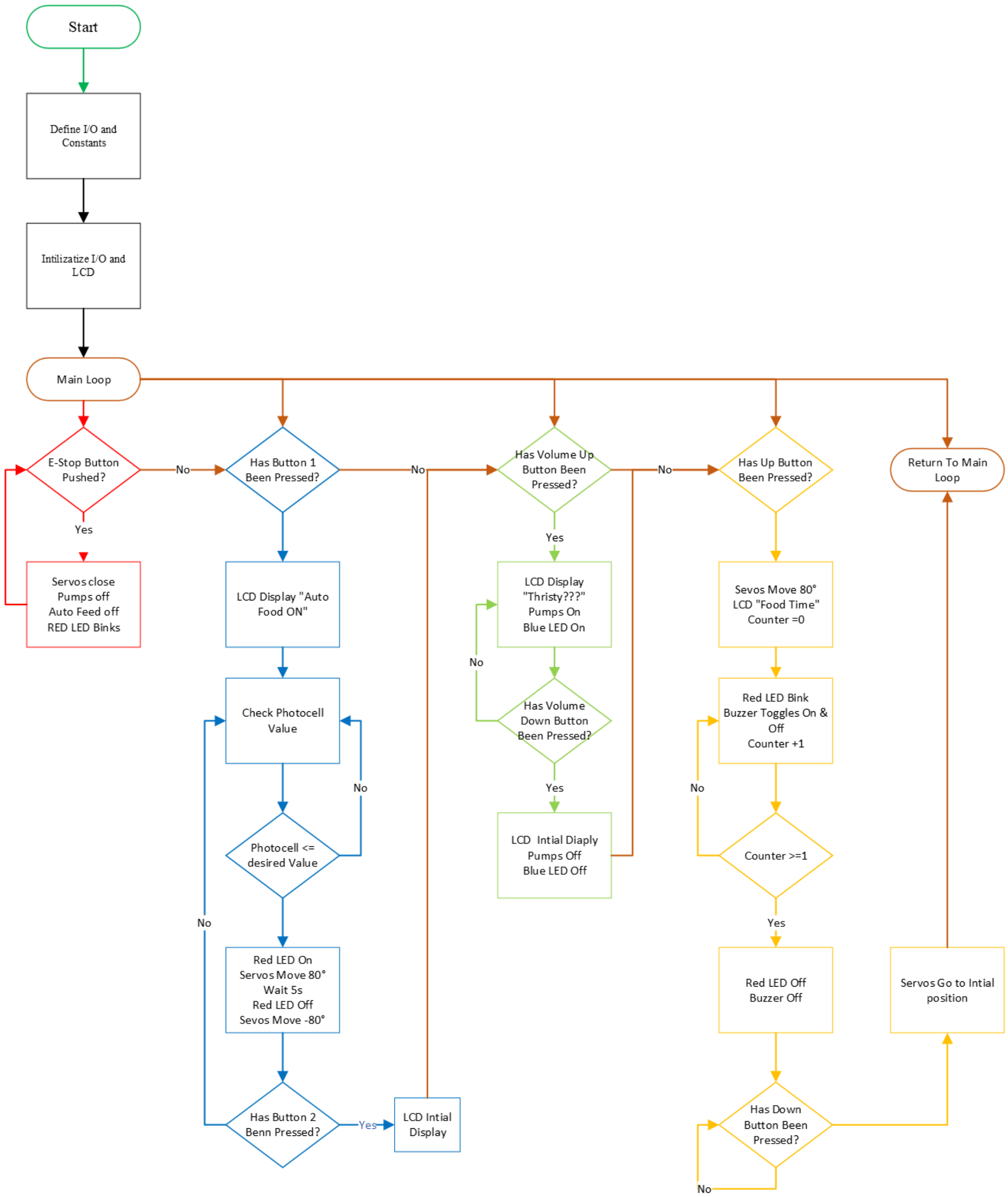

Figure 7: Flowchart of the code

The flowchart shows the sequence of how the code works with the system. From the input buttons until the final output and displays of the system.

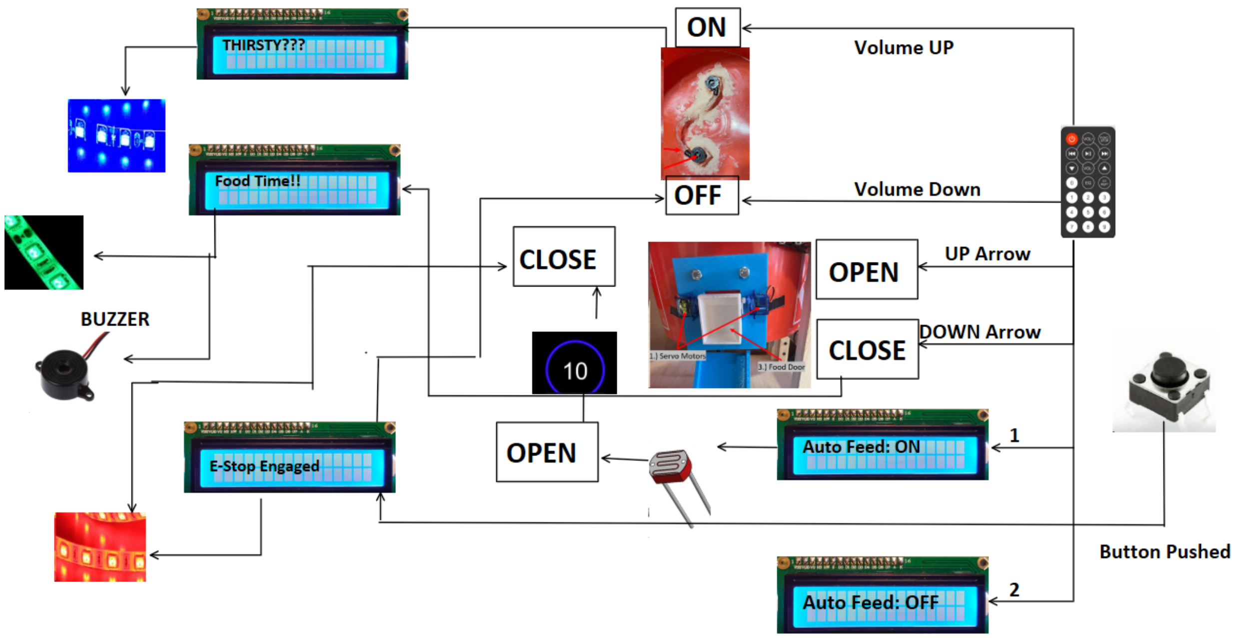

Figure 8: Function Diagram

The Function Diagram shows all of the parts and how they work together similar to the flowchart.

MECH307 - Final Code

DawgFeederCODE.pdf

[DawgFeeder_1.9.ino]