# CAPSTONE - FISH EGG COUNTER, TEAM 6

Portland State University
Maseeh College of Electrical & Computer Engineering

*Authors*

Trueman Singleton

Sydney McBee

Agustin Lopez-Vera

Sean Gilbert

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Faculty Advisor: John Lipor

Industry Sponsor: Jensorter, Curt Edmonson

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# 1 Abstract

The fish egg hatching industry is a large market that requires over 10 million fish eggs to be produced in Oregon annually by ‘spring pick’ when they incubate. These hatcheries need a way to produce eggs for species replenishment, including efficient methods of sorting and counting. Our mission as a capstone team is to create a fish egg counter for our sponsor Jensorter to sell to hatcheries by spring pick that is accurate and easy to use.

Our upgraded fish egg counter will be for hatcheries that need counting equipment as well as images of their counted eggs. The current design is in need of technological updates, including improved waterproofing, a greater accuracy of egg count, a faster count time, and a simple digital user interface. The design needs to be durable for the fish hatchery working style, as well as easy to use with gloves on and requires little attention/maintenance.

In this capstone project we created a working standalone fish egg counter prototype complete with imaging, accurate fake egg counting, egg ejection via water hose, battery powered electronics and partial waterproofing.

## 2 Introduction and Background

Our industry sponsor Jensorter is a fish egg sorter and counter manufacturer established for more than 50 years and ships their products all over the world. They have five models of fish egg sorters, a stand alone fish egg counter for salmon eggs, and a fry counter currently on the market. Salmon and trout fish eggs are around the size of a pea or a small BB. They are kept in large tanks, are red or pink in color, and are white when the egg is dead. The egg sorters that Jensorter developed are able to sort the eggs by color, detecting if they are dead or alive. It is important for fish hatcheries that purchase these sorters and counters to know exactly how many eggs are dead or alive in each batch for future predictions and to determine the health of their batches. The hatcheries raise the fish eggs to stock lakes and ponds as well as human consumption. It is beneficial for both the hatcheries that buy Jensorter machines, as well as the customer that will ultimately purchase the eggs to have accurate counts of healthy eggs.

Many hatcheries currently use an older counting system that is not as accurate as they would like- volumetric counting. This means they are weighing the eggs and estimating the number of eggs in the containers by the size of the container and checking it against previously counted containers. While this method is quick and efficient, it is not accurate which causes additional issues such as having to provide customers extra eggs in order to overestimate and not short-change them. Additionally, not having an accurate count of dead eggs may change the way the hatchery raises their eggs in the upcoming years.

Working in a hatchery is a demanding and labor intensive job. The equipment is constantly wet, which poses an electrical hazard. Hatchery workers also do not have the time to learn the process of utilizing an entirely new machine. Their equipment must be durable and user friendly as the user will most likely be wearing large gloves.

# 3 Requirements, Objectives and Deliverables

Our task is to design a fish egg counter for fish hatcheries that is durable, waterproof, accurate, very easy to use, and virtually hands off. The project should be completed by 'spring pick', which is when the eggs are ready to be incubated to be tested at Bonneville hatchery. The sponsor will then deliver it to the clients, which are various fish hatcheries. Our industry sponsor is Curt Edmonson who is helping design and spec the egg sorter. He works with Pacific Roe Technologies, and Jensorter to provide equipment to the hatcheries.

The counter may also have the ability to capture an image of every egg that goes through it and store it to be viewed by the egg hatchery workers for inspection. The main goal is to have a very accurate count of the eggs loaded into the counter. The user will be able to turn on the counter, dump the eggs in, choose either the amount of eggs they want counted, or choose to count all of the eggs deposited, and they will be able to walk away while it is counting. The counter should be able to be plugged into a computer via USB so software can be updated/debugged if need be. The parts should be easy to access for replacement of damaged or dead components. Below are our lists from our proposal.

## 3.1 Requirements and Specifications

Requirements From Proposal:

- Must display an accurate count of eggs
- Must be waterproof
- Must work with very minimal user input i.e power button, less than three options for starting the device
- Must rotate the eggs on a disk similar to a tilted record player
- Must use water to push the eggs off the tray into a separate bucket after counted
- The eggs must be counted with a sensor (camera or another sensor)
- Must have a display to show information such as egg count and options
- Must have a 'batch' feature for the counter. This is an option to count the number of eggs deposited, or count a 'batch' of eggs (a specified number of eggs input by the user)
- Should take a picture of each egg
- Should store egg pictures in groups by batches
- Should store each picture of each egg in a thumb drive
- Should have replaceable parts

- Should have the option to update the software via USB

Specifications from Proposal:

- Must use spring release toggle switches for UI
- Must be able to fit in a 4ftx4ftx4ft footprint
- Must cost less than $1000
- Must count fake eggs accurately up to 95
- Should count fake eggs accurately up to 100
- Should have a light sensor for each row of eggs to count rotations of disk
- Should be battery powered with a 18V ryobi drill battery
- Should count 500,000 eggs an hour
- Should use an STM32 processor
- Should use a ESP32-CAM sensor
- Should use a Raspberry Pi
- May be Wall Powered (Not Ideal)

### 3.2 What Changed?

Some of our original requirements and specifications changed after our initial project proposal. Our main requirement we did not reach was "must be waterproof". In our prototype some of our components were waterproof or semi-waterproof. The LCD enclosure is waterproof as well as the Pi enclosure, but due to drill holes for mounting they were not fully waterproofed. The buttons and switches themselves were waterproof but the enclosure they are in was not. We showed proof of concept for partial waterproofing using the dome cap cable gland on one of the enclosures but didn't have time to implement them throughout.

A spec we got rid of was "must use spring release toggle switches" because we actually found switches that were waterproof and would light up if needed in the dark hatcheries. This specification change was justified.

The spec "should have a light sensor for each row of eggs" changed multiple times. We first decided that we wouldn't be using a light sensor due to light conditions in hatcheries being unpredictable When we got towards the end of the project we realized that we would not be getting the egg disk with multiple rows, we decided to make our counter work with the egg disk we had that only had one sensor.

The specification "should count 500,000 eggs in an hour" was dependent on not only the motor speed but also the disk which we were using. Since we did not use our intended disk, we did not make this goal. This is described further in the X section.

"Should use an STM32" and "should use an ESP32-CAM" were both swapped out for a Raspberry Pi and a Raspberry Pi cam, described in the design section.

### 3.3 Deliverables

From our main requirements we have a list of our deliverables that our sponsor wanted delivered at the end of the project. None of these deliverables were changed, all were delivered.

Deliverables From Proposal :

- Project proposal
- Weekly Progress Reports
- Final report
- ECE Capstone Poster Session poster
- Bill of Materials
- Github Repository
  - Electrical CAD: Schematics and board layouts, including output files (Gerbers, PDFs, etc)
  - Mechanical CAD: enclosures, mechanisms, including output files (STLs, PDFs, etc)
  - Final code
- A working prototype
- User Manual or User Video
- A manufacturable design

# 4 Approach

The underlying problem this capstone team aimed to fix is focused on the time consuming and inaccurate fish egg counting methods that fish egg hatcheries currently utilize. Our method was to work off of the previous egg counter as much as possible so as not to confuse the users, who had years of experience with the old counter model. Initially we worked with Jensorter's team closely and often to gain an understanding of their previous works and their wisdom on prior solutions. Jensorter's office has many tools and parts we were able to use throughout the process, and they worked with us to learn to use them. Initially the industry sponsor suggested we use an array of ESP32 Cams and an STM board as well as a Raspberry Pi. Early on we decided this was not going to be our approach(discussed in the design portion of the report), and decided on using a Raspberry Pi to control all of our electronics as well as a singular Raspberry Pi Cam. The Raspberry Pi was robust enough to control all of our necessary electronics and was very compatible with the Raspberry Pi cam, making the code easier for the hatcheries to understand, adjust, and debug after purchasing.

We decided to develop IR sensors and the camera in parallel, both as counting options for the eggs. After a specified time, we had to decide if we would use the camera, sensors, or both to count the eggs by determining which was the most accurate. This ended up happening later than we expected. We were using the camera to count the eggs and the sensor to trigger the camera via white painted dots, but we ended up using the sensor armature to count the eggs themselves. Capturing images and having the Pi count the eggs via image processing turned out to be too slow due to write times, and our counting accuracy suffered.

# 5 Existing Design

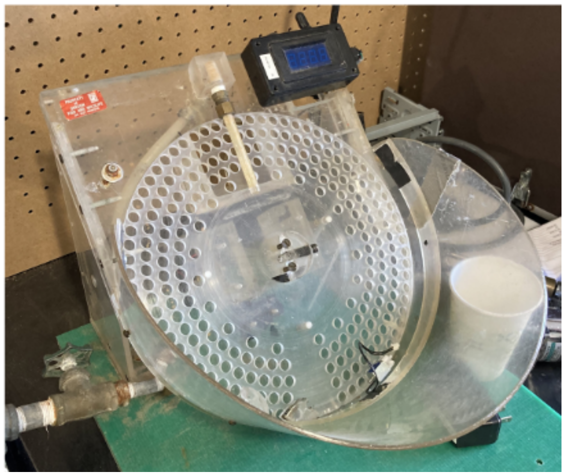


**Figure 1:** Jensorter 1971 Design

Instead of redesigning something that worked and was widely accepted by customers, our project was a continuation of a previous design shown in figure X from a previous patent. This old design is from 1971 and is in need of an update due to reasons discussed in the introduction.

Current users are comfortable with the old design because they are very familiar with it; however there are a couple of issues that our team aimed to address. The biggest being its shock hazard — the old design plugged into the wall. Customers were frequently getting shocked by the outlet due to them wearing wet clothes. Additionally, the old design only counted revolutions of the disk, not each individual egg. This caused inaccurate counts since not every hole on the disk(shown in figure X) would be filled with an egg. We were provided with the patent for the old design(shown in figures X and X). The main components include the hopper(12/16), the disk(20), the plate(14), the right and left sides(18), and the base which is not shown in the diagram but is a flat plate the whole chassis is mounted directly onto.

A majority of the information we used to influence our design was from multiple meetings with Curt and the team at Jensorter. Throughout the entire project we were using small red plastic beads in order to simulate fish eggs. Jensorter uses these beads on a daily basis to ensure their products work and test well before using real fish eggs which are often fragile. We took Jensorter's word that these beads would simulate real fish eggs and only tested our project with the beads. We also know that the hopper(large area to dump eggs) and disk system worked previously with the old patent, and were told that the eggs just stick in the holes of the disk until they are ejected with water. Jensorter assured us that a water hose works great to eject the eggs as long as you can control the pressure.

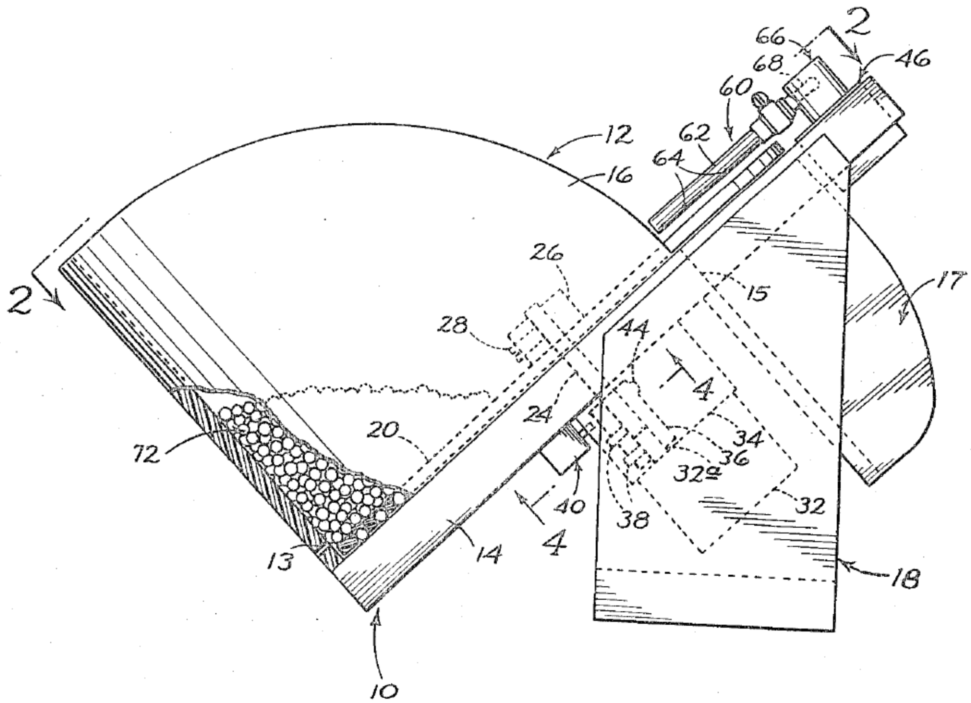



**Figure 2:** 1971 Patent Diagram

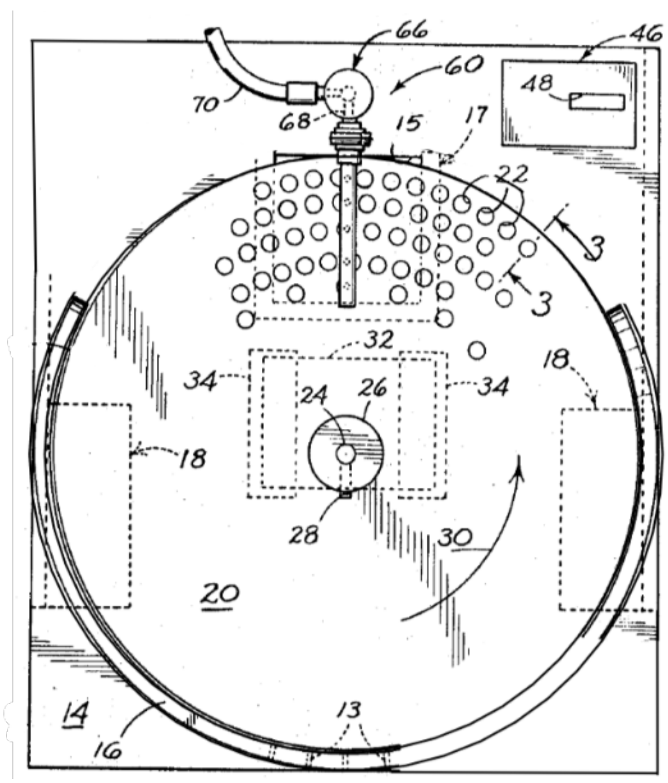



**Figure 3:** 1971 Patent Diagram

# 6 Design

Refer to figure x, the Block Diagram of the whole system for a high level overview before reading about our subsystems below.

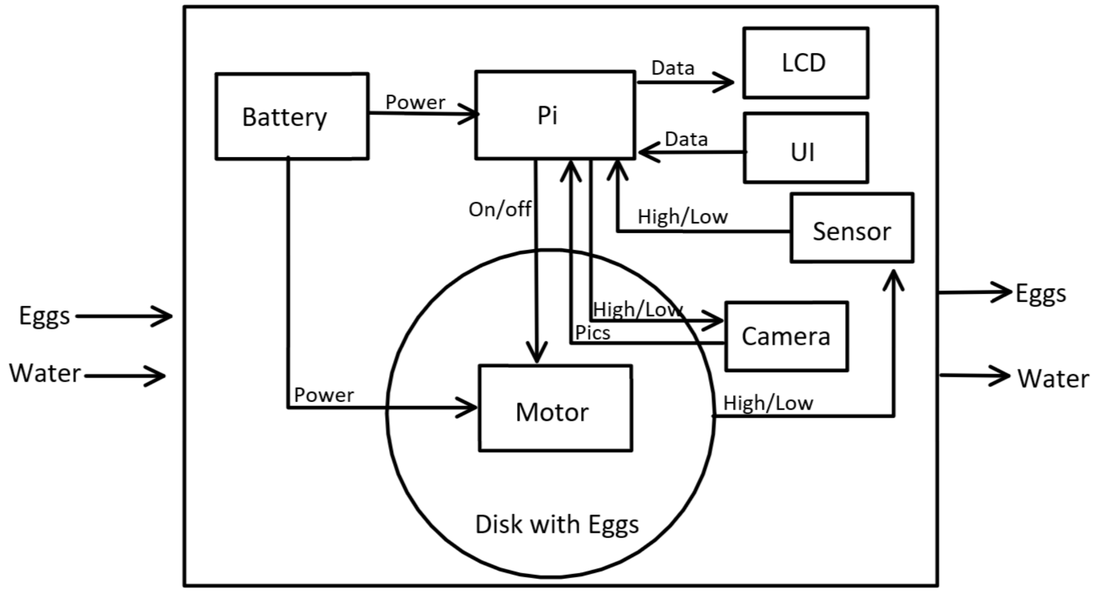



**Figure 4:** Block Diagram of the entire system

### 6.1 CHASSIS

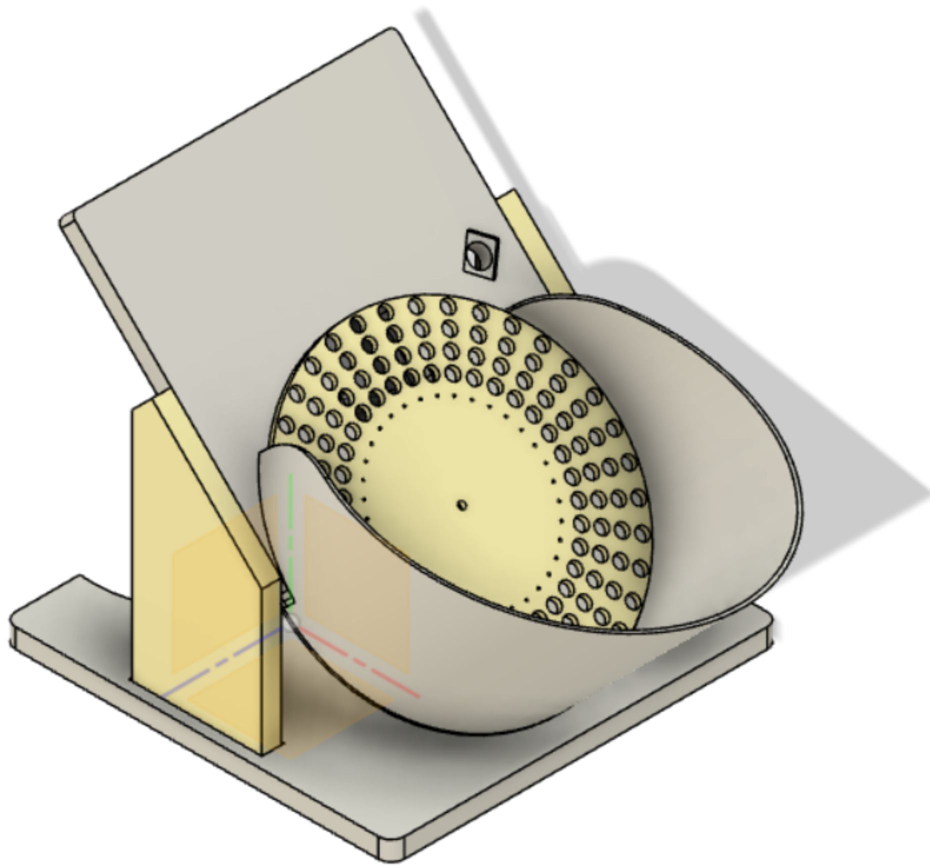


**Figure 5:** Fusion 360 CAD file of Chassis

The basic mechanism of the egg counter includes a fixture called the hopper, which is used to dump a tray of eggs into in order to be loaded on the disk. The eggs will then move onto a rotating disc to be counted, and an image will be taken of each egg to be stored on a thumb drive, and the eggs will be ejected through the back. This was the basic approach as to how the eggs would move through our apparatus. The camera is held in place with a camera armature purchased on Amazon, and the sensor is held in place with a PVC armature attached to the chassis. The UI is also mounted to the main plate. The main components in the chassis are detailed in the existing design section above.

### 6.2 RASPBERRY PI

Originally, we were given ESP32s and an STM32 board by our industry sponsor. Due to the Pi camera and plethora of python APIs for the Raspberry Pi, it became more of an obvious choice. We needed the computing power and it was an easier coding environment, which our sponsor expressed that they wanted for simpler debugging in the future. We initially had a plan of a counting mechanism which required openCV, which was something the STM32 board could not handle. Even though we did not go with that plan, openCV was still used to handle the imaging.

The downside of using the Raspberry Pi is primarily cost. With the chip shortage, Raspberry Pis are about $140. Luckily for the project, Raspberry Pis were cheaply obtained through the schools EPL for testing, but for a production run, it will likely be an issue. However the Pi ended up being the most expensive part of the project, and we were still way under our budget of less than $1000

### 6.3 CODE

The primary APIs used in the software were Raspberry Pi's GPIO library, OpenCV for image processing, and the time library. The idea behind the code was to be as simple and as automated as possible. This means that the photos and motor controls are automatic and there are defaults to run the counter.

One thing the client wanted was a "batching" feature, where the user can input a specific number of eggs they want to be counted. Creating the batching feature required a user to be able to input high quantities of eggs at once. The setup mode is more complex because it has to handle the extra batching feature. This necessitated the use of extra buttons to be able to adjust the size of a batch of eggs before stopping. Without the batching feature, the counter could run on a single start and stop switch. Instead of using a button to increment until the user reached a desired number, an extra button was implemented that allows the user to select which decimal place value they are changing the number of. This has the benefit of being controllable using one button, and using the other button for incrementing the number under the place value(1 through 9). Some extra cases had to be implemented, including ensuring the user cannot go above the maximum possible count and limiting the place value. It should be noted that if the user makes a mistake, the user can simply quickly toggle into continuous mode and back. But it is not an intuitive input unfortunately.

The handling of the camera and motor use python APIs to simplify the process. For the motors, all that was needed was a digital switch that would connect to the motors power supply. This is detailed further in the power section. This was handled by enabling a GPIO pin on the Pi which fed into the switch. This means the Raspberry Pi can turn the motor on and off when switching between running and setup mode. The image taking process is a lot more automated. OpenCV does have an integrated video feature that can run at high frame rates. This was required since some of the initial camera features required very fast still images while also being fast enough to handle other processes. Since openCV is optimized and can handle the multithreading and simplify the process of pulling stills, it was very desirable.

The image process in the final design was somewhat simple. Once the openCV APIs video feature was initialized, and the required frame rate was set, all that was needed was to pull the latest still from the buffer, then reduce the image, and save it as a jpeg. Luckily the Raspberry Pi provides fairly usable default settings for initialization and can tell how the Raspberry Pi should take pictures off the frame rate setting alone. This has some trade offs like maximum resolution and image grain, but those qualities were not important for our use case. We were already taking very up close pictures of the eggs.

It was really important to reduce the image size because of processing speed and memory size, especially since photos need to be processed at 30ms each. One of the biggest recurring problems was saving the images into storage. Where saving to a standard thumb drive would take more than 100ms. In comparison, the local SD card took 20ms to save, which was able to handle the speeds the Raspberry Pi 3 needed to work at. Processing speed really becomes an issue since the Raspberry Pi 3's processing speed would change depending on its temperature. This could be changed if we had used a Raspberry Pi 4, and the thumb drive would not have been an option, but the version 4 is expensive and difficult to find.

While there were likely good solutions to enable saving to a thumb drive, either through digging into how jpegs were saved or placing them in a large buffer before saving to a thumb drive; technical knowledge, uncertainty, and time constraints limited this course of action. In the meantime, images are stored on the microSD card on the raspberry Pi itself. It should be able to store about 500,000 images per gigabyte for the 16GB of free storage on the Raspberry Pi.

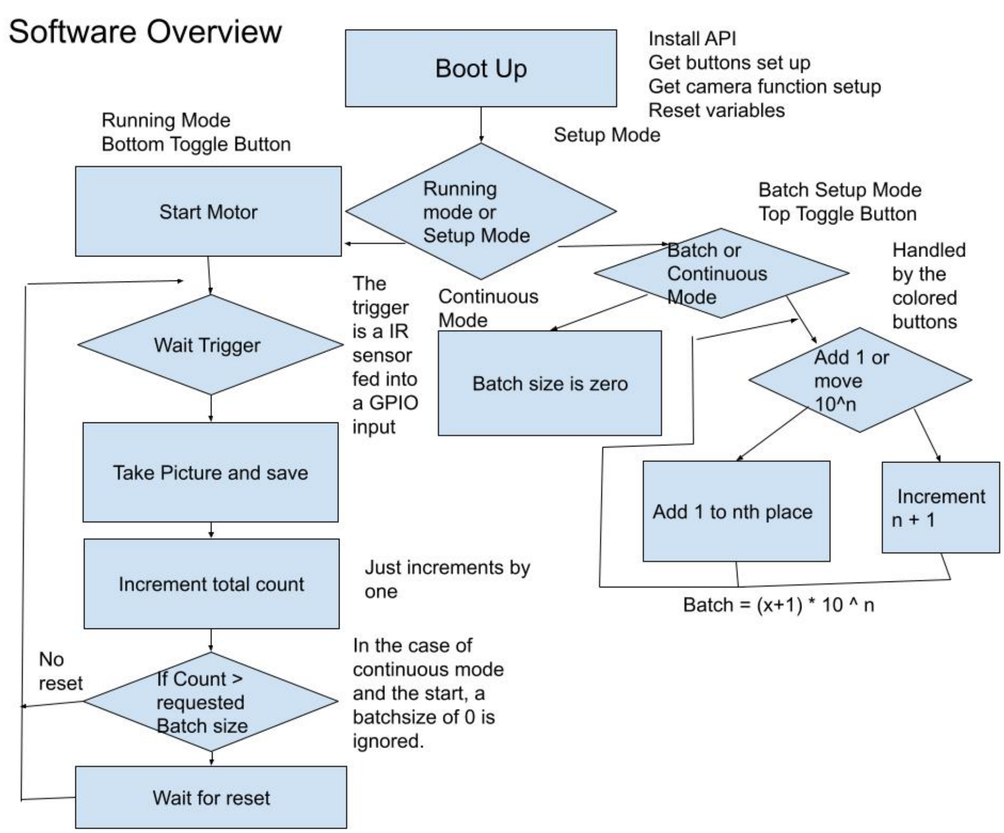



**Figure 6:** Software Block Diagram

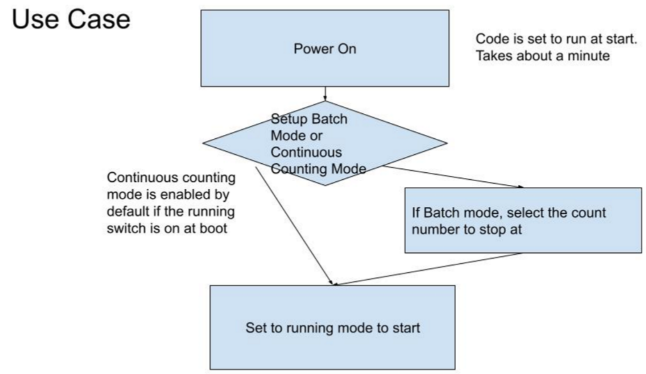



**Figure 7:** Use Case Block Diagram

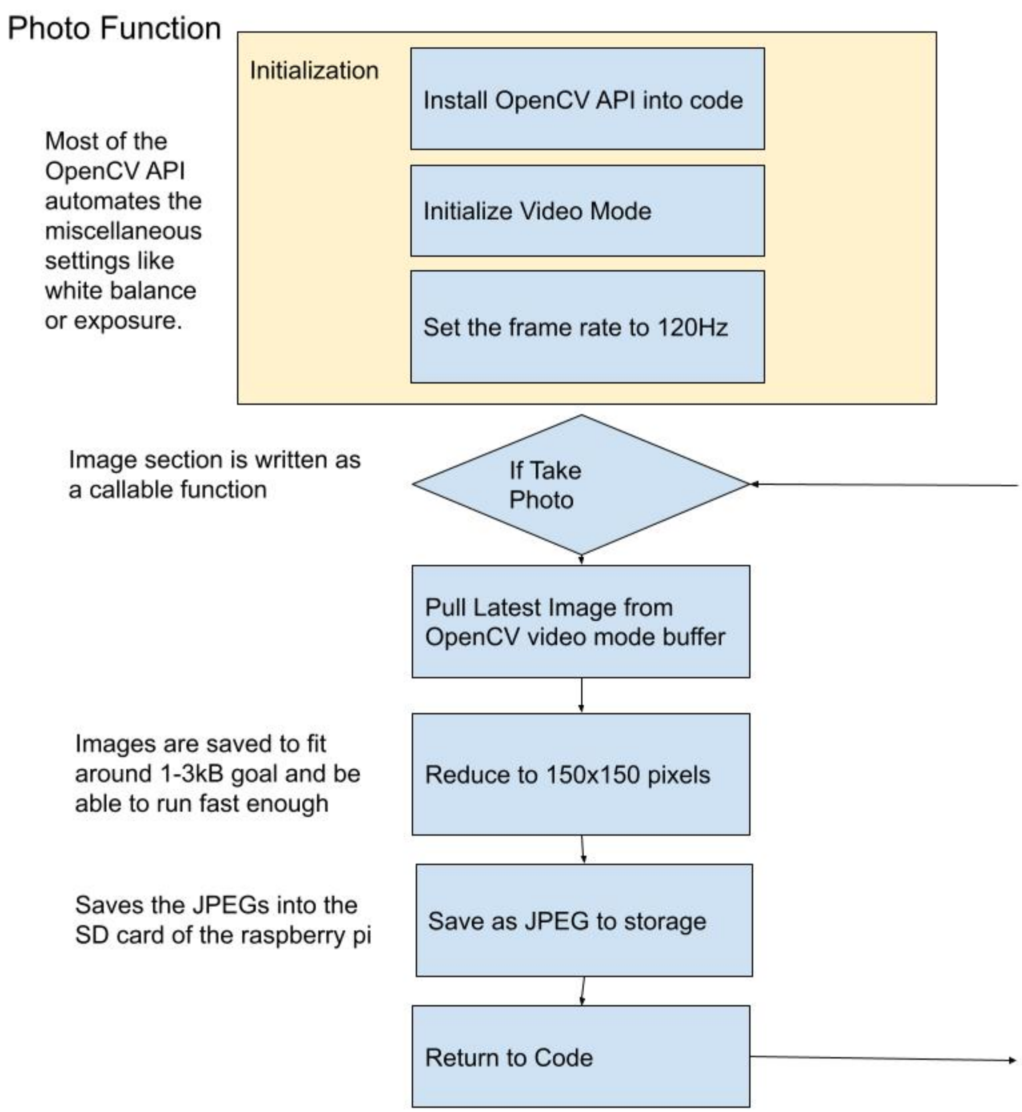



**Figure 8:** Photo Function Block Diagram

## 6.4 POWER SYSTEM

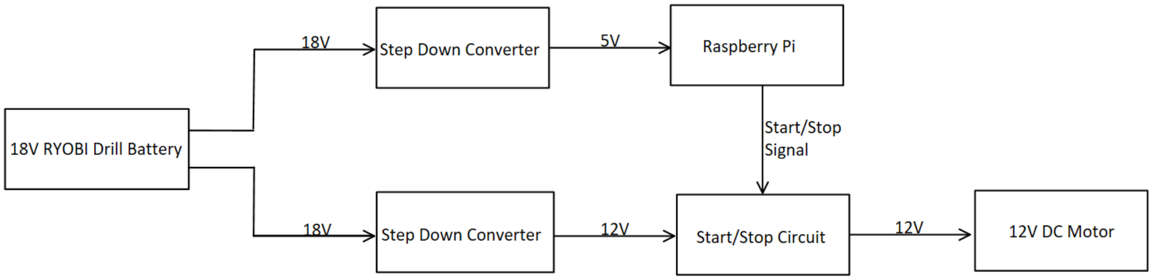



**Figure 9:** Step Down Block Diagram

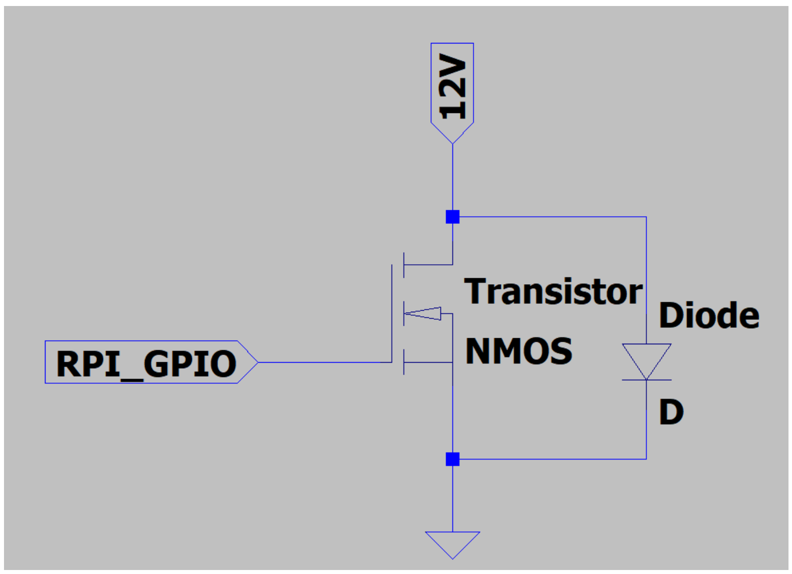



**Figure 10:** Motor GPIO Control Schematic

The power system consists of a 18V rechargeable RYOBI drill battery, a RYOBI drill battery adapter, two adjustable DC step down buck converters, a start/stop circuit and a micro USB power cable. The start/stop circuit consists of a TIP120 transistor, 100  resistor and a 15N822 Schottky Diode. The purpose of this circuit is to have a signal from a GPIO pin of the Raspberry Pi start and stop motor. The diode was included to prevent backwards current flow. Figure X illustrates the circuit, we have 12V feeding into the collector of the transistor and the signal of the Raspberry Pi feeding into the Base. The signal will open or close the transistor making the motor start or stop.

### 6.5 SENSORS

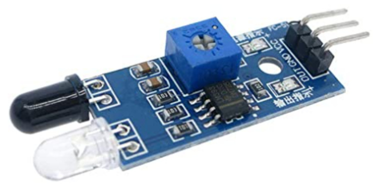


**Figure 11:** IR sensor

These IR sensors were purchased from amazon in a large pack for testing. They were tested initially with a record player(before our motor was running) with different fake eggs at different distances for counting accuracy purposes. These sensors have an IR emitter and receiver, which we thought would be more accurate than a photodiode/photoresistor (or a light sensor) in a hatchery with varying light levels. Since our disk that the eggs are loaded into is black, the IR does not reflect off of it. Anything that is reflective/ doesn't absorb light makes the sensors read a "high" output, which is what the Raspberry Pi GPIO are looking for. These boards were great for testing as they have an LED on them that lights up when the sensor is "high" and we could visually see if the eggs were being counted properly.

The sensors(shown in figure X) were decomposed for our purposes. By desoldering the two diodes and extending a wire through the sensor armature made from PVC we were able to keep the potentiometer and board within the Raspberry Pi enclosure. This allowed us to have a smaller armature for the sensors and makes adjustments to the potentiometer easier for the user if needed. Adjusting the potentiometer changes the detection distance or sensitivity of the sensor. A 3D print was created to hold the loose diodes in place to keep their detection angle.

### 6.6 CAMERA

The Raspberry Pi Camera version 2 was chosen because of its relative low cost and features compared to a USB webcam. Because of the Raspberry Pi's built in CSI connector, it is trivial to get the Raspberry Pi camera to shoot at 120 frames per second which is needed for images per egg. It also has superior latency compared to a USB web camera. This coupled with an easy installation, built-in APIs, and tutorials made the Raspberry Pi camera a great choice. If there were specific needs for higher fidelity images, this would have impacted our options though.

### 6.7 EJECTION

The ejection system consists of a hose adapter for a regular garden hose connected to a smaller hose. The hose adapter has an adjustable knob in order to change the pressure of the water coming out of the hose for the safety of the fragile eggs. The small end of the hose is attached to the plate of the main chassis and bent at a 90 degree angle in order to be parallel to the disk of eggs. Once the eggs pass under the water hose, small holes in the end of the hose allow water to stream over the eggs in their disk and break the seal that is keeping them suctioned into the disk. This then ejects them out of the back of the plate, down a small shoot and into a bucket the user has placed behind.

## 6.8 MOTOR

**Figure 12:** Motor

The motor was provided by our industry sponsor, it is a 12V DC gear motor that is designed for 50 rpm. It was a simple component to use, all that was needed was a 12V source and ground. The wires were soldered on and connected to the power system as described earlier in the report.

Modifications were made to the metal casing of the motor shown in figure X. The original screws were replaced with longer ones to be able to mount the motor on the chassis. Spacers and washers were used to align the motor with the disk.

### 6.9 UI and INTENDED USE

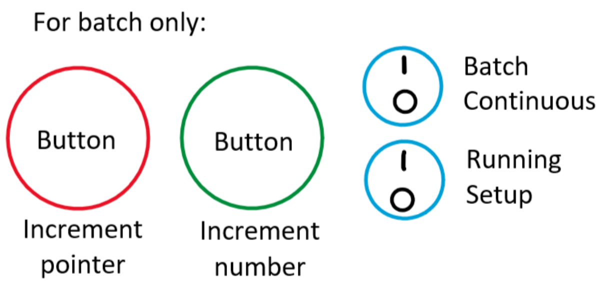



**Figure 13:** User Interface Buttons and Switches

The Egg Counter is operated through a user interface located at the top left of The Counter, making it easy to see no matter what degree the plate is tilted at. It consists of buttons and switches which interact with a LCD screen display. These buttons and switches were purchased because they are durable, have the option to light up, and are waterproof.

To operate the batching function this UI uses two extra buttons and a toggle than what a basic continuous model would have. As mentioned above, it would otherwise just require a toggle to run or stop. Additional physical components that you will navigate include the water hose valve that controls the water pressure for expelling counted eggs. This design should be universal with any fish hatchery, and is easy to use. They simply must attach any garden hose/water hose.
The other physical components are the battery, which one must plug in to the container placed under the egg shoot located behind the rotating disk.

The switches located towards the top of The Counter control the activation and mode of The Counter. The top switch controls the mode with up toggle setting it to batching mode and down toggle setting it to the continuous count mode. The lower switch determines if The Counter is active or not. The up position causes The Counter to start and the lower position pauses The Counter so the User can set up their preferred settings. The buttons are used when in batching mode as the green button increases the selected digit of the batch size while the red button changes what the selected digit is by rotating from right to left. The LCD display relays information on The Counter such as counter mode, batch size and total count of fish eggs. The final interactable component is the USB-A port which can be used to extract pictures of the counted eggs. If this were a Raspberry Pi 4 the user could use a USB stick, but with a Raspberry Pi 3 the user can grab pictures off of the Pi by plugging it in to an HDMI.

# 7 Testing

The testing of our design was done on separate subsystems leading up to a fully integrated design. The most basic tests involved checking if power reaches to set components or systems. Then the more advanced tests involve checking that the subsystems work as expected to produce acceptable results.

The most basic Test Plan that we can perform to ensure a working product involves first testing for functionality in purchased components. A simple case of this is when testing the motor, the battery socket is wired through the voltage amplifiers, straight to the motor, and plugged in to see if it produces any movement. From there the newly tested motor can be adjusted to a preferred speed before later integrated into the final prototype.

Following a large array of simple tests to prove our necessary components work as intended comes the basic integration tests. This involves combining working components together to check for errors. We combined the motor with the stand to ensure it could rotate the disk without error. We also combined the processor(Raspberry Pi) with the LCD to test display output. From here, problems between systems can be caught and fixed easily and once each paired component works, they can be integrated with more subsystems for further testing.

At the end of all the testing is the Full basic integration test which not only tests integration, but acceptance for the bare minimum product design. Here is where we test our design to see if fish eggs can be accurately counted and have their photos saved on a flash drive. First, simulated fish eggs represented by beads are either fed into the hopper or are taped into the disk holes. Then one set up of the counter to either continuous or batching mode is set, the device is activated and the tester can see if it counts correctly through the LCD screen's output. Once finished, the flash drive is then extracted to examine if the photos were saved or not.

Additional test plans were developed to further test our design for a larger range of expected challenges. These include environmental tests concerning the temperature and wetness of the expected work environment for our counters. There are other further tests such as ensuring the water system successfully ejects the live or simulated fish eggs.

# 8 Results

From repeated testing using our Full Basic Integration Test, and a few variations of it, additional data was able to be extrapolated resulting in the following results. When testing the accuracy of the counter when eggs are placed next to each other under a strict batch size of 100, we found that our counter was 100 percent accurate and thus had no problem detecting multiple eggs in groups or rapid succession. These tests also involved a variety of egg colors which proved that egg color from red to pink does not affect the counting ability of our device.

Next, the tests focusing on motor and wheel performance within the Full Basic Integration Test allowed us to view the operating rotational speed of the wheel which is 25 revolutions in 33 seconds, or roughly 50 revolutions per second. If the disk can contain 60 eggs, this would result in the ability to process roughly 3000 eggs in a minute or 180,000 in one hour. While this number doesn't quite meet our original goal of 500,000 eggs per hour, the solution would be to edit our 1 track disc to include 4 more tracks.

Finally, the last test we performed was a pseudo-exhaustive test where the batch size was set to 1000 eggs. From this test we found that over time the counter makes a few mistakes and lowers the device's accuracy to 99 percent through the few eggs that were missed in wheel rotations. Although we still meet our accuracy goal with these results, it still shows there is room for improvement in our design. Most all other necessary criteria was met in developing this fish egg counter, as discussed in the requirements portion. We view this as a very successful capstone.

## 8.1 Post Mortem

The IR sensors ended up working very nicely for egg counting. The Raspberry Pi and Pi cam also worked really well for what we wanted them to do, but since we were using a Raspberry Pi 3 instead of a 4 we were unable to get the write times we needed to quickly save all of the pictures onto a thumb drive instead of straight to the pi. The Raspberry Pi did give a couple heat warnings, so we would recommend adding heat sinks to the exterior of the metal box if running the counter for many hours with the camera on.

In terms of replaceability, most components are compacted and secured into boxes. If a user were able to access them despite that, they would need to be able to solder and desolder in order to replace the majority of our major components. The only major component not limited by this skill would be the wheel and hopper which would be attached by a simple bolt and handful of screws. However, the wheel and hopper are custom made and require Jensorter to produce them inhouse.

In terms of repeatability, our design is repeatable, but the process could be difficult with the few custom built components. Custom built components such as the backboard, wheel, and hopper are hard to obtain without the resources provided through Jensorter. It is possible to reproduce them given that the autocad files exist in order to print them.

The project was not completed to the degree that we would have liked. Ultimately we completed a prototype that is able to run main functions such as counting accurately, a functioning user interface with screen and image capturing and processing. The team would have liked to test the prototype using the hopper and correct disk to see how the beads would have loaded and counted. These two crucial parts of the counter would have given us a realistic test.

Overall the team had a good time working together, cracking jokes and stressing about image capturing with the camera.

# 9 Project Management and Resources

## 9.1 Project Resources

All electrical and mechanical parts were either given to us from Jensorter or bought from Amazon, ACE Hardware, Home Depot, Lowes and the Electronics Prototyping Lab at Portland State. We met in person at the Jensorter Manufacturing Site and the Electronics Prototyping Lab for construction of hardwear.

Our most used tool was the drill press used to create holes for screws to mount and attach components. A power saw and a laser cutter was needed to carve our ABS base components. Additionally, we made sure to solder all loose wires and enclose them using heat shrink or electrical tape. We used hand drills, wrenches, socket wrenches, screwdrivers, and heat guns as well. A complete list of all parts purchased(Bill of Materials) is referenced in Appendix X.

Helpful links we used:

- Camera Case: https://www.thingiverse.com/thing:92208/files
- Interrupt tutorial: https://roboticsbackend.com/raspberry-pi-gpio-interrupts-tutorial/
- Raspberry Pi 3 information: https://www.raspberrypi.com/products/raspberry-pi-3-model-b-plus/
- Controlling DC motors with Raspberry Pi: https://www.youtube.com/watch?v=BiJMsMguv-Mt=287s
- OpenCV Install https://www.jeremymorgan.com/tutorials/raspberry-pi/how-to-install-opencv-raspberry-pi/

Building Stations:

- Jensorter Manufacturing Site
- Electronics Prototyping Lab (EPL)

## 9.2 Project Management

Throughout the capstone we utilized resources that helped manage the project and gave us the ability to work on our prototype. The team decided early on to communicate via Discord. This included our team meetings. Meetings with our industry sponsor and advisor were scheduled for every Friday on Zoom. The Github repository has all of the documentation needed to recreate the project entirely. Our original project schedule is shown below in figure X. This mostly changed with the fact that we didn't end up needing a PCB manufactured and were not given the opportunity to test with real fish eggs at Bonneville Dam as we had hoped.

Software used for project management:

- Trello: Used as a task tracker for mostly hardwear items
- Github: https://github.com/sydmcbee/Fish-Egg-Counter-2022
- Gantt chart(Pictured below in figures X and X)
- Google Drive: Used to collaborate in real time with the team members. All documents in google drive are now in the Github repository
- Discord: Main method of communication
- Zoom: Used for weekly meetings

# GANTT CHART

| | |
|---|---|
| **PROJECT TITLE** | Improved Salmon and Trout Egg Counter |
| **PROJECT MANAGER** | Curtis Edmonson & John Lipor |

| WBS NUMBER | TASK TITLE | TASK OWNER | START DATE | DUE DATE | PCT OF TASK COMPLETE |
|---|---|---|---|---|---|
| **1** | **Capstone Initiation** | | | | |
| 1.1 | Initial Sponsor Meeting ' | Team | 12/3/21 | 12/3/21 | 100% |
| 1.2 | One-Minute Summary | Team | 1/3/22 | 1/7/22 | 100% |
| 1.3 | Class Check-Ins | Team | 1/7/22 | 6/3/22 | 20% |
| 1.6 | Project Proposal | Team | 1/23/22 | 2/4/22 | 60% |
| **2** | **Research and Design** | | | | |
| 2.1 | Raspberry Pi/ User Interface | Sydney | 1/23/22 | 2/18/22 | 25% |
| 2.2 | Micrcontroler Research | Agustin | 1/23/22 | 2/18/22 | 25% |
| 2.3 | Power Rail Research/Design | Trueman | 1/23/22 | 2/18/22 | 25% |
| 2.6 | ESP 32 Camera Sensor Design | Sean | 1/23/22 | 2/18/22 | 25% |
| 2.4 | Intial Schematic Design (LTSpice) | Agustin/Sean | 1/30/22 | 2/25/22 | 0% |
| 2.5 | Counter Sensor Research/Design | Sydney/Trueman | 1/30/22 | 2/25/22 | 0% |
| 2.7 | First Chassis Design | Sydney | 1/30/22 | 3/14/22 | 0% |
| 2.8 | First Eagle Schematic Design | Sydney/ Agustin | 2/25/22 | 3/14/22 | 0% |
| 2.9 | First PCB Design | Sydney/Agustin | 3/11/22 | 3/18/22 | 0% |
| **3** | **Prototype Build and Testing** | | | | |
| 3.2 | First Chassis Build | Team | 3/14/22 | 3/28/22 | 0% |
| 3.1 | First PCB Build | Team | 3/18/22 | 4/1/22 | 0% |
| 3.3 | First Prototype Spin | Team | 4/4/22 | 4/15/22 | 0% |
| 3.4 | Prototype Test | Team | 4/15/22 | 4/18/22 | 0% |
| **4** | **Final Product Build and Testing** | | | | |
| 3.1 | Prototype Revision | Team | 4/18/22 | 4/25/22 | 0% |
| 3.2 | Second Protoype Spin | Team | 4/25/22 | 4/29/22 | 0% |
| 3.3.1 | Bonneville Dam Testing | Team | 4/30/22 | 5/15/22 | 0% |
| **5** | **Capstone Completion** | | | | |
| 5.1 | Create Final Poster | Team | 5/16/22 | 6/3/22 | 0% |
| 5.4 | Final Poster Presentation | Team | 6/3/22 | 6/3/22 | 0% |
| 5.2 | Final User Manual/Video | Trueman | 5/23/22 | 6/10/22 | 0% |
| 5.3 | Final Report | Team | 5/23/22 | 6/10/22 | 0% |
| 5.5 | Sponsor and Advisor Presentation | Team | 6/10/22 | 6/10/22 | 0% |

**Figure 14:** Gannt Chart

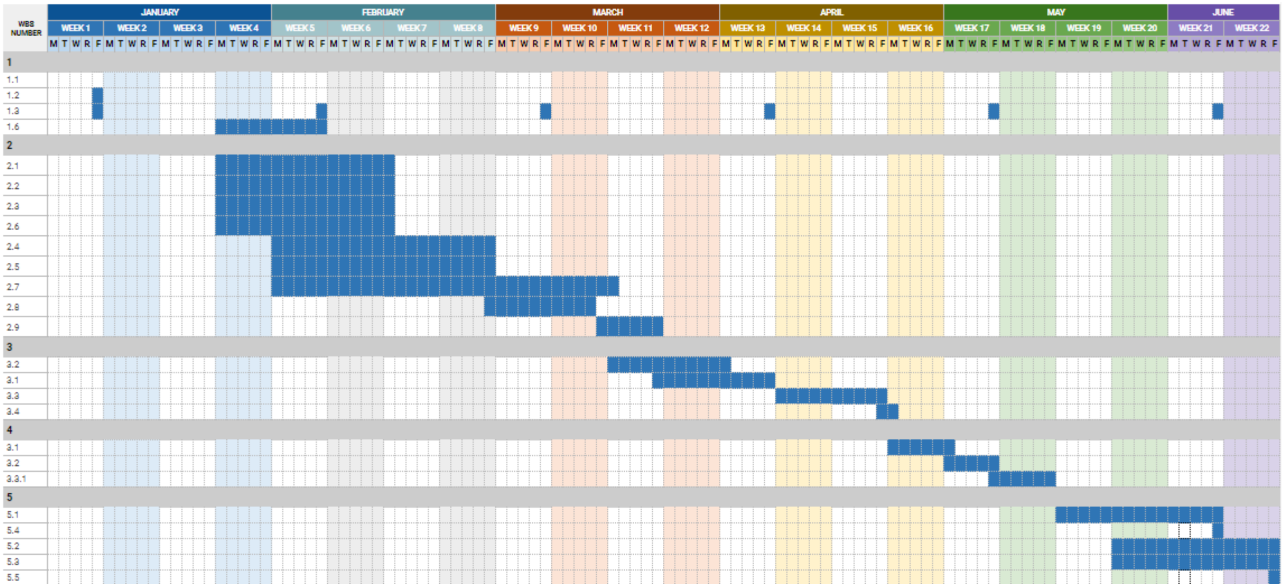



**Figure 15:** Gannt Chart

Our initial roles changed a little after starting the project because of shifts in the approach to the project. Our original roles were as follows:

Sydney: UI, 3D model armature, communication vector with industry sponsor and faculty advisor, photodiode

Agustin: STM32 Microcontroller, motor

Sean: Hooking up Camera Image Processing

Trueman: Battery, user manual, memory allocation, photodiode

Insead of a "photodiode" which we originally were going to use to count the eggs we switched to an IR sensor, and Sydney ended up mostly working on the sensors. Agustin ended up mostly working on the motor and battery circuit, and we scrapped the STM32 completely for the Raspberry Pi as our main microcontroller, which Sean mainly worked on. Sean still worked mainly on the image processing and camera. Trueman worked on the user manual and other various documentation such as the test plan.

# A Appendix: User Manual

## A.1 Assembly

1. Obtain the base, both sides, the plate, and the disk

2. Screw in the sides to the base using a drill

3. Use a wrench to tighten the plate onto the sides at desired angle

4. Attach the plate by first attaching the motor

   a. Fit the motor and tightened arbor into the holes from the back and use a wrench to tighten the nuts in place on the front of the plate. Use standoffs and washers on the motor in order to get the arbor flush against the plate

   b. Place a large washer on the arbor, then the disk, then another washer, and tighten with a reverse threaded nut. This is important to keep the disk tight during the counting process

5. Use PVC to build a sensor mount

   a. Cut lengths of PVC and use two 90 degree elbows in order to get a fully adjustable sensor mount.

   b. 3D print the file in Github to create sensor housing

   c. Desolder the IR sensors from their PBC and use long twisted pairs of wire to snake the sensors through the sensor mount PVC

   d. Glue the sensors(Diodes) into the 3D printed sensor housing and glue the housing into the end of the PVC

   e. Adjust the PVC arm and the potentiometer on the IR sensor PCB in order to calibrate the system to count the eggs

6. Create UI housing

   a. We used various plastic pre-waterproofed enclosures to build the user interface, which will be the most used part of the entire system

   b. Drill holes in the enclosures to snap in the switches, minding the fact that these particular switches have a notch on the side. c. Add silicone around the switches for further waterproofing. Solder long wires to the switches to run back to the Raspberry Pi

   d. Take apart the buttons using the yellow tab and drill holes to fit the button down into so it will be flush with the enclosure Use a crimp kit to crimp the ends of the wires that will be screwed down in the buttons. These wires will run back to the Raspberry Pi. These buttons are dust and waterproof and are industrial. We did not attach wires in order to light up the switches or buttons, but there is an option to if needed/desired

e. Using a clear lidded enclosure, glue standoffs to the lid and screw the LCD into them. The clear lid will allow the user to view the screen. Make sure there is room and length for the four wires attached to the LCD to return to the Raspberry Pi

f. On our project we used two different enclosures for the buttons/switches and the LCD. You may put them all in one enclosure or in two, or directly onto the base plate if desired. In order to maintain the original waterproof enclosure, use a combination of dome cap cable glands, silicone, and heat shrink if wires must exit the enclosure

g. Mount the enclosure using screws to the UI if using a separate enclosure. Waterproof with silicone if needed

7. Assemble and attach Raspberry Pi enclosure

a. We used a wooden board cut to fit inside a waterproof metal enclosure that could be screwed and unscrewed for easy mounting purposes

b. Attach the Pi, IR sensor potentiometer(s), transistor circuit for motor control, and the two step down circuits for both the motor and the Pi to the board in such a way that the user can still access the needed Raspberry Pi ports. This will vary with whichever version of Pi you have purchased. Attach using screws or glue

c. Utilizing the same waterproofing method as the prior enclosures, waterproof the wire exit with heat shrink, silicone, and dome cap cable glands to tightly fit the wires through the hole. This was not completed in our prototype due to time

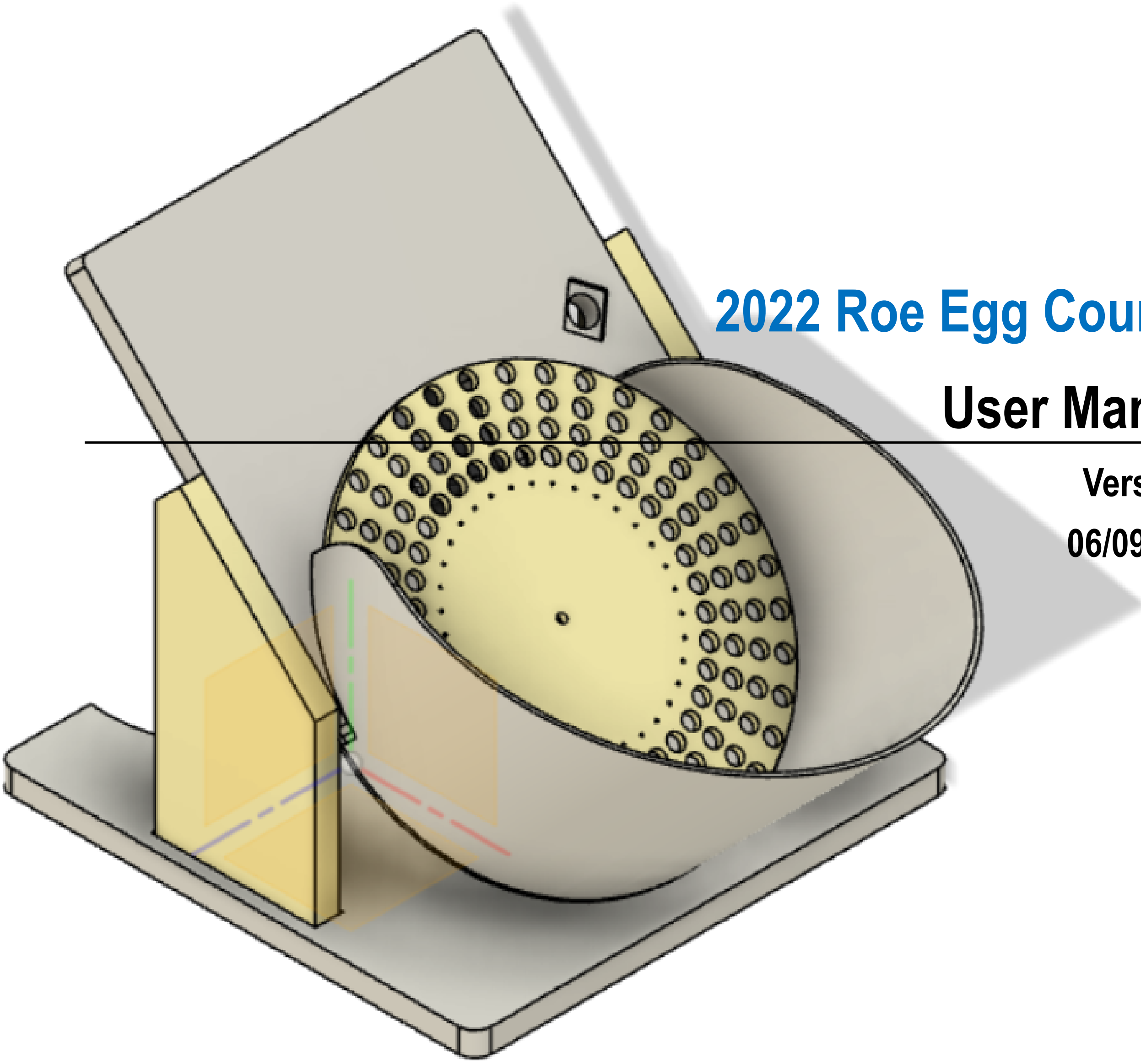
d. We attached our circuit enclosure to the base of the chassis for easy access using Command Strips

8. Assemble the camera mount

a. 3D print the camera case provided in the Github. This one is not waterproof

b. Super glue the camera case or screw it into a camera mount

c. Attach purchased camera armature and screw in the camera. Attach the camera flat cable



# 2022 Roe Egg Counter

# User Manual

**Version γ**

**06/09/2022**

# Table of Contents



# List of Figures

**No table of figures entries found.**

# List of Tables

# 1. Introduction

This User Manual provides the information necessary for device operators to effectively use the 2022 Roe Egg Counter. Throughout this document the device as a whole will be referred to simply as the Counter as a shorthand title. The Counter consists of a variety of components that are grouped by the overall function for categorizations based on their overall purpose: Stand, Power System, Water System, User Interface (UI), Circuitry System. Expect components within a category to directly affect others within the same category.

## 1.1 Overview

The main purpose of the 2022 Roe Egg Counter is to speedily and accurately count the fish eggs deposited into its hopper and then expunge the counted eggs. In addition to this, the Counter records photos of the fish eggs during operation which can be extracted and reviewed. The Counter is composed of larger series of components such as:

- The Stand which consists of ABS components that hold all other components.
- The Power System that safely connects and converts battery power to the Circuitry System.
- The Water System that guides the eggs out of The Counter.
- The User Interface which allows the user to control The Counter
- The Circuitry System consisting of the processor, motor, and sensors that allow autonomous function once activated through the UI

The 2022 Roe Egg Counter is ready to be used in wet and dry environments as long as an active hosed water source is available. Extreme heat or cold has not been tested for this model.

# 2. Getting Started

## 2.1 Cautions & Warnings

Improper use of the 2022 Roe Egg Counter may result in electrocution, physical harm, and/or potential water damage. To prevent such outcomes, please follow the following instructions.

## 2.2 Set-up Considerations

To ensure safe usage of the 2022 Roe Egg Counter inspect the device for any cracks in its support or along the body. Physical damage to the device's stand may create instances of improper expulsion of roe causing damage to the product. Next, inspect that all wires are fully sealed and free of damage to prevent risk of degeneration from corrosion which can cause a risk of malfunction or worse, electrocution. Also inspect that the battery is properly inserted into its slot on The Counter and is dry upon doing so or else risk electrocution. Next, ensure the water hose is firmly attached to the connector on The Counter to prevent leakage, poor volume, poor pressure, as well as workplace hazards as results of loose water. Finally, ensure The Counter's rotating disk is unimpeded to avoid malfunction upon activation.

## 2.3 User Access Considerations

The 2022 Roe Egg Counter is equipment meant for use by employees to count fish eggs with their size being dependent on the equipped disk/wheel. Use of the 2022 Roe Egg Counter outside of this field is discouraged and prohibited.

## 2.4 Accessing the System

To activate the system, a user must have a 18V battery to power The Counter and an active water hose to allow for egg ejection. No account is needed to access the machine's most basic functions, but details on batching may be enforced by your management. If a user desires to record photos through use, then a USB flash drive must be installed prior to use.

## 2.5 System Organization & Navigation

The 2022 Roe Egg Counter is operated through a user interface located at the top left of The Counter. It consists of buttons and switches which interact with a LCD screen display. Physical components that you will navigate include the water hose insert and its valve that control the water pressure for expelling counted eggs. The other physical components are the inserted battery, which powers The Counter's electrical components, and the container placed under the slide located behind the rotating disk to collect counted eggs. The switches located towards the top of The Counter control the activation and mode of The Counter. The top switch controls the mode with up toggle setting it to batching mode and down toggle setting it to the continuous count mode. The lower switch determines if The Counter is active or not as the upper toggle causes The Counter to activate and the lower toggle pauses The Counter so the User can set up their preferred settings. The buttons are used when in batching mode as the green button increases the selected digit of the batch size while the red button changes what the selected digit is by rotating from right to left. The LCD display relays information on The Counter such as counter mode, batch size and total count of fish eggs. The final interactable component is the USB-A port which can be used to extract pictures of the counted eggs.

## 2.6 Exiting the System

There is no special procedure to exit the 2022 Roe Egg Counter. Simply switch the lower switch down to halt the machine, then disconnect the battery to ensure the device is safely deactivated.

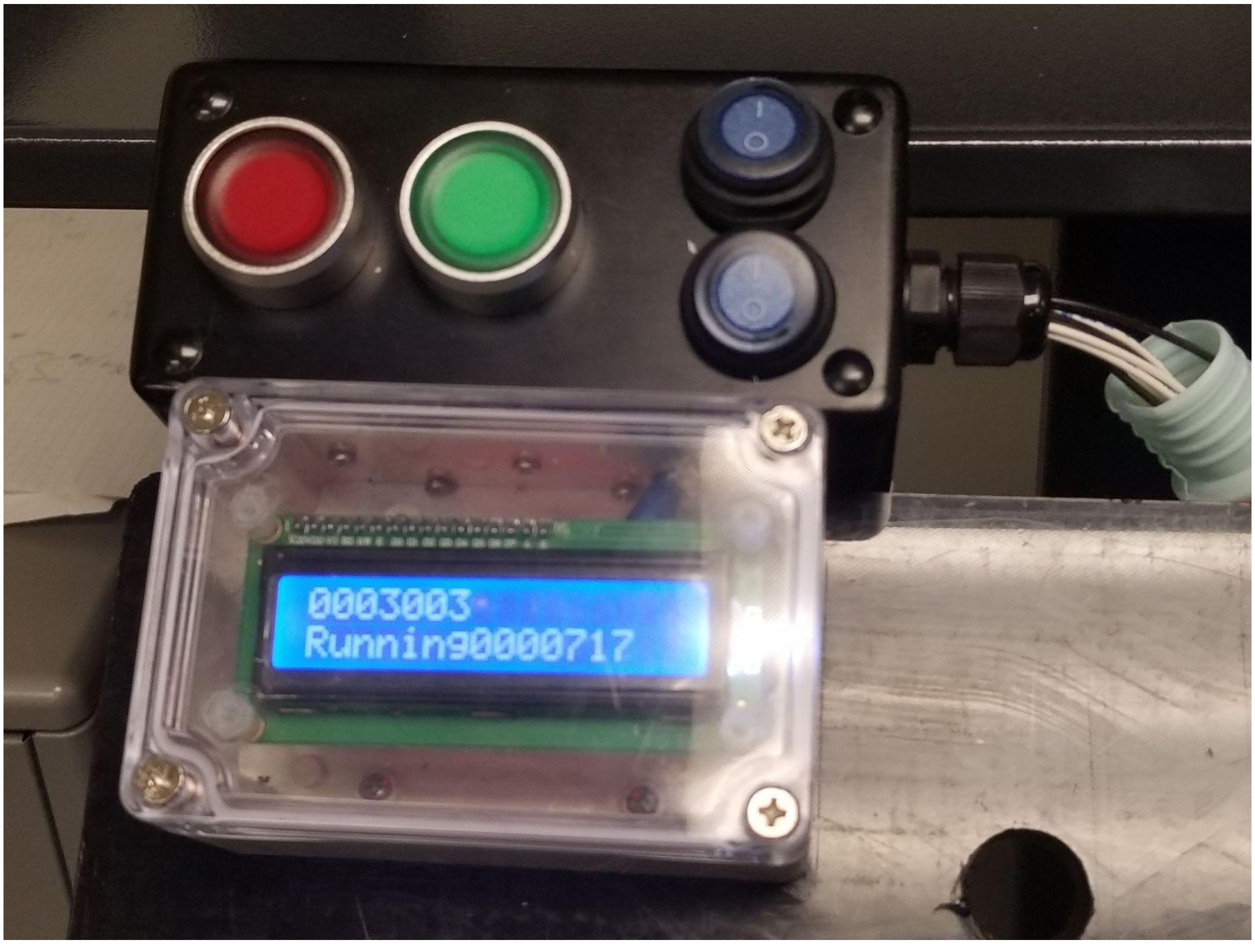
# 3. Using the System

The following subsections provide detailed, step-by-step instructions on how to use the various functions or features of the 2022 Roe Egg Counter.

## 3.1 Fish Egg Counting

To perform the main feature of the 2022 Roe Egg Counter, follow the following steps:

1. Double check that The Counter is ready to be used
    a. Ensure that a working water hose is attached to the valve located at the base of The Counter.
    b. Examine The Counter for any damage before use.
    c. Switch the bottom switch into the down position to prevent unwanted movement upon start up.
    d. Ensure that the 18V battery pack is inserted into it’s port located at the base of The Counter and wait 26 seconds for boot up.
2. Set up the additional equipment for best performance
    a. Place a receiving receptacle behind The Counter, below the slide, and preferably in the rounded groove in the base of the Stand.
    b. Turn the valve to allow the hose water to flow through the Water System’s hose and into the receiving receptacle.
3. Add the fish eggs into the hopper that you wish to be counted.




4. Input your desired settings using the buttons and LCD screen located besides each other.
    a. For continuous use, set the top switch to the lower position and continue to step 5.
    b. For batching use, set the top switch to the upper position.
    c. Then select the batching size by using the two buttons to increment until satisfied. (Green increments digit, while Red increments digit position)
5. Once the settings are selected activate The Counter by setting the lower switch into the upper position. The machine will activate and begin counting eggs.
6. Proceed to replenish new fish eggs in the hopper until finished. Also tend to the receiving receptacle to ensure workplace spillage is avoided.
7. Once finished, toggle the lower switch to stop the counter. Correct execution can be observed through the stopping of the wheel.
8. Once finished with operating the 2022 Roe Egg Counter, it is advised to safely remove the hose and battery to prevent damage to these components and The Counter.

### 3.1.1 Saving Fish Egg Pictures

1. Before starting a count, the option of recording pictures of the counted eggs is available to you.

2. Simply attach a USB-A external hard drive in any form to the female port located on the Circuitry box on the Stand prior to activating The Counter.
    a. Other names for external hard drives are “flash drive”, “jump drive”, “thumb drive”, “data stick”, or actual hard drives with USB conversion.
    b. Please note that the data storage device used must have available space in order to record any new photos.
3. Once inserted, The Counter should automatically save photos taken during the counting process to the attached external hard drive.
4. Once done with the count, the data storage device can be safely removed from The Counter and can be viewed at a later time.

# 4. Troubleshooting & Support

## 4.1 Error Messages

Common error signs are found on the LCD display screen.

- If the Screen remains unlit after battery insertion, this is a sign the battery is lacking charge, dislocated, or there is a break in the wiring.
- If the Screen is lit, but refuses to display words or produces unintelligible lettering, then wait a minute as the processor may be slower than expected. Other possible reasons could be the wires connecting the display may be compromised due to fissure or exposure leading to corrosion. Another possible cause is with use of a dysfunctional battery.

## 4.2 Special Considerations

If a crack in any of the Stand or hard plastic materials appears, it is suggested that the model be labeled inoperable and replaced. The inoperable model may then be disassembled for parts for possible use elsewhere, but this action is not recommended nor is the action of mending the inoperable model's cracks with strong water-proof adhesive in order to continue unhindered use.

## 4.3 Support

**Table 1 - Support Points of Contact**

| Contact | Organization | Phone | Role | Responsibility |
|---|---|---|---|---|
| Jensorter | Jensorter | 541-389-3591 | Manufactuare | Responsible for creation of quality product. |

# Appendix A: Record of Changes

**Table 2 - Record of Changes**

| Version Number | Date | Author/Owner | Description of Change |
|---|---|---|---|
| 1.0 | 3/08/2022 | Team ROE | First edition released. Mainly Template and small details. |
| α | 4/11/2022 | Team ROE | Fleshed out the majority of document. |
| β | 4/18/2022 | Team ROE | Added pictures and made small edits to better match the current Prototype. |
| γ | 6/09/2022 | Team ROE | Finished fully and severe changes made to match the final Prototype. |

# Appendix B: Glossary

**Table 3 - Glossary**

| Term | Acronym | Definition |
| --- | --- | --- |
| User Manual | UM | This document that you are reading. |
| Batching | | The separation of egg counts by a variable number set by the user. |

# Appendix C: Approvals

The undersigned acknowledge that they have reviewed the User Manual and agree with the information presented within this document. Changes to this User Manual will be coordinated with, and approved by, the undersigned, or their designated representatives.

**Table 5 - Approvals**

| Document Approved By | Date Approved |
|---|---|
| Name: <Name>, <Job Title> - <Company> | Date |
| Name: <Name>, <Job Title> - <Company> | Date |
| Name: <Name>, <Job Title> - <Company> | Date |
| Name: <Name>, <Job Title> - <Company> | Date |

# B Appendix: Tooling

Tools Used:

- Drill Press
- Soldering Station
- Hand Drills
- Screwdrivers of all sizes
- Monitor, Mouse, keyboard
- HDMI Cable
- Heat gun
- Hand saw
- Chop saw
- Files
- Pipe cutters
- Tape
- Wrenches/socket wrenches of all sizes
- Alan wrench for the arbor
- Silicone for waterproofing and attachment
- Hot glue gun
- Super glue

Software Installation:

- Installing raspberry pi:
  - Get computer
  - Plug in and wipe micro SD
  - Install Raspberry pi imager onto a micro SD card
  - Plug in micro SD and boot pi
- APIs and libraries:
  - Open terminal
  - Type: sudo apt-get update && sudo apt-get upgrade
  - Type: sudo raspi-config
  - Type: goto advanced options
  - Type: expand filesystem
  - Type: goto interfacing and enable CSI & I2C
  - Type: apply and while still in config
  - Type: sudo apt install python3-tk python3-pip python3-venv
  - Type: apt install python3-pip
  - Type: pip3 install thonny
  - Type: sudo apt-get install rpi.gpio
  - Type: sudo apt-get install i2c-tools
  - Type: sudo apt-get install python-smbus.
  - Type: sudo reboot
  - Type: mkdir ˜ /src && cd ˜ /src
  - Type: wget https://bootstrap.pypa.io/get-pip.py
  - Type: $ sudo python3 get-pip.py
  - Type: sudo pip install opencv-contrib-python
- Checking Installation:

  - In command console
  - Type: i2cdetect -y 1
  - Assuming the i2c is plugged in, you should see some numbers in the grid
  - If not check power and wiring
  - Within python:
  - Test installing apis for errors

- Getting code:

  In browser:

  https://github.com/sydmcbee/Fish-Egg-Counter-2022/blob/main/ImageCapture/FinalCodeNoImages.py

  Or

  https://github.com/sydmcbee/Fish-Egg-Counter-2022/blob/main/ImageCapture/FinalCode.py

  - Create folder in /home/pi/FtoSpm or alter cv2.imwrite line

- Run on boot:
  - In console:
  - Type: crontab -e
  - Type: @reboot python3 /home/pi/"placewherepythonisstored"/FinalCode.py &
  - Ctrl + o to save
  - Type: sudo reboot

Versions:

- OpenCV 4.5.5
- Python 3.7.3

Bill Of Materials for: [TEAM 6] [TEAM R.O.E]
Last modified: [2/14/2022]
PCB version: [PCB VERSION #1]
BOM revision: [BOM REVISION #0]

| Cnt | Part References | Mfg | Mfg PN | Description | Dist |
|---|---|---|---|---|---|
| 1 | LCD | JANSANE | 1602 | LCD Display Screen | Amazon |
| 1 | I2C | JANSANE | PCF8574T | IIC I2C Module Interface Adapter | Amazon |
| 1 | Motor | MOLON | CHM-1250-1M | DC Gearmotor, 50 rpm, 12V, Vented | Zoro |
| 1 | Power Source | Moticett | P100 | 3.6Ah Ni-Mh, Ryobi 18V Battery | Amazon |
| 1 | Processor | adafruit | 3775 | Raspberry Pi 3 Model B 2019 Quad Core 64 Bit WiFi Bluetooth | digikey |
| 1 | Stand Base | Jensorter | - | Large cut sheet of 1 inch thick ABS | - |
| 1 | Stand Backboard | Jensorter | - | Large cut sheet of 1 inch thick ABS | - |
| 2 | Stand Legs | Jensorter | - | Large cut sheet of 1 inch thick ABS | - |
| 2 | Stand Slide Mounts | Jensorter | - | Small cut portion of 1 inch thick ABS | - |
| 3 | Stand Slide Piece | Jensorter | - | Small cut portion of 1/4 inch thick ABS | - |
| 1 | Stand Wheel | Jensorter | - | Large cut disk of 1/4 inch thick ABS | - |
| 1 | Wheel Knut | Hillman | 810515 | 5/8 inch reverse threaded machine nut to secure the wheel | Lowes |
| 2 | Wheel Washer | Hillman | 830582 | 1/4 inch washer to support the wheel in motion | Lowes |
| 10 | Tester Beads | NITOPUPU | - | Beads used to simulate fish eggs | Amazon |
| 4 | Motor Spacer long | Hillman | 880416 | 1 inch spacers placed on the motor's screw shafts | Lowes |
| 12 | Motor Spacer short | Hillman | 35010 | 1 cm spacers placed on the motor's screw shafts | Lowes |
| 6 | Stand Screw Mounts | BC Precision | SNG1004 | Wedge screw mounts | Amazon |
| 6 | Stand Screws | Hillman | 35160 | 1/4 inch hex head screws | Lowes |
| 2 | Buttons | mxuteuk | 31160000 | Waterproof Button with LEDs | Amazon |
| 2 | Switches | Qidoe | - | Waterproof Rocker Switch with LEDs | Amazon |
| 1 | Pi Box | Fielect | LT20190902H-006 | Waterproof metal enclosure for Pi | Amazon |
| 1 | Button Box | LeMotech | | Waterprrof plastic box to house the Buttons and Switches | Amazon |
| 1 | LCD Box | LeMotech | 43237-2 | Transparent Cover Waterproof ABS Plastic Junction for display | Amazon |
| 1 | Camera box | PSU EPL | - | 3D printed camera mount | PSU EPL |
| 1 | Camera Arm | Pipishell | PIWS02 | Flexible gooseneck jaw clamp camera stand | Amazon |
| 1 | Camera Arm Cover | NUTTY TOYS | - | Makeshift Plastic covering to waterproof camera wires along camera arm | Amazon |

Bill Of Materials for: [TEAM 6] [TEAM R.O.E]
Last modified: [2/14/2022]
PCB version: [PCB VERSION #1]
BOM revision: [BOM REVISION #0]

| Cnt | Part References | Mfg | Mfg PN | Description | Dist |
|---|---|---|---|---|---|
| 2 | DC Adjustable Buck Converters | EBOOT | MP1584EN | DC-DC Adjustable Buck Converter with max input 24V to min output 0.8V | Amazon |
| 1 | Power USB | Starlander | 26121600 | Male USB Micro power cable | Amazon |
| 1 | Battery Terminal | Crtbelfy | - | Port for the 18V battery | Amazon |
| 1 | Sensor Arm | Charlotte Pipe | PVC 04007 0600 | 3/4 inch PCB pipe used to waterproof and hold the IR sensor | Lowes |
| 2 | Sensor Arm Joints | Dura Plastics | L406-007 | 3/4 inch PCB pipe elbow joint | Lowes |
| 1 | Pi Camera | adafruit | 3099 | Raspberry Pi Camera Board v2 - 8 Megapixels | adafruit |
| 1 | IR Sensor | Esooho | 0 | IR Infrared Sensor Module | Amazon |
| 1 | Thumb Drive | SanDisk | SDCZ36-016G-B35 | USB-A External Hard Drive for photo collection | Amazon |
| 1 | Wood Circuit Mount | ReliaBilt | 84259 | Wooden board | Lowes |
| 1 | Heatsink | LoveRPi | LYSB018BGRDVS | Heatsinks for Pi processors | Amazon |
| 1 | Dome Cap Cable Gland | ElecDirect | - | Waterproof cable holders | PSU EPL |

**VERSION INFO**

| Rev | Date |
|---|---|

| Dist Part Number | Order Link | Cost Ea. | Cost Total | Notes |
|---|---|---|---|---|
| B07D83DY17 | https://www.amazon.com/ | $9.99 | $9.99 | |
| - | https://www.amazon.com/ | $0.00 | $0.00 | Paired with LCD |
| G900461373 | https://www.zoro.com/mo | $66.91 | $66.91 | https://www.molon.com/dc-motors-gearmotors/pm-parallel-shaft-gearmotors/chm-dc-detail |
| B07DNBCSD9 | https://www.amazon.com/ | $17.99 | $17.99 | |
| 1528-3775-ND | https://www.digikey.com/e | $35.00 | $35.00 | https://www.adafruit.com/product/3775 |
| - | - | $0.00 | $0.00 | created in house |
| - | - | $0.00 | $0.00 | created in house |
| - | - | $0.00 | $0.00 | created in house |
| - | - | $0.00 | $0.00 | created in house |
| - | - | $0.00 | $0.00 | created in house |
| - | - | $0.00 | $0.00 | created in house |
| 67419 | https://www.lowes.com/pd | $0.64 | $0.64 | |
| 817716 | https://www.lowes.com/pd | $1.18 | $1.18 | |
| B09FKXNBRQ | https://www.amazon.com/ | $9.99 | $9.99 | Given by |
| 137118 | https://www.lowes.com/pd | $1.20 | $4.80 | |
| 67847 | https://www.lowes.com/pd | $5.98 | $5.98 | |
| B089PT9SZH | https://www.amazon.com/ | $7.90 | $7.90 | |
| 63764 | https://www.lowes.com/pd | $6.98 | $6.98 | |
| B083VWY28M | https://www.amazon.com/ | $12.99 | $12.99 | |
| B08T1XT4YP | https://www.amazon.com/ | $9.49 | $9.49 | |
| B07ZM21DW3 | https://www.amazon.com/ | $26.99 | $26.99 | |
| B07W6SJGJM | https://www.amazon.com/ | $8.59 | $8.59 | |
| B07C97HXX8 | https://www.amazon.com/ | $9.99 | $9.99 | |
| - | https://www.thingiverse.cc | $0.00 | $0.00 | Free print from |
| B07ZH78VDM | https://www.amazon.com/ | $16.99 | $16.99 | |
| B09HNF6VSF | https://www.amazon.com/ | $5.97 | $5.97 | |

| Dist Part Number | Order Link | Cost Ea. | Cost Total | Notes |
|---|---|---|---|---|
| B01MQGMOKI | https://www.amazon.com/ | $16.99 | $16.99 | |
| B09DKYPCXK | https://www.amazon.com/ | $9.99 | $9.99 | |
| B09782DQQK | https://www.amazon.com/ | $14.98 | $14.98 | |
| 23971 | https://www.lowes.com/pd | $6.98 | $6.98 | |
| 23868 | https://www.lowes.com/pd | $0.71 | $1.42 | |
| 3099 | https://www.adafruit.com/ | $29.95 | $29.95 | |
| B07FJLMLVZ | https://www.amazon.com/ | $9.88 | $9.88 | |
| B001XURP8G | https://www.amazon.com/ | $9.99 | $9.99 | |
| 50246 | https://www.lowes.com/pd | $1.52 | $1.52 | |
| B018BGRDVS | https://www.amazon.com/ | $4.49 | $4.49 | |
| | | $0.00 | $0.00 | Gift from EPL |
| | | **TOTAL:** | **$307.31** | |

# C Appendix: Testing

## Fish Egg Counter Test Plan 1 (Basic Operations):

**Items Tested:**

- Power System
- Wheel
- Camera
- Buttons
- Motor
- Raspberry Pi
- LCD Display

**Test Objectives:**

- ○ Functionality
- ○ Integration
- ○ Acceptance

**Necessary Testing Resources:**

- Beads (fish eggs replacement)
- 18V battery
- External Hard Drive (USB-A)

**Test Cases:**

- ○ Power Test
- ○ Camera Test
- ○ Button/Display Test
- ○ Motor Integration Test
- ○ Camera Integration Test
- ○ Full Basic Integration Test

## <u>Fish Egg Counter Test Plan 2 (In Depth Testing):</u>

**Items Tested:**

- Power System
- Wheel
- Camera
- Buttons
- Water System
- Motor
- Raspberry Pi
- LCD Display
- Stand
- Counter Code

**Test Objectives:**

- Functionality
- Integration
- Environmental
- Acceptance
- Use

**Necessary Testing Resources:**

- Beads (fish eggs replacement)
- 18V battery
- Active water hose
- External Hard Drive (USB-A)
- Computer

**Test Cases:**

- Power Test
- Camera Test
- Button/Display Test
- Counter Test
- Full Integration Test
- Motor Integration Test
- Camera Integration Test
- Full Basic Integration Test
- Water System Test
- Wet Environment Test

| | | | | | | |
|---|---|---|---|---|---|---|
| **Test Author:** Team 6 | | | | | | |
| | **Test Case Name:** | Power Test | **Test ID #:** | #001 | | |
| | **Description:** | Supply correct voltage from battery to motor | **Type:** | □ white box<br>□ black box<br>□ _________ | | |
| **Tester Information** | | | | | | |
| | **Name of Tester:** | | **Date:** | | | |
| | **HW/SW Version:** | Version 1.0 | **Time:** | | | |
| | **Setup:** | Assemble the circuit connecting the battery slot to the voltage amplifier, then to the motor. | | | | |

| **STEP** | **Action** | **Expected Result** | **PASS** | **FAIL** | **N/A** | **Comments** |
|---|---|---|---|---|---|---|
| 1 | Ensure the circuit is securely assembled. | The wires will not have breaks nor be exposed outside of their connections at the terminals. | | | | |
| 2 | Check the battery, battery slot, and motor for damage | These components should be free from cracks, water, and excess debris. | | | | |
| 3 | Place battery into the battery slot | The battery should activate the motor automatically | | | | |
| 4 | Observe motor speed | The motor should be rotating at a constant speed | | | | |
| 5 | Unplug the battery | The motor should stop | | | | |
| 6 | Adjust the motor speed using the small screw jetting from its side. | The screw should turn with constant resistance, and should drastically change the motor's speed on any rotational change. | | | | |
| 7 | Repeat steps 3 through 6 until satisfied with motor speed | You can move to step 8 once the wheel speed is to a preferable speed. | | | | |
| 8 | Remove battery | The device should be safe to be moved. | | | | |
| | **Overall test result:** | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Test Author:** Team 6 | | | | | | | |
| | **Test Case Name:** | Full Basic Integration Test | | | | **Test ID #:** | #002 |
| | **Description:** | Test that the counter delivers expected and acceptable results when its separate component systems are integrated together. | | | | **Type:** | ☐ white box<br>☐ black box<br>☐ _________ |
| **Tester Information** | | | | | | | |
| | **Name of Tester:** | | | | | **Date:** | |
| | **HW/SW Version:** | Version 1.0 | | | | **Time:** | |
| | **Setup:** | Combine the Power system circuit, the motor, Raspberry Pi, LCD, buttons, and camera. Then mount the Wheel onto the motor. | | | | | |
| **STEP** | **Action** | **Expected Result** | **PASS** | **FAIL** | **N/A** | **Comments** | |
| 1 | Check circuit for irregularities. | The circuit should be firmly connected without any breaks. All components should be connected together as well. | | | | | |
| 2 | Place the fish eggs into the slots on the wheel. | The eggs should be unobscured once inserted to the wheel. The suggested method to secure them into the holes is with tape. | | | | | |
| 3 | Insert USB external hard drive into the USB-A Port on the Raspberry Pi | | | | | | |
| 4 | Insert the battery into the Battery Slot | The Counter Should activate, indicated by the LCD lighting up. Full boot up takes 26 seconds | | | | | |
| 5 | Use the buttons and LCD screen to set the batch amount | | | | | | |
| 6 | Activate the Counting process. | While the motor turns, the device will count the fish eggs it observes | | | | | |
| 7 | Wait for the Counter to stop. | The final count for the batch will be displayed on the screen. | | | | | |
| 8 | Deactivate the device | Stop the counter operation by switching to set up mode and unplugging the battery | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9 | Remove the harddrive | | | | | | |
| 10 | Connect the external harddrive to a computer | The pictures should be viewable within a folder. | | | | | |
| | **Overall test result:** | | | | | | |