Design of a System to Detect Diseased Spots on Fishes

By

Rakesh Sarker

17221016

Zainab Gulshanra

19321047

Abrar Zahin

17221002

Emon Chowdhury

19321033

A Final Year Design Project (FYDP) submitted to the Department of EEE in partial fulfilment of the requirements for the degree of Bachelor of Science

Electrical and Electronics Engineering

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Abrar Zahin

17221002

Emon Chowdhury

19321033

Academic Technical Committee (ATC) Panel Member:

Dr. Mohammed Belal Hossain Bhuian

Associate Professor,Department of EEE, Brac University

Abdullah Hil Kafi

Lecturer,Department of EEE, Brac University

Md. Mahmudul Islam

Lecturer,Department of EEE, Brac University

Electrical and Electronics Engineering

Brac University

September 2023

Declaration

It is hereby declared that

1. The Final Year Design Project (FYDP) submitted is my/our own original work while completing degree at Brac University.
2. The Final Year Design Project (FYDP) does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The Final Year Design Project (FYDP) does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I/We have acknowledged all main sources of help.

Student's Full Name & Signature:

Zainab Gulshanara	Rakesh Sarker
[Student Full Name]	**[Student Full Name]**
19321047	17221016
Emon Chowdhury	Abrar Zahin
[Student Full Name]	**[Student Full Name]**
193201033	17221002

Approval

The Final Year Design Project (FYDP) titled "[Design of a system to detect diseased spots]" submitted by

1. Zainab Gulshanara(19321047)]
2. Rakesh Sarker (17221016)
3. Abrar Zahin (17221002)
4. Emon Chowdhury (19321033)

of Fall, 2023 has been accepted as satisfactory in partial fulfilment of the requirement for the degree of Bachelor of science on 14.12.2023.

Examining Committee:

Academic Technical Committee (ATC): (Chair)

____
Dr. Mohammed Belal Hossain Bhuian
Associate Professor
Department of EEE Brac University

Final Year Design Project Coordination Committee: (Chair)

____
Dr. Abu S.M. Mohsin
Associate Professor
Department of EEE BRACUniversity

Department Chair:

____
Dr. MD.Mosaddequr Rahman
Professor and Chairperson
Department of EEE BRACUniversity

Ethics Statement

We hereby attest and verify that the Final Year Design Project titled "Design of A System To Detect Diseased Spots On Fishes" has successfully met all specified requirements. The project was executed collaboratively by the group members, and comprehensive research from various sources, including research papers, journals, and articles, was utilised. The literature review encapsulates a synthesis of this research, with proper citations.In summary, we confirm that the entire project report has a similarity index of 9%.

Abstract

Implementing a monitoring framework to specifically target and track diseased spots within the context of indoor fish farming or biofloc systems presents a highly valuable strategy. This specialised system, finely tuned for disease detection, holds the capability to swiftly and accurately pinpoint affected areas. Such precision facilitates the timely implementation of isolation protocols or treatment measures, thereby significantly mitigating the risk of disease propagation. The literature aims to discuss the design methodologies, the usage of engineering tools, cost benefit analysis and sustainability concerns while implementing the monitoring framework. Furthermore, the integration of stakeholders into this intricately designed monitoring process serves to amplify collaborative efforts. By actively involving farmers, researchers, and health authorities, a synergistic approach emerges, fostering not only heightened awareness but also expediting response mechanisms. This inclusive engagement not only bolsters the overall resilience of the facility but also serves as a proactive measure in curbing the potential dissemination of diseases, thereby upholding the integrity and sustainability of indoor fish farming or biofloc systems.

Keywords: Monitoring Framework; Disease Propagation; Timely Implementation; Synergistic Approach

Acknowledgement

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Chapter 1: Introduction

1.1 Introduction

Poor systematic management has resulted in a significant increase in disease prevalence within the fish culture system in Bangladesh, posing a critical challenge. Freshwater fish species in Bangladesh exhibit diverse symptoms, including gill rot, tail and fin rot, dropsy, red spot, EUS, white spot disease, and nutritional deficiencies [2]. These ailments manifest visibly distressing signs in fishes, such as haemorrhaging of fins, inflammation, frayed fins, necrotic and ulcerative lesions across their bodies, haemorrhaged opaque eyes, and excessive scale and mucus production [2].

Recent observations highlight substantial health hurdles faced by mono-sex Nile tilapia farming in the Jessore region, posing a threat to their successful cultivation. Stakeholders, notably the dean of fisheries at the Agricultural University of Bangladesh, emphasize the significant economic contribution of the fish industry annually while acknowledging the health challenges encountered by mono-sex Nile tilapia farmers [2].

An autonomous monitoring system emerges as a promising solution to alleviate the burdens faced by fish farmers. Its implementation could significantly reduce the workload on farmers while ensuring the health and well-being of their fish stocks. Automating the tracking and identification of fish spots could revolutionize fish farming practices, offering an efficient means of overseeing a large population of fishes [2]. Given the substantial volume of fish in these farms, manual monitoring becomes increasingly challenging, consuming valuable manpower and time. Automating this process not only saves crucial man-hours but also promises more effective disease management and surveillance, thus safeguarding the industry's sustainability and productivity.

1.1.1 Problem Statement

Bangladesh stands as an agriculturally intensive country, with a substantial portion of its economy reliant on this sector. Approximately 3.69% of the nation's total Gross Domestic Product (GDP) is derived from agriculture, and notably, 22.60% of the agricultural GDP is attributed to aquaculture [1]. However, the consolidation and expansion of aquaculture face persistent challenges, primarily concerning disease outbreaks. Within the domain of shrimp production, for instance, an alarming estimate indicates that about 40% of global production is lost annually due to disease-related issues [2].

In the context of aquaculture methodologies like Biofloc, the assessment of fish health remains a manual task, heavily reliant on skilled observation of fish behavior, resulting in an inefficient process [3]. Addressing this challenge necessitates innovative solutions, and among the proposed strategies, the development of an autonomous robot emerges as a promising prospect. Such a robot could revolutionize the monitoring and assessment of fish health, transcending the limitations of manual observation [3].

The envisioned autonomous robot is envisioned to function as a sophisticated monitoring system capable of continuously observing and evaluating the health parameters of fishes within aquaculture setups. This technological innovation is proposed to relay real-time data to users, facilitating prompt and informed decision-making in the event of any abnormalities detected in fish behavior or health conditions. By providing timely alerts, this system aims to prevent substantial stock losses that might occur due to undetected health issues [3].

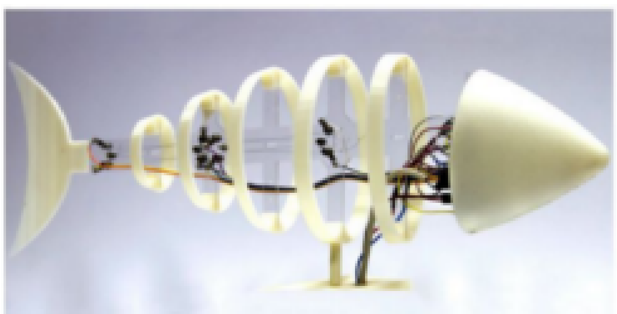
This proposed technological intervention seeks to bridge the gap between traditional manual assessment methods and the imperative need for timely, accurate, and proactive measures to safeguard aquaculture stocks from diseases and potential losses.

1.1.2 Background Study

Several research endeavours have delved into diverse image processing techniques for applications ranging from fish disease identification to hardware trojan detection, employing innovative methodologies to enhance accuracy and reliability in their respective domains.Malik et al. (2017) [3] introduced an image-based fish disease detection technique that utilized segmentation techniques (Canny, Prewitt, Sobel) for edge detection. Their approach amalgamated Histogram of Gradient (HOG) and Features from Accelerated Segment Test (FAST) for feature extraction and classification. The emphasis was on improving classification accuracy by avoiding sole reliance on a single method.Lyubchenko et al. (2016) [4] focused on clustering objects in fish disease identification images through segmentation actions based on clusters. Their method involved using markers for individual objects and calculating proportions of object area and infected area on fish bodies. However, the approach was criticized for being time-consuming and inefficient due to the requirement for individual marking.Malik et al. (2017) - Epizootic Ulcerative Syndrome (EUS) detection [5] specifically targeted a fungal pathogen-induced fish disease. Their approach combined Principal Component Analysis (PCA), Histogram of Oriented Gradients (HOG), and Features from Accelerated Segment Test (FAST), employing a neural network for classification. Varying combinations of techniques yielded differing accuracy rates. [4] Verma et al. (2017) - Kidney stone detection [5] utilised morphological operations and segmentation to identify regions of interest (ROI) for Support Vector Machine (SVM) classification. Challenges encountered included the similarity between kidney stones and low image resolution. Zhou et al. (2017) - Device-free presence detection [6] introduced SVM-based detection of human presence using channel state information (CSI) fingerprints. The SVM classifier played a pivotal role in detecting human presence without the necessity for dedicated hardware. Trojans in hardware detection (Inoue et al., 2017) [7] employed SVM for detecting hardware trojans. Their evaluation encompassed netlists containing various types of hardware trojans, examining normal and abnormal behaviour patterns. These research endeavours encompass an array of image-based applications, employing a fusion of image processing and machine learning techniques to achieve accurate and reliable outcomes in their respective domains. In another stride towards advanced aquaculture monitoring, a team of students from North South University devised an IoT-based Fish monitoring system. This system enabled the monitoring and measurement of vital parameters such as temperature, pH levels, oxygen supply, and dissolved ammonia levels. The acquired data was efficiently relayed to users via an application.

IoT based monitoring system

Moreover, a collaborative effort between researchers from the Technical University of Madrid and the University of Florence resulted in the development of a robot fish capable of testing water pH levels. Notably, this robot mimics the movement patterns of real fish and responds dynamically when encountering highly acidic areas, altering its swimming patterns and providing notifications to pinpoint areas with unfavourable pH levels .



Robot fish which mimics fish movement

Fish Detection in Underwater Environments Using Haar-like Features

A significant contribution by George C., documented in an IEEE publication [13], centered on automated fish detection based on Haar-like features derived from underwater images obtained via a Remotely Operated Vehicle (ROV). The analysis involved diverse imaging conditions due to the dynamic imaging platform and varied environmental backgrounds. This research introduced a novel dataset, "labelled fishes in the wild," encompassing annotated training and validation image sets alongside an independent test video image sequence. Multiple Haar cascades were developed from the training set and evaluated on the validation and test video images. Performance evaluation demonstrated true positive detection rates ranging from 63% to 89% for seven classifiers. These diverse initiatives underscore the continual exploration and refinement of image processing techniques, contributing to advancements in diverse fields ranging from aquaculture monitoring to underwater fish detection [8]

1.1.3 Literature Gap

The current literature surrounding underwater fish monitoring reveals a significant gap in the comprehensive tracking of spots or lesions on fishes in real-time aquatic environments. [9] While advancements have been made in underwater imaging and surveillance, there remains a lack of robust methodologies specifically designed to track and monitor the health conditions of fishes by identifying and analyzing spots or lesions on their bodies.

Traditionally, direct visual observation or manual inspection of fishes underwater has been the primary approach for assessing their health. However, this method is limited in its scope and efficiency. It heavily relies on human observers' abilities to identify and track potential disease indicators or abnormalities, which can be challenging, time-consuming, and prone to errors. Moreover, this approach is hindered by factors such as water turbidity, varying lighting conditions, and the inherent limitations of human vision underwater.

The integration of cameras and image processing technologies offers a promising avenue to bridge this literature gap. By leveraging advancements in underwater imaging systems and employing sophisticated image processing algorithms, it becomes feasible to track, detect, and analyze spots or lesions on fish bodies in real time. These technologies can enable automated monitoring of fish health by continuously scanning and analyzing live footage captured by underwater cameras. The implementation of image processing techniques, such as segmentation algorithms, pattern recognition, and machine learning, can facilitate the identification and tracking of specific features or abnormalities on fish bodies. By detecting and analyzing spots or lesions, these systems could potentially alert users or aquaculture practitioners to health issues or disease outbreaks promptly. Additionally, the captured data can be processed to provide comprehensive insights into the prevalence, spread, and severity of diseases within aquatic populations.

This advancement would not only streamline the monitoring process but also provide users with enhanced accessibility to real-time fish health data. It would empower aquaculture managers, researchers, and conservationists with a more efficient and accurate means of remotely monitoring and managing fish populations. Moreover, by enabling early detection and intervention, these systems have the potential to significantly reduce losses due to diseases and contribute to the overall health and sustainability of aquatic ecosystems.The development of robust image processing methodologies tailored for underwater fish monitoring, specifically focusing on tracking spots or lesions, represents an untapped area within the literature. By filling this gap, researchers and practitioners can create innovative tools that revolutionize underwater monitoring, offering a comprehensive, efficient, and non-invasive approach to assess fish health and well-being in aquatic environments.

1.1.4 Relevance to current and future Industry

The current landscape of image processing techniques applied in diverse industries holds significant implications for the present and future of various sectors, particularly in aquaculture, healthcare, and technological advancements.

Aquaculture Industry:

In aquaculture, the application of image processing techniques for fish disease identification and monitoring plays a pivotal role in enhancing productivity and mitigating losses. The utilization of sophisticated algorithms and machine learning models for disease detection not only aids in early diagnosis but also enables prompt intervention, thereby safeguarding fish stocks and ensuring sustainable aquaculture practices. The ongoing development of IoT-based monitoring systems and autonomous robots equipped with image-based health assessment capabilities showcases a promising trajectory for the industry. Future advancements are anticipated to focus on enhancing the accuracy, speed, and scalability of these systems, potentially revolutionizing aquaculture practices worldwide. [12]

Healthcare and Medical Imaging:

Beyond aquaculture, image processing techniques are pivotal in healthcare, especially in medical imaging. These technologies are employed in various diagnostic tools such as X-rays, MRIs, CT scans, and ultrasound imaging. Advancements in image processing facilitate enhanced accuracy in disease diagnosis, surgical planning, and treatment monitoring. The evolution of machine learning and AI-based algorithms continues to augment the capabilities of medical imaging, potentially leading to more precise and personalized healthcare interventions. Future advancements are anticipated to revolve around the integration of these techniques into telemedicine, wearable health devices, and AI-driven diagnostic tools, enabling remote patient monitoring and personalized medicine on a broader scale.

Technological Advancements and Robotics:

In the realm of technological innovations, image processing techniques are instrumental in the development of autonomous systems, robotics, and artificial intelligence. The fusion of image-based detection methods with robotics has led to the creation of robots mimicking natural behaviors and abilities, such as the fish-shaped robot capable of monitoring water quality. Such innovations hold immense promise in various industries, including environmental monitoring, surveillance, and search-and-rescue operations. The future of these advancements is poised to focus on further integration with IoT, AI-driven decision-making, and the development of more sophisticated autonomous systems capable of real-time adaptive responses.

The relevance of image processing techniques to current and future industries is profound, with implications extending across multiple sectors. The continued advancements in these technologies are anticipated to drive innovation, efficiency, and precision across diverse applications. Future developments will likely focus on enhancing the scalability, accuracy, and real-time capabilities of these techniques, thereby reshaping industries, optimizing processes, and paving the way for a more technologically driven and sustainable future.

The continual refinement and integration of image processing methodologies into various industries signify an exciting frontier, promising transformative changes in how we perceive, analyze, and utilize visual data across different sectors.

1.2 Objectives, Requirements, Specification and constant

Objectives

● Build a system to monitor the health of fishes by keeping track of the spot or tumors on their bodies using image processing

●Build a system which will constantly aid in surveil fishes using a live action camera.

Scope

● The project is limited to monitoring abnormal spot or lesions on fish bodies and their pace or agility

● The project will monitor the all species of fishes

● The focus of this project is primarily to target only the fish farming industry of Bangladesh.

1.2.2 Functional and Nonfunctional Requirements

Functional Requirements

1. Abnormal spots and lesions detection in fishes

2. Create a food dispenser to help gather fishes in one distinctive place

3. Create a mobility feature for the system to better move around the water

4. Create proper insulation for the camera since it is placed underwater

5. A remote controller should be able to guide the system to move.

Non-functional Requirements

1. Testing the system and collecting feedbacks from farmers

2. Keeping emergency battery backup

3. Maintenance of the system so that it can operate effectively

1.2.2 Specifications

1. The system will be able to zoom and enlarge images. The system's optical zoom will allow it to enlarge the images of spots over fishes without deteriorating the original quality. Thus it will allow users to identify any spots relating to disease easily.
2. A food dispenser unit is designed to attract fish toward the system while monitoring sessions. The entrance of the gateway is crafted using a servo motor controlled gateway.

System Level Specifications

Subsystem	Specs
Power Subsystem	2200mAh, 7.4V~22.2V, Rechargeable
Data Processing Subsystem	1.5 GHz quad-core Cortex-A72 (For 4GB RAM), 64-bit processor, Broadcom BCM2711, 209~525 FPS
User Interface Subsystem	6 Channels,2.4GHz~2.480GHz Frequency, Working Current 120m, 4.8V~6.0V
Mechanical Subsystem	ESCs - 30A(Constant Current), Input Voltage- 11.1V 12V~24V, Current - 20A, Power - 20W~200W 3.0V~7.2V, Stall Torque 4.8V~6.6V
Communication Subsystem	500 MB file size, Average Data Transfer Rate = 1.67 MB/second

Component Level Specification

Component	**Specs**
Battery	**Lipo Battery 2200maH/11.1V**
Camera	Videos: 4K/30fps, 2.7K/30fps, 1080P/60fps Photos: 16MP, 12MP, 8MP, 5MP, 2MP Waterproof: Up to 98 ft with SJCAM Waterproof Case Time-Lapse, Car Mode, Webcam, etc. 170 Degree Wide Angle Lens
BLDC motors[Thrusters]	Voltage:12~24V Current:20A Motor KV: 1000KV Power:30~200W 1piece CW, 1piece Anticlockwise

Raspberry Pi	Processor: Broadcom BCM2711, quad-core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz Memory: 1GB, 2GB, 4GB or 8GB LPDDR4-3200 SDRAM (depending on model) Wireless LAN: 2.4 GHz and 5.0 GHz IEEE 802.11ac, Bluetooth 5.0, BLE USB: 2 USB 3.0 ports, 2 USB 2.0 ports
Power Bank	Voltage~5V,Current~1A,12000Mah, 2USB-C Ports
Servo Motor	Operating Voltage:3V~7V,Stall Torque@4.8V: 1.2kg-cm
ESC	Voltage:5V,Current:3A,Input Voltage:11.1V~17.1V
Remote Controller	Channels: 6, Range: 5~10 feet

1.2.3 Technical and Non-technical consideration and constraint in design process

1. **Inspection duration**- Inspecting and monitoring a huge fish tank will require a longer period of time compared to smaller fish tanks.Therefore the time taken for completing one full cycle for observation will not be identical.

2. **Small sets of error while collecting data**- Data needs to be collected by the system throughout its surveillance.Hence there might be chances of misjudgment while collecting data during its 24 hrs supervision.

3. **Muddy water conditions**- In this sort of water conditions fishes will become less visible to the system due to lower levels of natural illumination caused by rapid attenuation of light with distance passed through water making it blurred between the fishes and the system.Hence making it difficult to detect and monitor fishes**.**

1.2.4 Applicable compliance, standards, and codes

IEEE Std 1872-2015, IEEE Standard for Ontologies for Robotics and Automation

It provides guidelines and frameworks for developing ontologies specifically tailored for robotics and automation systems. Adherence to this standard ensures a standardized method for organizing and representing knowledge, enhancing interoperability, and facilitating communication among different components within the sub systems.

IEEE 1680.2-2012, IEEE Standard for Environmental Assessment of Imaging Equipment

This outlines criteria and benchmarks for evaluating the environmental performance of imaging devices, promoting sustainable and eco-friendly practices in this technological domain. Introducing a robotic system on the water could disrupt the flora and fauna of the water based ecosystem.

1.3 Summary of the proposed project

The project aims to revolutionize fish health monitoring through an integrated system leveraging cameras, and advanced image processing algorithms. It incorporates a multifaceted approach, an image recognition system for identifying abnormal spots on fish, and a communication module for relaying critical data to users.

A camera system captures fish footage, undergoes image restoration algorithms to enhance clarity, and employs image recognition techniques to detect potential health issues like abnormal spots or lesions on the fish.

The system communicates critical information to users via a display, presenting data on water parameters, fish health indicators, and other relevant metrics, empowering users to make informed decisions for timely intervention.

1.4 Conclusion

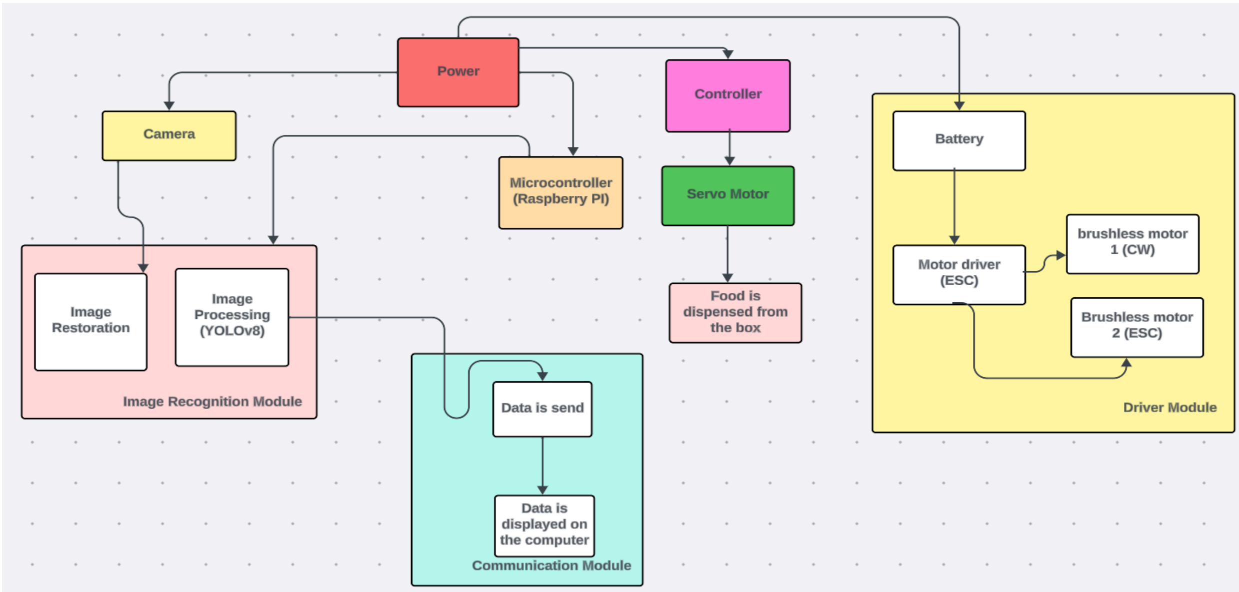
In conclusion, the fish spot monitoring system represents a significant advancement in aquaculture technology. It amalgamates cutting-edge technologies, imaging systems, and intelligent algorithms to enable comprehensive and real-time assessment of fish health and water quality.

By providing instantaneous data on crucial parameters and potential health concerns, this system enhances the ability to preemptively address fish health issues. Its user-friendly interface empowers operators to take proactive measures, ensuring the well-being of aquatic life while promoting efficient aquaculture practices. The project stands as a testament to the potential of integrating technology to improve fish health monitoring, offering a practical and effective solution for sustainable aquaculture management while ensuring environmental conservation and economic viability in the fishery industry.

Chapter 2: Project Design Approach

2.1 Describe multiple design approach

- **Floating Robot Approach**



- **Driver Module**

  The Driver Module functions as the locomotion component of our system, facilitating its movement across water surfaces. It comprises a Lipo rechargeable battery connected to the Electronic Speed Controller (ESC), which governs the speed of the paired 2 BLDC motors. The motors operate in opposing directions, one rotating clockwise and the other counterclockwise, ensuring balanced propulsion.

  Control over the motion is established through a controller linked to a Bluetooth module, enabling seamless and remote management of the system's navigation. This integration allows precise control and maneuverability, empowering users to guide the system effortlessly from one location to another on the water.

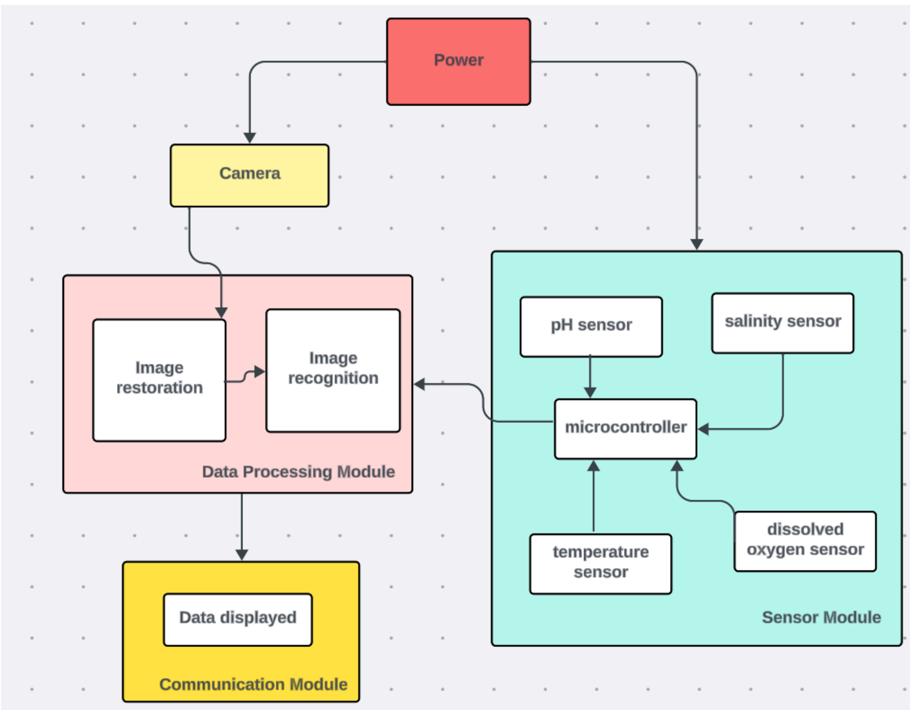
- **Image Recognition Module**

  The captured videos from the camera are transmitted to the Raspberry Pi operating system. Here, the footage undergoes through the YOLOv8 algorithm to detect and identify any unhealthy spots present on the fish. Subsequently, these identified issues are displayed to the user in real-time on a monitor for immediate observation and action.

  YOLOv8, or You Only Look Once version 8, is an advanced object detection algorithm. It swiftly detects objects within images or videos in a single pass through the neural network. It divides images into grid cells, predicting bounding boxes and class probabilities for objects in each cell. Utilizing a Feature Pyramid Network, it captures object features at various scales for accurate detection. With its efficient architecture, YOLOv8 strikes a balance between speed and accuracy, making it ideal for real-time object detection tasks.

- **Food Distribution**
  Food is dispensed on the water body so that the fishes can gather in one particular spot and make it easier for our system to collect fish footage easily.
- **Communication Module**
  The data is displayed to the user via a monitor, enabling the user to take immediate action if the system detects any abnormal lesions on fish bodies.

- **Smart Tank Approach**



This approach deals with a stationary tank which has inbuilt sensors and image recognition module with a camera attached for surveillance. The tank will have space for attached displays to let users know the levels of the parameters which are required to be measured.

1. Sensor module

This approach will have 4 sensors (Ph sensors, salinity sensors, temperature sensors, and dissolved oxygen sensors connected to the tank to measure pH levels, temperature levels, dissolved oxygen levels and salt levels of the water.)

2. Data Processing module

The camera embedded will take pictures periodically and go through image restoration algorithms since the turbid water and loose particles cause scattering of light. After the image has been enhanced, image recognition algorithms will be employed. This will record and learn to recognize any abnormal spots or tumours on the skin of fishes. Furthermore, after the images have been restored, they will also be used to measure the agility of fishes.

3. Communication module

The user will be informed of the parameters of the fish and water via a display on the tank. The levels of salt, pH, dissolved oxygen, temperature, speed of fish and any possible lesions will be shown on the display.

2.2Analysis of multiple design approach

Factors	**Floating Based Design Approach**	**Smart Tank Approach**
Cost	Comparatively less expensive due to the lack of sensor subsystem	More expensive due to the additional sensor subsystem
Efficiency	Due to the system being mobile and the presence of the food dispenser, the system is more efficient in taking videos of fishes and carrying out image processing.	This system does not have the means to be mobile, so not efficient for image processing tasks
Usability	Requires a controller to control the motion of the system; thus could require additional practice for getting used to the system	The sensor readings will be displayed and the user does not have to go prior training to operate the system.
Manufacturability	Simplified production process, facilitating faster assembly and reduced manufacturing costs.	Integration of sensors contributes to heightened manufacturing complexity, resulting in increased expenses and extended production times.
Impact	The impact relies on the operator's judgement and proficiency. Adequately trained operators can minimize undesired outcomes.	The impact is contingent upon the efficiency of algorithms and sensors. By appropriately optimising, environmental impact can be mitigated.
Sustainability	Reduced environmental impact during operations allows human operators to make real-time decisions, safeguarding sensitive areas.	While there is a prospect for sustainable operation, it's essential to consider the ongoing energy consumption during operations.
Maintainability	Easier to maintain since the system can be taken apart easily, making it easier to troubleshoot any errors.	Harder to maintain since the system is built-in and cannot be taken apart easily.

2.3 Conclusion

The floating based design is the most efficient, cost friendly and sustainable approach in regards to detecting lesions on fish bodies.

Chapter 3: Use of Modern Engineering and IT Tool

3.1 Introduction

Different IT tools were used to get the results we want from simulations to check how well our system works.There were many tools online and after extensive research and comparisons of various alternatives we picked the best ones. But, before using a tool, it's important to learn about it and make sure it's accurate. We spent time looking into different tools and chose the best combination of computer hardware and software that suits our needs.

3.2 Select appropriate engineering and IT tools

Tools	Description	Applications
Proteus	Proteus is a software tool widely used in engineering for virtual prototyping and simulation of electronic circuits.	Creating circuits,simulating their behaviour and testing them.
Fusion 360	A versatile cloud based software by Autodesk that integrates design, simulation and manufacturing processes in one platform.	For designing the 3D model of our system.
Google Colab	A free cloud-based platform provided by Google that allows users to write and execute Python code collaboratively.	Provides free access to GPU making it an attractive choice for machine learning tasks.
YOLO V8	Latest Version of YOLO algorithm for object detection	Used for real time object detection from images and videos
Python Libraries	A Python library is a collection of modules and functions that enable us to perform specific tasks without having to write the code for those tasks from scratch	For mathematical operations,machine learning, data manipulation etc
Raspberry Pi 4B	A single-board computer having all the components needed for fully functional computer including processor, memory,chipset etc	Used for running all the algorithms of our project.

ESC	Used as a contraction for electronic speed controller	Changes the amount of power to the electric motorform from the battery
BLDC Motors	Brushless DC motors that operates without brushes	Utilised for our system's mobility
Lipo Battery(2200maH)	A rechargeable battery of lithium-ion technology	For providing sufficient energy inorder to make the system operational
Transmitter and Receiver(2.4GHz)	A device that sends data wirelessly and receives that transmitted data through antenna	For manoeuvring our system

Table 1:List of Engineering IT Tools

3.3 Use of modern engineering and IT tools

<u>Hardware Part:</u>

Raspberry Pi 4B: A single-board computer having all the components needed for a fully functional computer including processor, memory,chipset etc. The algorithms were uploaded and were run later for detection of the diseased spots over fishes.

ESC: A crucial component in the control system of our system. It is responsible for regulating the speed of the electric motor.ESCs regulate the power supplied to the motor. By adjusting the amount of electrical current sent to the motor, the ESC controls the speed of the motor.It commonly uses PWM to control the motor

BLDC Motors: It's basically DC motors without brushes. The absence of brushes reduces friction and is used for precise control of motor speed and direction.

Lipo Battery: LiPo (Lithium Polymer) batteries are a type of rechargeable battery known for their high energy density, lightweight design, and ability to deliver high currents.It is used for providing enough energy to make our system operational.

Transmitter and Receiver: Transmitter is a device or equipment that generates and sends signals or information in the form of electromagnetic waves. The primary function of a transmitter is to convert information into a signal that can be transmitted over a medium, such as air or a cable. In wireless communication, transmitters often convert information into radio waves for transmission.Whereas, receiver is a device or equipment that captures and interprets signals or information sent by a transmitter. It is designed to convert received signals back into a format that can be understood and utilised.

Software Part:

Proteus: A tool for designing electronic circuits. With the help of it we can draw schematics, place components, and connect them to create a virtual representation of our project.

Fusion 360: Fusion 360 is a cloud-based 3D computer-aided design (CAD), computer-aided engineering (CAE), and computer-aided manufacturing (CAM) platform developed by Autodesk.It employs parametric modelling, allowing users to create 3D models with design parameters that can be easily modified and updated. This feature facilitates iterative design processes.Therefore, with the help of it we can model our 3D design to get an idea of how our system will look like.

Google Colab: Colab provides an online environment for creating and running Jupyter Notebooks, which combine code, text, and visualisations in a single document.It provides free Graphics Processing Unit (GPU) and Tensor Processing Unit (TPU) resources. This is particularly beneficial for users running machine learning models that can take advantage of accelerated computing.

YOLO V8: A popular object detection algorithm used in computer vision and image processing. The term "YOLO V8" could refer to the eighth version or iteration of the YOLO algorithm. YOLO is known for its real-time object detection capabilities. Each new version typically brings improvements in accuracy, speed, and the ability to detect a wider range of objects.

Python Libraries: A Python library is a collection of modules and functions that enable us to perform specific tasks without having to write the code for those tasks from scratch. Here are some popular that we used for creating our algorithm:

1. **NumPy:** Numerical computing library for handling large, multi-dimensional arrays and matrices.
2. **Pandas**: Data manipulation and analysis library, providing data structures like DataFrames.
3. **Matplotlib**: 2D plotting library for creating static, animated, and interactive visualisations.
4. **Seaborn:** Data visualisation library based on Matplotlib, providing a high-level interface for statistical graphics.
5. **TensorFlow:** Open-source machine learning library developed by Google, widely used for deep learning applications.
6. **PyTorch:** Deep learning library known for its dynamic computational graph and ease of use.
7. **Open CV:** OpenCV, short for open-source computer vision library, is a freely accessible tool for computer vision applications. It is widely used to enhance the implementation of machine perception by offering a real-time infrastructure for computer vision tasks. Its functionalities extend to various image processing features, including object detection, facial recognition, and tracking. The library supports these applications to enable efficient and practical utilisation of computer vision in diverse fields.

3.4 Conclusion

The evolution of modern engineering has been greatly influenced by the creation of a diverse array of powerful and cutting-edge software applications. These sophisticated tools play a pivotal role in enabling us to achieve our distinct objectives with enhanced efficiency and reliability. As these software programs have progressed over time, they have refined their capabilities, ensuring the precision of the results they deliver. In the process of creating a prototype, it becomes imperative not only to ensure that it functions as intended but also to guarantee its alignment with our overarching objectives. This requires a nuanced understanding and skillful application of specific tools and technologies. The intricate synergy between these tools and technologies is fundamental in bringing forth a prototype that not only meets the intended purpose but also adheres to the highest standards of functionality and performance. Thus, the mastery of these tools becomes a key factor in the successful realisation of engineering projects and the attainment of desired outcomes.

Chapter 4: Optimization of Multiple Design and Finding the Optimal Solution

4.1 Introduction

To achieve our project's desired outcome, we have put forth two distinct design approaches. While all these designs are capable of yielding the final result, their operational methodologies diverge significantly. In simpler terms, each design follows a unique process to attain the common goal. For the first design we have explained its working procedure and for the second design we have shown its simulation and obtained some parameters. Later taking all the advantages and disadvantages that these designs might possess we came to a conclusion and then deduced our optimal design.

4.2 Optimization of multiple design approach

<u>Design Approach 1(Floating Robot Approach)</u>

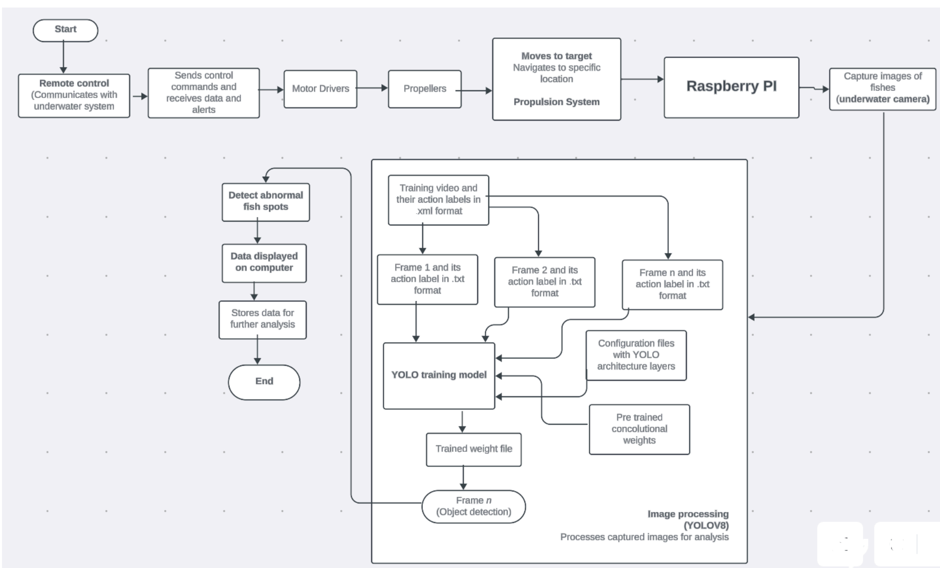


Fig 1.0: Flowchart of Design 1

The flowchart shown above shows how the system will operate.To start working, the device will go to a specific location in the fish tank using its propulsion system controlled by a remote controller.Once it reaches its targeted position the food dispenser will turn and provide foods to attract fishes so that they come near the camera module.The algorithm that we upload in raspberry pi for image processing will help detect any abnormal spots(Red spot) that are present on fishes. The images collected from underwater will then be displayed via a monitor(can connect any type of monitor/Laptop). Thus giving an overall idea on whether or not any infected fishes are present in the fish tank.Once the monitoring session gets complete the system will return to base(Via remote controlled signal) storing data of the images collected for further analysis

Image Processing

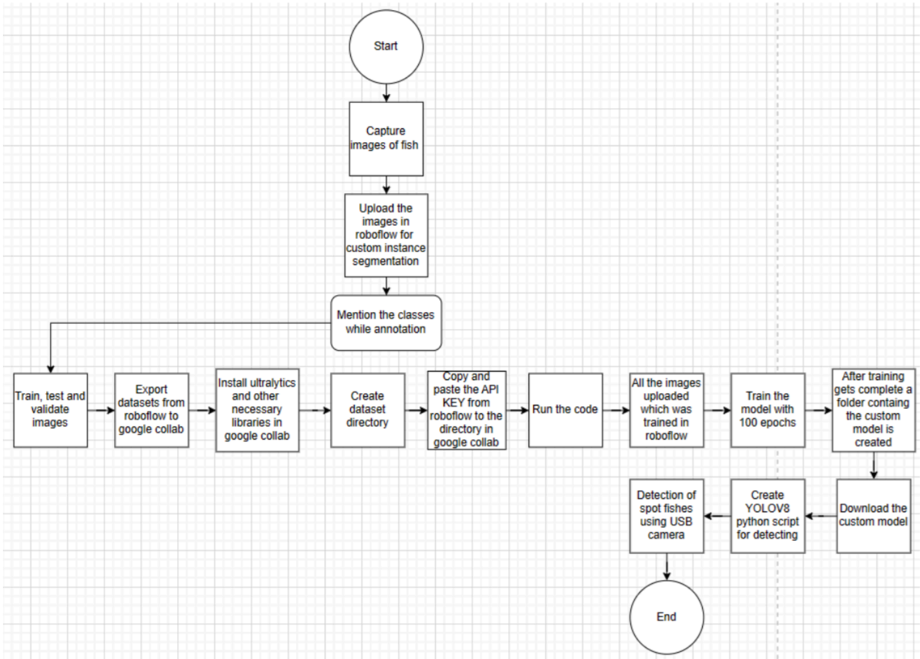


Fig 1: Flow chart of YOLOV8 algorithm for image processing

The flowchart shown above shows the steps required for the completion of the algorithm for detection of diseased spot(EUS) over fishes using a USB camera. The images of fishes were captured at first from an indoor fish farming.Then those images were uploaded in roboflow(a computer vision platform that simplifies the process of building computer vision models) for custom image segmentation.The classes were mentioned while annotation(Fig 1.1).Next those images were trained tested and validated which is crucial for the model to understand the underlying patterns in the data, allowing it to make accurate predictions on new, unseen data.The datasets were then exported from roboflow to google colab. Colab provides a temporary and isolated environment for each session therefore we needed to install necessary libraries like ultralytic,pytorch etc before working out with our algorithm. Later we created a dataset directory(Fig 1.2) where the API key of our trained model sample was pasted from roboflow to the directory.All the images which was trained in roboflow were uploaded to google colab on which we ran about 100 epochs. After the epochs got completed a folder containing the custom model was created from where we downloaded our custom model.Afterwards we created a python script for detection using USB Camera for detection of the diseased(red spot/EUS) over fishes.

Fig 1.2: Annotated sample of diseased fish(EUS)

```
!mkdir {HOME}/datasets
%cd {HOME}/datasets

!pip install roboflow

from roboflow import Roboflow
rf = Roboflow(api_key="ruhJ1uqkZcywfAZPJvBh")
project = rf.workspace("fydp-6ifbl").project("rpi4-yolov8-segmentation-kcago")
dataset = project.version(1).download("yolov8")
```

Fig 1.3: Code for dataset directory

<u>Dataset</u>

Fig 1.4: Some of the sample images the diseased spotted fishes used in dataset

Result

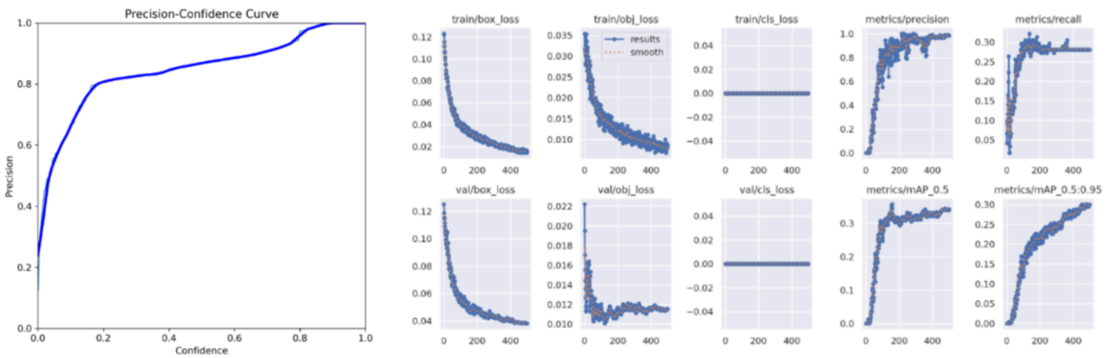


Fig 1.5: Precision Confidence curve

The Precision-Recall Confidence (PRC) curve is a graphical representation of a model's performance that considers the confidence or probability associated with its predictions. The curve is particularly useful when evaluating models on imbalanced datasets or when considering the trade-off between precision and recall at varying confidence levels. From the curve shown above(Fig 1.4) as the number of epochs increased the precision of our model increased along with it as well.

Calculations of design approach 1

Motor Calculations

In general a system requires at least 2 pounds of thrust for every 100 pounds of weight to move through the water effectively.We will be using the rule of thumb for calculating minimum thrust for the system to move.The estimated weight our **Robot Based Approach(Design 1)** will be 5kg which equals to 11 pounds. According to the rule of thumb:

Tmin =[(11/100) × 2] lbs = 0.22 lbs of thrust, minimum thrust required for the system.

Motors	**Quantity of Thrust**
12v	55 pounds or less
24v	Over 55 pounds up to 80 pounds
36v	Over 80 pounds up to 115 pounds

Table 01: In general Terms Voltage/Thrust Ratios

From the table it can be estimated that the amount of thrust that will be produced by the device system should not exceed 55 pounds.Therefore, the motor that we will be using is a 12V BLDC Motor**.** The calculation is given below:

V= 12V
RPM = kV × V
kV = 980 RPM/V
Therefore,RPM= 980 × 12 = 11760

4 Blade propeller is suitable for a 12V BLDC motor,The specification of the propeller is shown below:

Diameter, D = 62mm/2.44 inches
Propeller Pitch = 43.4mm/1.709 inches.

So according to the Static Thrust Equation:
T = 4.392399(10−8)) ∗ RPM ∗ ((d^3.5)/✓Pitch) ∗ (4.23333(10−4) ∗ RPM ∗ Pitch)

Here,
T = Thrust in Newton
d = Diameter of Propeller in inch = 2.44 inches
Propeller pitch = Pitch in inch = 1.709 inches.
RPM = Speed of Motor

Then,
0.22 = 4.392399*(10^-8)*RPM*((2.44^3.5)/✓1.709)*(4.23333(10^-4)*RPM*1.709)
RPM = 19971

To achieve effective movement through the water and generate 0.22lbs of thrust a combined motor speed of 19971 rpm is needed.Since the rover will be using 4 propellers, the required single motor speed for the rover will be
= 19971/4 rpm
= 4992 rpm
So based on the provided data,opting for BLDC motor is well supported for the system's propulsion.The calculation indicated a need for a motor speed of 4992 rpm to ensure efficient system movement in water.The chosen motor is capable of reaching a maximum speed of 11760 rpm,significantly surpassing the required minimum speed.Consequently,the selection of BLDC motor is indeed well-founded.

Total Required Power For The System

Total Required Power = Required Force × Velocity of the System
We are assuming the speed of the system will be 1m/s.
Frictional Resistance = ½ * r* (v^2) * As * Cf, where **r** is the density of water = 1000 kg/m^3,**As** is the Hull's Weighted Area = (0.30 * 0.20)m^2,**Cf** is the resistance coefficient = 0.1 and we estimated the velocity of the system to be 1 m/s ,Residual Resistance = R(R/Δ) ∗ (∇ρg) Here, R(R/Δ), Residual Resistance, Ratio = 0.07
Depth of Immersion of the system:
Length = 0.30m, Width = 0.20m, Height = 0.15m
Volume of the System = 9*10^-3m^3

Weight of Water Displaced = Density of Material The System is Made from * Volume of The System * Gravity
The exoskeleton of the system is made from PVC, which has a density of 1380 kg/m^3
Weight of Water Displaced = 1380*9*10^-3*9.81 = 121.84N

Weight of Water Displaced = Weight of The System

Volume of Water Displaced = (Weight of Water Displaced/Weight Density of Water)
= [121.84/(1000*9.81)]
=0.012m^3

Volume of the Body in Water = Volume of Water Displaced = 0.30*0.20*h =0.2.Therefore, h = 0.2m.
Depth of Immersion of Rover (h) = 0.2/2 = 0.1m

∇,Systems Volumetric Displacement = (Length * Width * Depth of Immersion of the system)
= 0.30*0.20*0.1=0.006m^3
Total Resistance of Rover = ½ *r*(v)^2*As*Cf+R(R Δ) ∗ (∇ ∗ ρ ∗ g)
= ½ * 1000*1^2*0.06*0.1 + 0.07 * 0.006*1000*9.81
=7.12N
Therefore 7.12N is needed for a 1 m/s velocity of the system is
Required Power = Required Force * Velocity of System
= 7.12 * 1
=7.12W

Calculation for the ideal power bank for Raspberry Pi 4B

To build a power bank for the Raspberry Pi 4, we will need to consider the voltage and current requirements. The Raspberry Pi 4 operates at 5V, and as mentioned earlier, it's recommended to have a power supply that can provide at least 3 amps for reliable operation.

Calculate the Power Requirement (Watts):

- Power (W) = Voltage (V) * Current (A)
- For the Raspberry Pi 4, Power = 5V * 3A = 15W

Determine the Operating Time:

- Decide on the desired operating time on battery power (in hours). Let's say we want the Raspberry Pi to run for 4 hours on battery.

Calculate the Capacity (mAh):

- Capacity (mAh) = (Power (W) * Operating Time (hours)) / Battery Voltage (V)
- Using the example, Capacity = (15W * 4h) / 5V = 12,000mAh

Speed Control of BLDC(Brushless Direct Current) motors

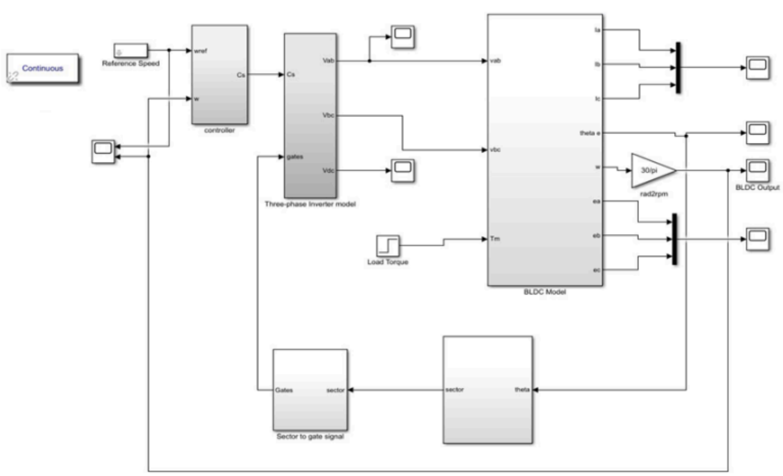


Fig 1.6: Block Diagram of Speed Control BLDC motor

Parameters of Reference Speed And Load Torque

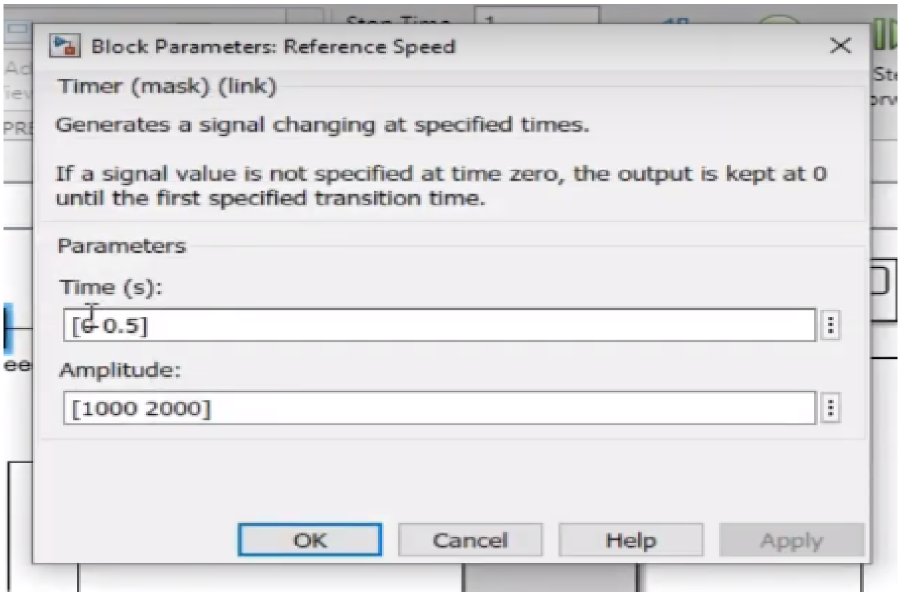


Fig 1.7:Block Parameters of Reference Speed

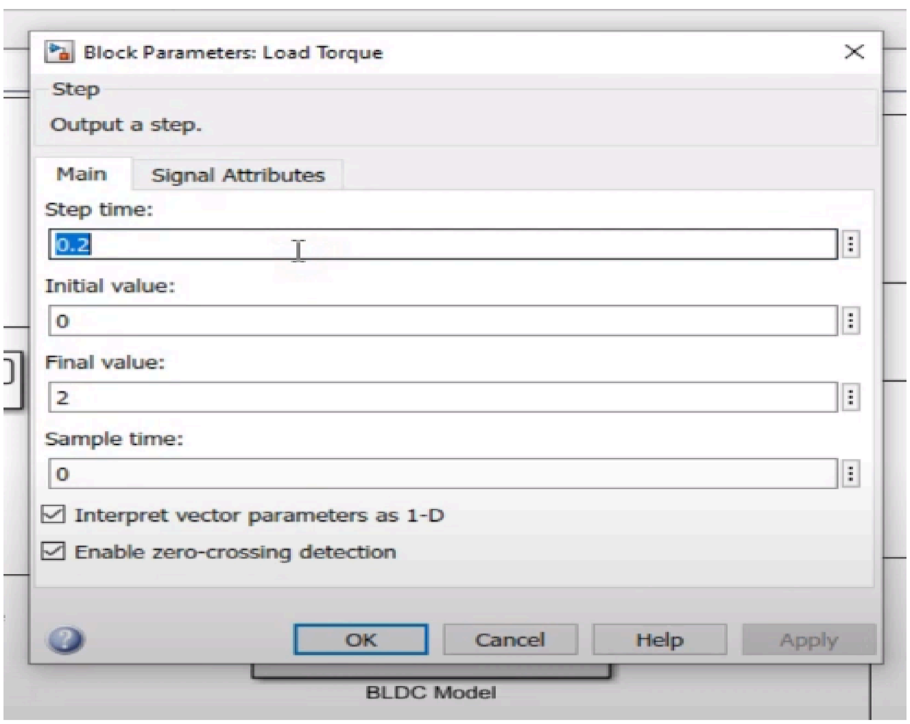


Fig 1.8:Block Parameters of Load Torque

The diagram shown above in Fig 2.4 illustrates the Six-Step Commutation Control technique applied to BLDC motors.This approach facilitates motor speed regulation by using a PI controller connected with six switches. The control methodology revolves around segmenting the motors;s applied voltage into six discrete steps,with each step involving the manipulation of voltage through the switches to manage the motor's rotational speed.The controller's input involves the discrepancy in speed,while its output entails determining the appropriate duty cycle for the PWM signal.This methodology.The **MATLAB** implementation of PI controller, orchestration of the six commutation steps via the switches,simulation of the control system,fine-tuning the PI controller's coefficients, and scrutinising the system's performance.This methodology is both straight forward and efficacious,readily lends itself to MATLAB's versatile platform for seamless analysis and implementation.

Output Result

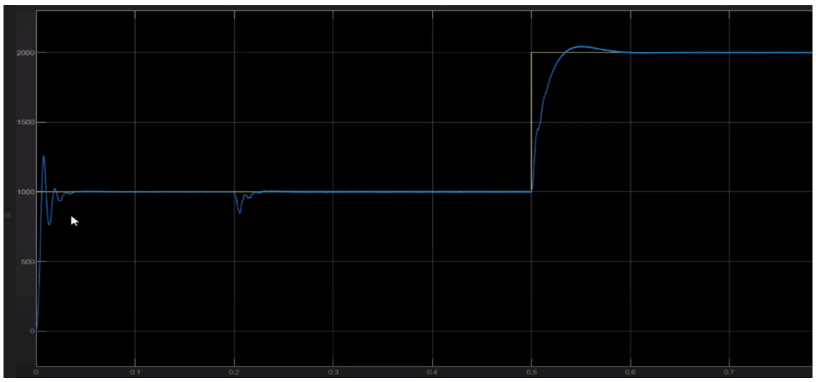


Fig 1.9: Rpm vs Time

The provided graph illustrates the initial transient response.The Y-axis represents Rpm of the motor and the X-axis represents time.Here beyond 0.02 seconds, the system attains a steady speed of 1000 RP. Around 0.2 second mark, a reduction in speed is evident, attributed to the load torque impact.The speed reduction aligns here with expectations, as the electromagnetic torque is anticipated to eventually counterbalance the load torque.Notably,at 0.5 seconds, a reference speed of 2000 RPM is prescribed.Remarkably,by 0.56 seconds, the system stabilises precisely at this designated speed, affirming the proper functionality of the control circuit.

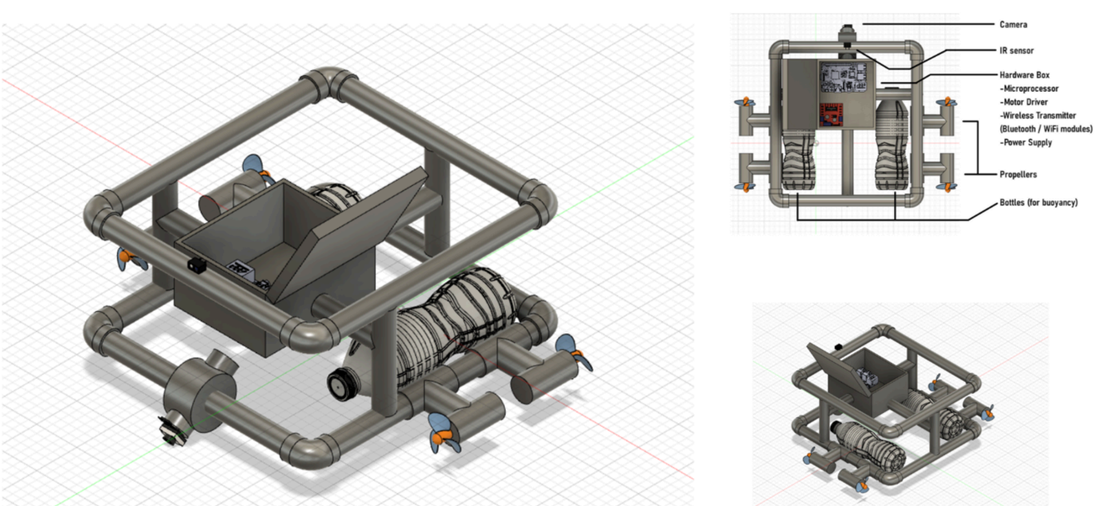


Fig1.10: 3D Design of the Model Using Fusion 360(Prepared at 400D)

The model was designed using Fusion 360 to give our faculty members an idea of how our system might look.

Design approach 2 (Smart Tank)

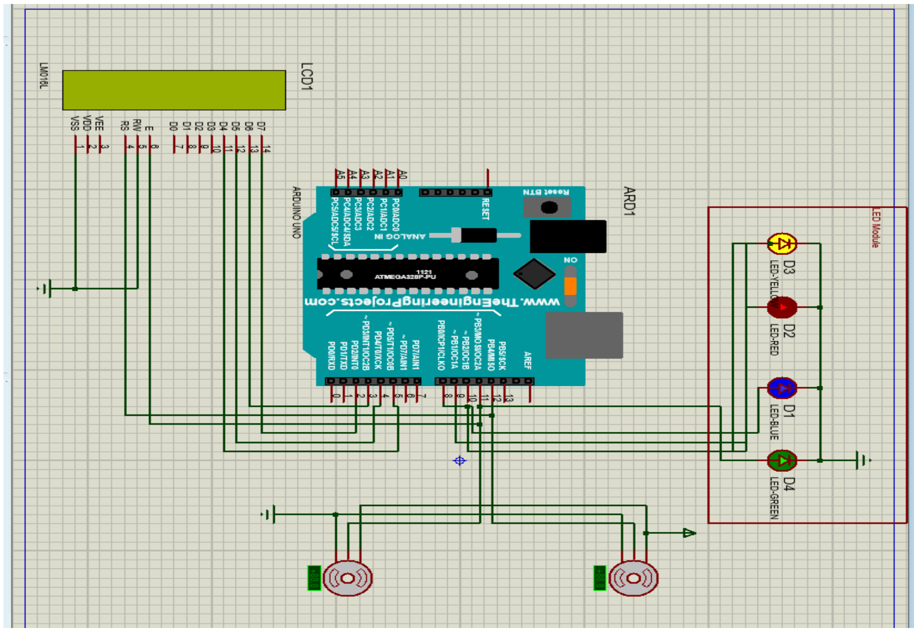


Fig 2.0: Circuit Diagram of Design approach 2

The circuit shown in the diagram above is an autonomous system for monitoring diseased fish spot and fragile fish movement.The device will be using 2 servo motors at two ends of the fish tank on which the cameras will be mounted, placed at two side of the fish tank so that it can cover the whole fish tank for monitoring purposes.The servo motor will help the camera to move clockwise and counterclockwise by controlling the direction of electrical current flowing through its coil.The LCD display and the led lights will blink to alert users thus will serve as a notification system.The circuit diagram is a visual guide that illustrates how different circuit parts are linked together.It helps us grasp the system's design and how it works.

Motor Calculation

Servo Motor Calculation For Design 2

A sample calculation for selecting a servo motor to rotate a camera mounted on a fish tank.Assuming the following parameters:

Camera Weight:200 grams

Distance from Rotation Axis:0.1m

Desired Rotation Speed:30 degrees per second

Voltage:5V

Safety Margin:20%

Torque = Force * Distance

= Camera Weight * Distance from Axis * Gravity

= 0.2kg * 0.1m * 9.81m/s^2

= 0.1962 N.m

Torque with Safety Margin = Torque * (1 + Safety Margin)

= 0.1962 N.m * 1.20
= 0.2354 N.m
Power Required To achieve the Desired Rotation Speed = Torque * Angular Speed
= Torque * (Rotation Speed in radians/s)
= Torque * (Rotation speed in degrees/s * π/180)
= 0.2354 N.m * (30degree/s * π/180)
= 0.0234 N.m/s
Now that we have the power requirement, we can choose a servo motor that meets or exceeds this specification.

4.3 Identify optimal design approach

Assessment Metrics	**Design 1 [Floating Robot Approach]**	**Design 2 [Smart Tank]**
Mobility	Can navigate within the fish tank	Not movable
Control	Provides direct Maneuverability	Autonomous
Target Monitoring	Can target fishes more accurately	Can target fishes less accurately
Accuracy	Enables accurate control of the floating system	Predetermined and set in advance through programming
Non-Intrusive approach	Non-Intrusive	Non-Intrusive
Efficiency	Requires human involvement while monitoring,making it a bit less efficient	Operates automatically without human involvement making it more efficient
Manufacturability	Difficult to do	Easy to do
Usability	Usable	Usable
Increased Scope	Possible	Not Possible

Table 02: Comparison between Design 1 and Design 2

Priority Chart

Assessment	Design 1	Score out of 10	Design 2	Score out of 10
Mobility	10	10/10	2	2/10
Control	8	8/10	6	6/10
Target Monitoring	9	9/10	7	7/10
Accuracy	8	8/10	6	6/10
Non-Intrusive Approach	8	8/10	8	8/10
Efficiency	7.5	7.5/10	9	9/10
Manufacturability	6	6/10	10	10/10
Usability	8	8/10	8	8/10
Increased Scope	9.5	9.5/10	5	5/10
Total Score out of 90	74		61	

Table 03: Total Score From Analysis of Design 1 and Design 2

According to the table shown above, after analysis of different criteria and requirements design 1(Floating Based Approach) scored more than design 2(Smart Tank).**Design 1 scored 74 out of 90 and Design 2 scored 61 out of 90.** Therefore based on these we selected **design 1 as our optimal design approach.**

4.4 Performance evaluation of developed solution

Parameters	Optimal Design Approach(Floating based System)
Mobility	High
Cost	Moderate
Target Monitoring	Very High
Effectiveness	High
Environmental Impact	Low
Accuracy	Very High
User interface(UI)	Moderate
Privacy	High
Adaptability	Moderate

Table 4: Performance Assessment of Optimal Approach

Explanation

Mobility: The system needs to manoeuvre in different directions and places while identifying the diseased fish spot.Therefore our system will be able to move around in any indoor fish farming tanks quite easily due to its mobility feature.

Cost: The cost of the system(Floating Based Approach) is moderate depending upon the prices of all the components that are being used.However, it can be counterbalanced by reducing the number of fish mortality and boosting business growth in indoor fish farms.

Target Monitoring: This targeted monitoring approach ensures that efforts are directed where they are most needed, enhancing the overall efficiency of the fish farming operation.

Effectiveness: With the ability to move freely, the system can promptly identify diseased fish spots. Early detection is crucial for implementing timely interventions and preventing the spread of diseases, thereby reducing fish mortality rates.Therefore the optimal approach is very much effective.

Environmental Impact: The system is designed to operate without causing disturbance to the aquatic environment. Its floating nature minimises disturbances to the water and the fish, ensuring a non-intrusive presence. Efforts are made to design the system to be energy-efficient. Utilising low-energy components and optimising power consumption contribute to a smaller environmental footprint.

Accuracy: The system can move as close as possible near fishes for identifying those diseased spots.As a result it has a higher accuracy in detection of the diseased spot precisely.

User Interface(UI): The system offers real time data of the diseased spot detected over fishes(Red Spot/EUS). The information can later be displayed in a monitor/laptop thus helping farmers to identify and remove any diseased fishes as soon as possible.

Privacy: Minimum amount of data necessary for the system's functionality was collected. Hence we avoided unnecessary data collection to minimise the potential impact of a privacy breach.Privacy policies will also be discussed with users including how the data is collected,used and protected.

Adaptability: The device is capable of adapting to fluctuations in environmental conditions within the indoor fish farming facility.It is designed in such ways that it can integrate with new technologies and upgrade seamlessly. The system's adaptability is reflected in its ability to support remote monitoring. This feature allows users to access real-time data and make informed decisions from different locations, enhancing operational flexibility.

Parameters	**Design Approach 2(Smart Tank)**
Mobility	Low
Cost	Low
Target Monitoring	Moderate
Effectiveness	Moderate
Environmental Impact	Low
Accuracy	Moderate
User interface(UI)	High
Privacy	High
Adaptability	Low

Table 4.1: Performance Assessment On Design Approach 2

<u>Explanation</u>

Mobility: The system's primary mobility feature is its ability to rotate the camera. This rotational capability allows the camera to cover different areas within the fish tank, providing a dynamic view of the fishes from various angles.As it cannot move therefore it will be difficult for monitoring fishes in larger fish tanks where fishes are far away from the device.

Cost: Depending on the materials that are needed to build this design the cost of this system is comparatively less. However some key features will be missed whilst using this system.

Target Monitoring: The system should target the detection of diseases or among the fishes. This involves using the camera to identify visual cues, such as unusual marking(Red Spot).

Effectiveness: The device will be able to collect real time data. However detection will take time as the system is fixed in one corner of the tank.

Environmental Impact: The use of non-invasive monitoring techniques, such as visual observation through cameras, helps minimise direct impacts on the fishes. This reduces stress and potential harm associated with physical interventions for disease detection.It will also use low-energy components and optimising power consumption contributing to a smaller environmental footprint.

Accuracy: The system's ability to provide real-time monitoring contributes to accuracy. However, lacking timely detection and immediate alerts that allow for prompt intervention,reduces the overall accuracy.

User Interface(UI): The UI of this system is quite user friendly as it allows users to operate without extensive training.Clear and straightforward design elements contribute to ease of use.

Privacy: Implementing access controls to restrict user permissions based on roles and responsibilities. Users should only have access to the data and functionalities necessary for their specific tasks.

Adaptability: Although the system can access real time data. However the device is not capable of adapting to fluctuations in environmental conditions within the indoor fish farming facility.The system neither has the ability to support remote monitoring.

Ways to evaluate the effectiveness and performance of design approach 1

Methods	**Explanation**	**Goal**
Fish Tank/Aquaculture system testing	Testing performance of the floating based system in different environmental conditions and places.	To evaluate and identify how well the system performs in each of these conditions.
Battery Life Testing	Experimenting the battery life of the system while monitoring the fishes	To ensure that the system can operate long enough
Scalability Testing	Analysing whether the system can monitor properly in larger areas	To assess the scalability of the system while diseased fish monitoring and pinpoint potential areas for enhancement
Usability Testing	The usability of the system employing the floating robot approach for monitoring fish disease refers to how easily and effectively users can interact with and utilise the technology for assessing the well-being of the fish.	To test the usability and user experience with the system while monitoring fishes

Data Analysis	Examine the data collected by the system during monitoring diseased fish spot to assess system's efficiency	To identify the effectiveness of the system on fish spot monitoring based on the data collected
Security Testing	Assessing the robustness of a design to pinpoint possible weaknesses and guarantee the safeguarding of user data.	Enhances user confidence and trustworthiness by ensuring the security and safeguarding of user data from potential risks and threats.
Cost Analysis	To analyse the total cost needed in creating the system for fish spot monitoring	Evaluating cost-effectiveness of the system

Table 4.2: Ways to evaluate the effectiveness and performance of design approach 1

4.5 Conclusion

After a thorough performance analysis, Design 1 emerges as the optimal approach for monitoring diseased fish spots. It outperforms the alternative design in terms of accuracy, effectiveness, scalability, and environmental impact. Design 1's mobility features and early detection capabilities are standout attributes, crucial for preventing disease spread. The precision and adaptability of this design, coupled with advanced machine learning and image processing, ensure rapid analysis and actionable feedback. While acknowledging the need for skilled personnel, Design 1 presents a robust and efficient solution, empowering farmers to minimise fish mortality and fostering sustainable aquaculture practices.

Chapter 5: Completion of Final Design and Validation.

5.1 Introduction

The floating based approach(Design 1) for tracking fish spot using machine learning algorithm is a highly productive and streamlined way for monitoring fish. The high resolution camera used by the system which will collect images of fishes from underwater later which will be analysed to provide accurate and real time information about fishes.The system can be adapted in any environmental conditions and it is highly scalable and can be used for monitoring in both large and small fish farms. The device can move on water without physical intervention and can reduce both the time and cost involved in manual monitoring methods.The informations about diseased spotted fishes can be collected remotely thus allowing farmers to retrieve data and obtain information on any monitors or laptops.

5.2 Completion of final design

The following features listed below are essential for fulfilling the purpose of this project's stated objective and standards.
Mobility: The prototype must be able to navigate water effortlessly,encompassing the capacity for turning, advancing, and reversing for precise and accurate monitoring.

Monitoring mechanism: The system will be monitoring from a stationary state attracting fishes through foods that will be distributed using a food dispenser.

Food dispenser: The main reason behind creating a dispenser is to attract fishes to specific areas making it easier to observe and monitor them. It can also provide regular and scheduled feeding and establish a routine for fish in the monitored area.

Data Transmission: Establish a communication system to enable real-time data transfer. Utilise RF modules or employ alternative wireless communication techniques for this purpose.

User Interface: Create a user-friendly platform for overseeing aquatic surveillance and fish monitoring and design an interactive dashboard enabling users to monitor fishes in the floating system.Implement a user-controlled system for tracking and monitoring fishes.

Power System: We need to ensure that our floating based system will be able to run for longer periods.This could entail selecting an appropriate battery variant and optimising energy usage to minimise power consumption.

Safety Mechanism: To enhance operational safety, integrate safety measures such as emergency stop mechanisms.

Cost Effectiveness: Evaluate the cost-effectiveness of implementing a floating-based system for monitoring diseased fish spots by examining the efficiency of resource utilisation in relation to the project expenses.

Stakeholder Engagement: Ensuring stakeholders needs and expectations. Stakeholders engagement throughout the project design.

Therefore keeping in mind these parameters will help project managers play a crucial role in ensuring that the design is thorough,impactful and resource efficient.Thus guaranteeing an effective outcome and streamlined in its resource utilisation.

5.3 Evaluate the solution to meet desired need

Parameters	**Clarification**
Objectives	Are the project goals clearly defined, quantifiable, attainable? Do these objectives align with the needs and expectations of the stakeholders?
Scope	Is the project's plan clear, and does it include all the areas and different types of environment and fishes that need to be monitored?
Design selection	Is the design selected suitable and non intrusive towards fishes?
Camera selection	Does the camera possess the required clarity, viewing range, and capability to identify infected spots?
Information processing and interpreting	Is the software suitable for handling and analysing the gathered data? Does it deliver precise and dependable outcomes?
Data Privacy	Is there a strategy to guarantee the security and confidentiality of the gathered data? Have precautions been implemented to thwart unauthorised access or misuse of the data?
Cost-effectiveness	Is the project design economically efficient?
Risk Management	Have potential risks to the project been recognized and dealt with? Is there a strategy in place to handle and minimise these risks?
Stakeholder interaction	Did the stakeholders find the project outcomes satisfactory? Were their requirements and anticipations fulfilled?

Table 5: Assessment of the solutions

Therefore by scrutinising these factors, project managers can verify the successful validation of the project design for supervising diseased fishes.

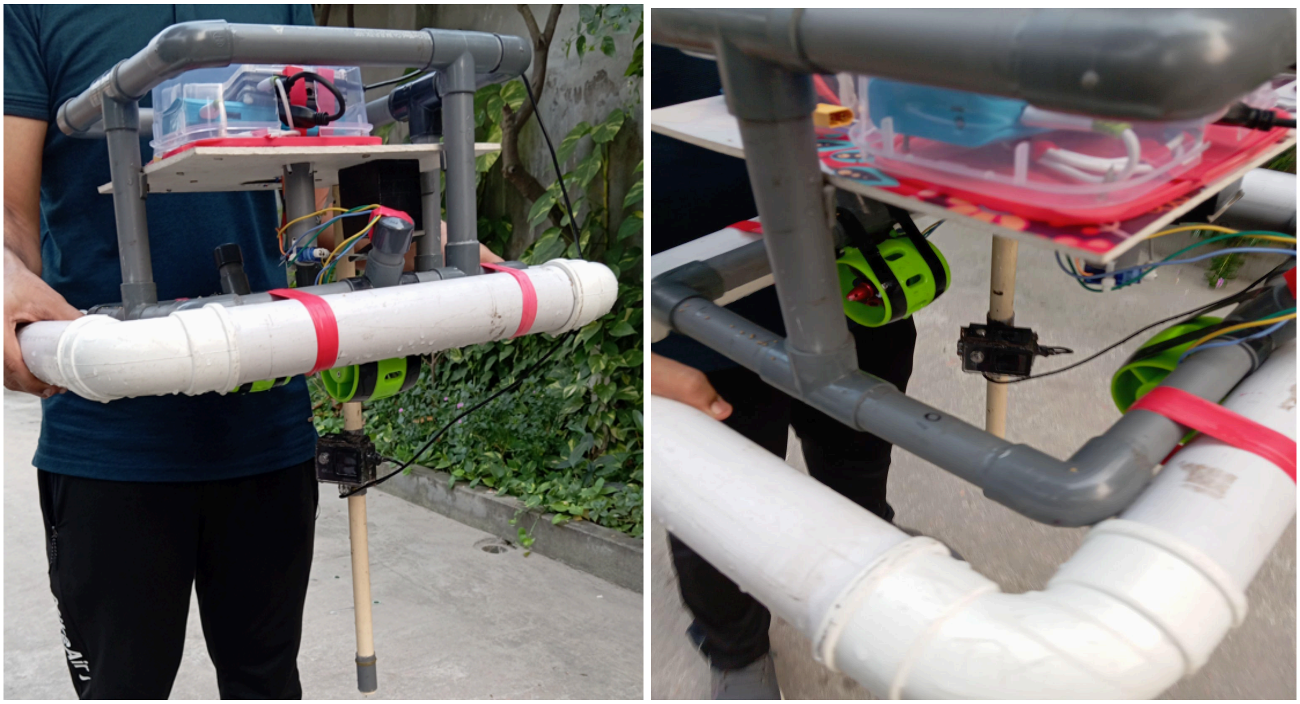


Fig 3.1: Floating Approach Design For Monitoring Fishes

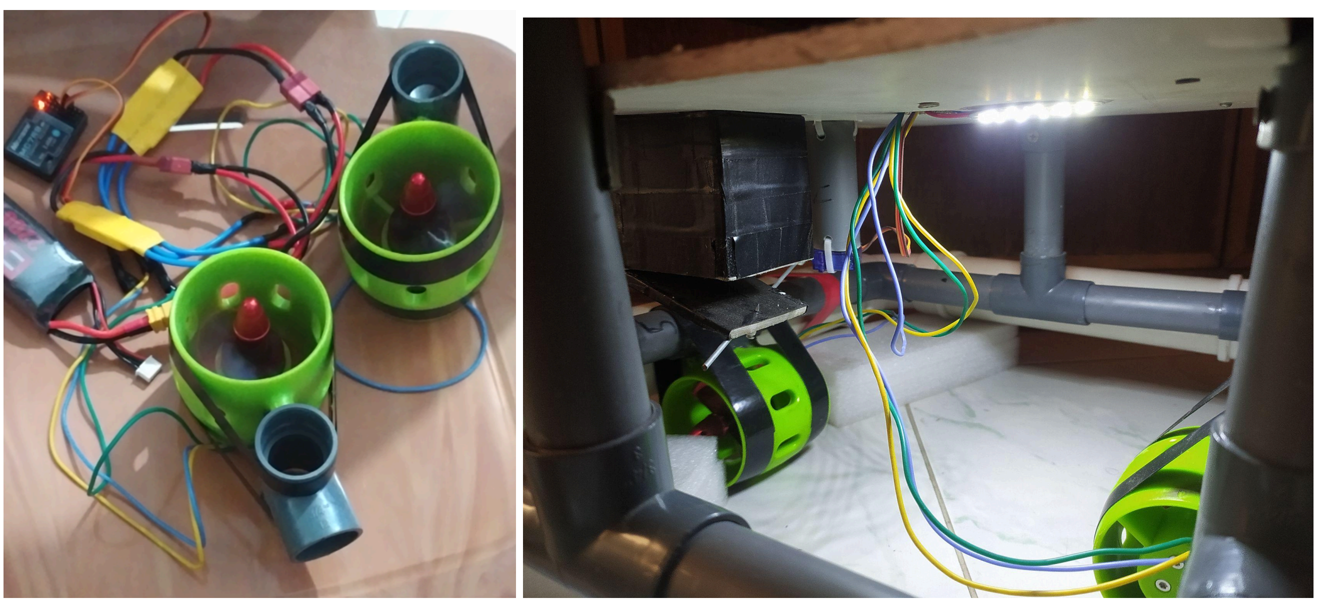


Fig 3.2: Circuit Connections

Fig 3.3: Monitoring the presence of spotted fishes (Red Spot/EUS) in an indoor fish farming system and displaying the information on a monitor.

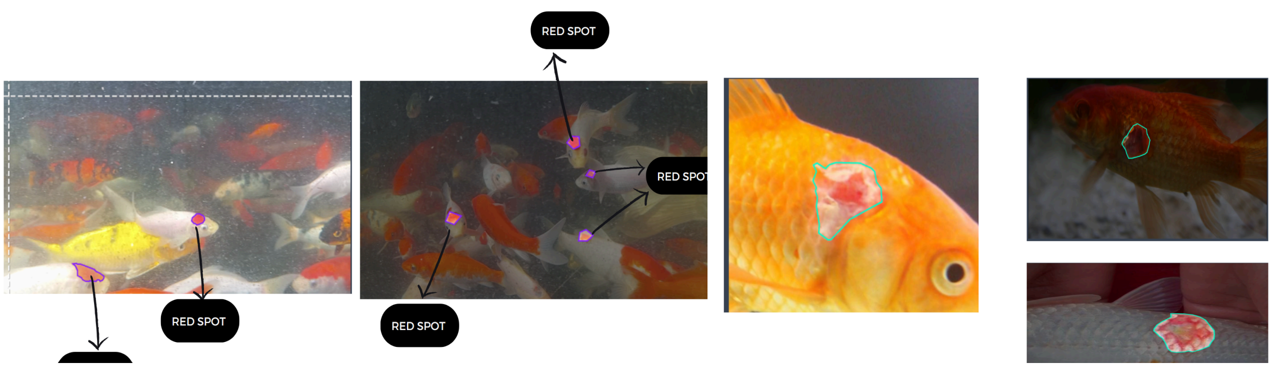


Fig 3.4: Sample Images of Annotation by custom image segmentation of the Diseased Spots Using Roboflow

5.4 Conclusion

In summary, employing a floating based approach for monitoring with image processing through machine learning emerges as a notably effective and efficient way for identifying the diseased spot accurately. This methodology delivers precise and instantaneous assessments of diseased fishes thus helping prevent spread of the disease. Additionally, it maintains a minimal environmental footprint and equips farmers with valuable insights and recommendations, enabling them to enhance yields and decrease fish mortality.

Chapter 6: Impact Analysis and Project Sustainability

Introduction

The proposed engineering project's impact analysis and sustainability evaluation are the main topics of this chapter, which also places a strong emphasis on the design strategy. The chapter assesses the project's implications in a number of domains, including societal, health, safety, legal, cultural, and environmental aspects.

Societal Impact:

Advancements in fish health monitoring, facilitated by the proposed solution, have far-reaching societal implications that extend beyond the realms of aquaculture industries, research, and conservation efforts. These advancements represent a fundamental shift towards more responsible and sustainable fishery practices, thereby influencing global food security and societal well-being.

Aquaculture Industries:

The solution's impact on aquaculture industries is substantial. By offering an innovative approach to continuously monitor fish health, it introduces a transformative tool for fish farmers and industry stakeholders. This technology can mitigate the risks associated with disease outbreaks, reducing economic losses due to fish mortality, and minimising the need for indiscriminate use of antibiotics or chemicals. Ultimately, it aids in ensuring the production of healthier fish stocks, thereby improving the overall quality of products reaching markets.

Research and Conservation Efforts:

In the sphere of research, the solution contributes valuable data and insights into fish health trends and disease patterns. Continuous monitoring offers researchers a wealth of real-time information, aiding in the understanding of diseases affecting fish populations. Such knowledge is crucial in the development of targeted interventions, disease management strategies, and conservation measures. Additionally, it serves as a platform for ongoing studies and contributes to the accumulation of scientific knowledge in the field of aquatic health.

Responsible Fishery Practices:

Promoting responsible fishery practices is pivotal for sustainability. By enabling early detection of fish health issues, the solution facilitates proactive responses, reducing the risk of disease transmission and potentially preventing the spread of infections to wild fish populations. This responsible approach aligns with ethical standards and regulatory measures, fostering a more conscientious attitude towards aquatic life and environmental conservation.

Contribution to Food Security:

The solution's impact on food security is noteworthy. By enhancing fish health monitoring, it helps secure a more reliable and consistent supply of fish products. Healthy fish stocks lead to increased productivity in aquaculture, contributing to meeting the growing global demand for high-quality protein sources. Moreover, ensuring healthier fish populations reduces the risks of foodborne illnesses, thereby bolstering consumer confidence in fishery products.

Health and Safety:
Improved fish health monitoring through the proposed solution marks a significant stride in enhancing health and safety standards within aquaculture practices. This advancement fosters a proactive approach to disease prevention, which in turn diminishes reliance on extensive chemical treatments, thereby mitigating potential health risks posed to both fish and consumers.

Disease Prevention and Reduction of Chemical Treatments:
The proactive nature of the solution allows for early detection and monitoring of fish health indicators, enabling swift interventions in the event of potential disease outbreaks. By promptly identifying signs of illness or abnormalities in fish populations, aquaculture managers can implement targeted and less invasive treatment strategies. This approach reduces the necessity for extensive use of antibiotics, pesticides, or other chemical interventions, which can have adverse effects on aquatic ecosystems and the health of aquatic organisms.

Minimization of Health Risks:
The decreased reliance on chemical treatments as a result of enhanced monitoring positively impacts the health of both fish and consumers. Excessive use of chemicals in aquaculture practices can potentially lead to the development of antibiotic-resistant strains of pathogens, posing risks to fish health and compromising food safety. By minimizing the exposure of fish to these treatments, the solution contributes to producing healthier fish stocks, thereby reducing the likelihood of harmful residues in fish products destined for human consumption.

Consumer Confidence
The improved health monitoring system promotes consumer confidence by ensuring the production of high-quality and safe fishery products. Consumers are increasingly concerned about the quality, safety, and sustainability of the food they consume. By reducing the risks of disease in farmed fish, the solution aligns with food safety standards, meeting consumer expectations for safe and wholesome seafood products.

Environmental Impact: Furthermore, the reduced use of chemicals aligns with environmental safety. Chemical treatments in aquaculture can lead to water pollution, disrupting aquatic ecosystems and causing ecological imbalances. Minimizing the reliance on such treatments helps preserve water quality and ecosystem health, fostering a more sustainable and ecologically sensitive approach to aquaculture.

Legal Compliance:
Ensuring legal compliance within the realm of aquaculture practices is paramount to guaranteeing the ethical treatment of aquatic life and maintaining environmental sustainability. The proposed system, designed for fish health monitoring, aligns with and contributes to adherence to various regulations, encompassing animal welfare standards and environmental laws governing aquaculture practices.

Animal Welfare Regulations:
The system's implementation complies with established animal welfare regulations that aim to safeguard the well-being of aquatic organisms within aquaculture settings. These regulations often include specific provisions concerning the prevention and management of diseases in farmed fish. By offering a proactive

approach to disease detection, the system adheres to standards set forth in these regulations by promoting early intervention and minimizing the suffering of fish populations.

Environmental Laws in Aquaculture:
Environmental laws and regulations play a crucial role in overseeing aquaculture activities to ensure minimal impact on ecosystems. The proposed system, by reducing the reliance on chemical treatments through improved health monitoring, contributes to environmental compliance. This aligns with regulations aimed at minimizing pollution, maintaining water quality, and preserving biodiversity within aquatic environments. The reduced use of chemicals helps prevent contamination of water bodies, promoting compliance with strict environmental standards.

Ethical Treatment of Aquatic Life:
Ethical considerations underline the system's adherence to legal compliance. By employing advanced monitoring techniques that prioritize early disease detection, the system facilitates ethical and responsible management of fish health. Ethical treatment of aquatic life is upheld through the reduction of stress and suffering in fish populations, aligned with regulations emphasizing humane and ethical practices in aquaculture operations.

Industry Standards and Best Practices:
Moreover, the system aligns with industry standards and best practices advocated by regulatory bodies and industry associations. Compliance with these standards signifies a commitment to responsible aquaculture practices, contributing to the sustainability and reputation of the industry.

Continuous Monitoring and Adaptability:
The system's continuous monitoring capabilities ensure adaptability to evolving regulatory requirements. It allows for real-time adjustments in response to changes in regulations or emerging best practices, ensuring ongoing compliance with legal and ethical standards.

Cultural Sensitivity:
In Bangladesh, cultural attitudes towards fish and aquatic life are deeply intertwined with the nation's heritage, economy, and daily life. The cultural significance of fish extends beyond mere sustenance, playing a vital role in societal traditions, beliefs, and practices. Therefore, when implementing solutions related to fisheries and environmental conservation in Bangladesh, understanding and respecting these cultural perspectives are essential.

Importance of Fish in Bangladeshi Culture:
Bangladesh, known for its extensive river systems, has a strong cultural connection to fish. Fish is a staple food in the Bangladeshi diet and holds significant cultural importance, often symbolizing prosperity, fertility, and good fortune. Fishermen, as key contributors to society, are respected for their roles in providing fish as a primary source of protein.

Traditional Fishing Practices:
Bangladesh has a rich heritage of traditional fishing practices passed down through generations. These practices often involve artisanal or small-scale fishing methods that are deeply embedded in the local culture.

Traditional fishing communities have unique knowledge about fish behavior, breeding seasons, and sustainable fishing practices based on their cultural experiences.

Festivals and Celebrations:
Festivals like "Pohela Boishakh" (Bengali New Year) and "Jal Utsab" (Water Festival) often incorporate fish-centric elements, symbolizing abundance and prosperity. Additionally, the "Bengali wedding ritual" commonly includes the presentation of fish as a symbol of good luck and prosperity for the newlyweds.

Cultural Attitudes Towards Conservation:
Bangladesh's cultural fabric includes values that emphasize environmental conservation and sustainability. Many cultural beliefs and practices advocate for the preservation of natural resources, including rivers and aquatic ecosystems. Concepts like "Maatsya Nyaya" (the law of fishes) convey the idea of respecting and protecting fish and aquatic life.

Challenges and Cultural Sensitivity:
When implementing solutions for fisheries and environmental conservation in Bangladesh, understanding these cultural nuances is crucial. Any intervention or solution should consider these cultural sensitivities to ensure acceptance and effectiveness. Solutions that align with traditional practices, respect local knowledge, and involve community participation are more likely to succeed and be embraced by the Bangladeshi society.

Professional Practice and Solution Development:
Technical and Non-Technical Issues: The project addresses both technical aspects (image processing, surveillance technology) and non-technical facets (ethical, cultural, legal) pertinent to aquaculture and environmental impact.

Value of Consideration: Demonstrating the importance of integrating societal, health, safety, legal, and cultural aspects into engineering solutions highlights a comprehensive and responsible approach to problem-solving.

Evaluation of Sustainability and Impact:

Environmental Impact: The solution minimizes environmental harm by reducing the need for indiscriminate use of chemicals or interventions in aquatic ecosystems. It supports ecosystem balance and biodiversity conservation.

Sustainable Solutions: The system promotes sustainable aquaculture practices by enabling early disease detection, minimizing environmental disturbances, and potentially reducing resource wastage.

Validation of Sustainability: The project's impact assessment should consider long-term effects on aquatic habitats, fish populations, and resource utilization, ensuring the solution's sustainability and minimal ecological footprint.

Conclusion:

The engineering project's impact assessment encompasses diverse dimensions, reflecting its societal, health, safety, legal, cultural, and environmental implications. Emphasizing a comprehensive evaluation ensures that the solution aligns with ethical, legal, and environmental standards while contributing positively to aquaculture practices and environmental conservation.

Chapter 7: Engineering Project Management.

7.1 Introduction

Our final year design project unfolds in three distinct phases: P (Proposal Writing), D (Design Report), and C (Completion), each accompanied by comprehensive guidelines and instructions. Throughout each stage, we diligently adhere to a Gantt chart and maintain a logbook, thoroughly outlining tasks and schedules. Our proactive approach ensures that we fulfil our responsibilities promptly.If there are unexpected delays, we have already thought about possible problems and figured out good solutions.Regular weekly meetings with our faculty advisors serve as crucial touchpoints, aiding us in maintaining a clear project vision and addressing any emerging concerns.

7.2 Define, plan and manage engineering project

The gantt charts shown below represents the project schedule over time. It displays tasks, start and end dates and the duration of each task. Gantt charts provide a timeline view of the entire project, allowing team members to see:

1. Task Sequence: The order in which tasks are to be completed.
2. Task Duration: The time required for each task.
3. Task Overlaps: Whether certain tasks can be performed simultaneously or if there are dependencies.
4. Project Milestones: Significant points or achievements in the project timeline.
5. Project Timeline: The overall duration of the project.

<u>EEE 400P</u>

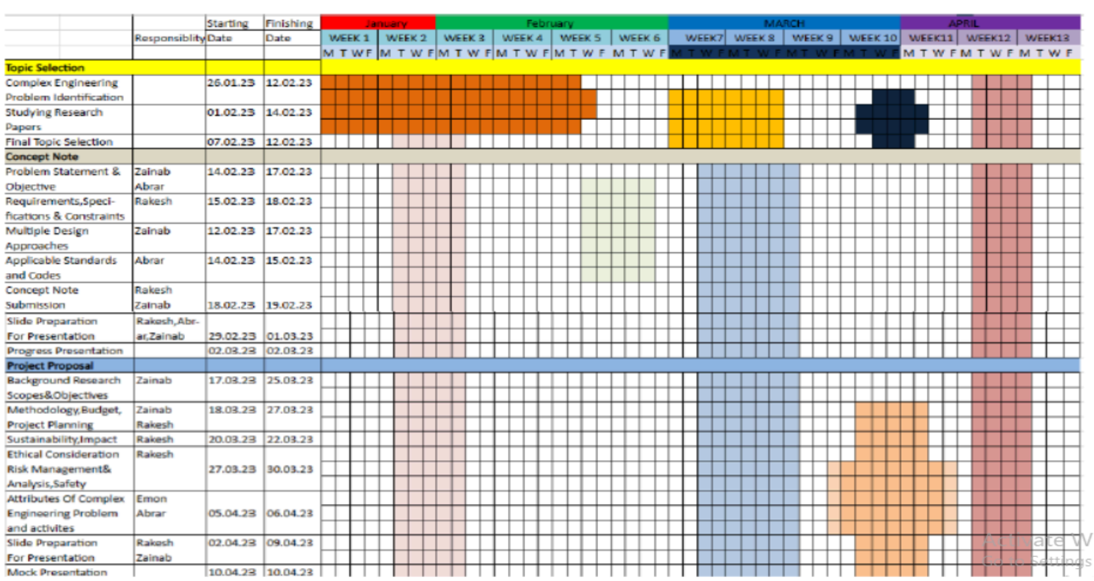


Fig 4.0: Gantt Chart 400P

EEE400D

Fig 4.1: Gantt Chart 400D

EEE 400C

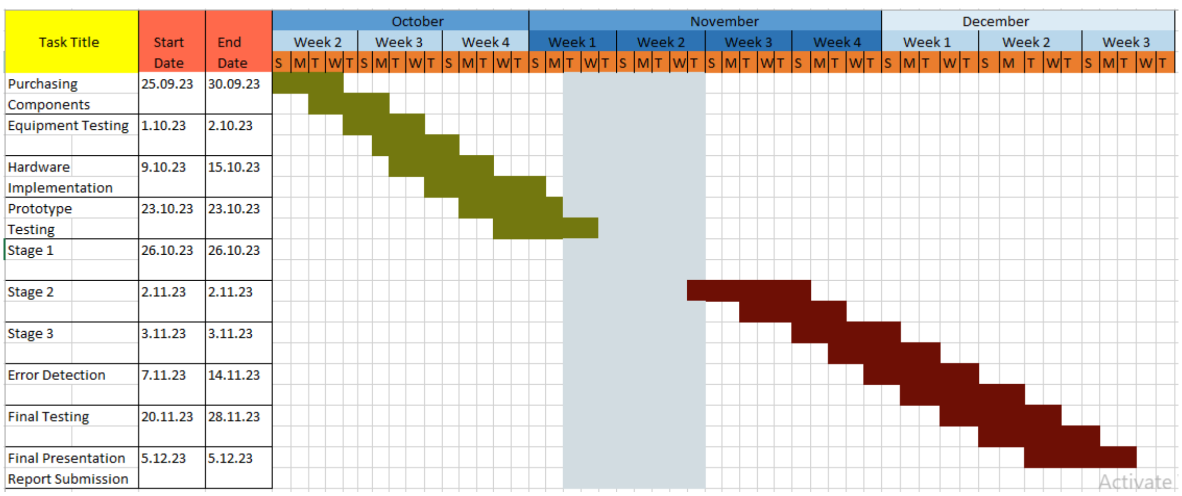


Fig 4.2: Gantt Chart 400C

7.3 Evaluate project progress

As our project proposal got accepted we started working with our proposal writing.We distributed our responsibilities quite evenly among team members, ensuring clear specification of tasks for each individual. Every team member had a specific assignment to accomplish within a predefined timeline.Moreover we had faculty meetings every week where we discussed our problems. Subsequently,our group members convened online meetings to identify and formulate solutions. We conducted several presentations at the university and also shared our progress with the ATC members. The processes were almost similar in 400P, 400C and 400D.In each of these stages we had to deliver a presentation and afterwards we needed to write reports about the progress of our project. In 400D we had to simulate our designs(Design 1 & Design 2) alongside we had to develop a 3D design using fusion 360 which gave us ideas regarding the hardware components and the architecture of the system. We also developed algorithms using YOLOV8 and CNN for both our design and later deduced our optimal design which meets both our functional and nonfunctional requirements to an optimal standard.

Over the semester break, we bought the parts needed for our best design choice. Now, in the last part of the project (Completion stage), our main goal is to build a prototype of our design that achieves our project's objective. We started building our prototype dividing the task among our group into two parts(software & hardware) and in the meantime we searched for an indoor fish farm/ fish tank where we can test our device once it gets functional. The process of constructing the prototype was a memorable and noteworthy experience for us. At the very beginning we designed the frame of our system using PVC pipes. Inorder to make the architecture floatable we trial it with many different materials like plastic sheets, water bottles, tire tubes etc however it wasn't working out well and in most of the cases the system tends to lose its stability. Later we used hollow PVC pipes to create a basement underneath the architecture helping the system to attain stability thus making it floatable. We also continued our software task in between where we preferred to stick with the YOLOV8 algorithm for image processing. Next we looked into the hardware part where motor connections were made with ESC(Electronic Speed Controller) and then connections were made by soldering it with the battery unit. A food dispenser was also built using plastic sheets and was connected to a servo motor which provided a gateway for the system to close and open. Both the dispenser and motors can be remote controlled, receiver to the system's controller was connected channel wise. Therefore, when the system was completely built and fully functional we took our system to Narayanganj where the fish tanks were located. There we tested our prototype and it was successful in detecting the diseased spots(Red spot/ EUS/ shown in Fig 3.4).

7.4 Conclusion

Project management serves as a crucial aspect for engineers, enabling them to transform conceptual ideas into functional realities starting from the ground up. It acts as a guiding tool, ensuring engineers stay on course and simplifying the overall process. A well planned project management approach encompasses all essential details required for a higher likelihood of success.

Chapter 8: Economical Analysis.

8.1 Introduction

Economic analysis is the systematic evaluation of the financial feasibility and impact of a project, involving a thorough examination of costs, benefits, and potential risks. It plays a pivotal role in project management by aiding decision-makers in making informed choices based on economic principles. By assessing the cost-benefit ratio, allocating resources efficiently, and identifying potential risks, economic analysis ensures that a project not only adds value but also aligns with long-term sustainability goals. Additionally, it influences project planning, design, and decision-making processes, enhancing investor and stakeholder confidence. Ultimately, economic analysis serves as an essential tool for optimising resource utilisation, mitigating risks, and ensuring the financial success and viability of a project.

8.2 Economic analysis

The economic analysis of the proposed floating-based approach for detecting diseased spot fishes in a fish tank or indoor fish farming involves a comprehensive assessment of the financial aspects associated with implementing and maintaining the system. This analysis considers various factors, including the initial investment, operational costs, potential benefits, and long-term sustainability. The costs associated with acquiring and installing the necessary hardware, such as sensors and monitoring devices, as well as the development of the software for disease detection, form part of the upfront expenses. Operational costs, including energy consumption, maintenance, and potential upgrades, are also factored into the economic analysis. On the benefits side, the analysis would explore the potential gains from improved fish health, increased productivity, and reduced losses due to early disease detection. Additionally, long-term viability and sustainability factors, such as the system's adaptability to changing technology and its impact on overall fish farm productivity, are considered. The economic analysis aims to provide insights into the financial feasibility and returns on investment, aiding decision-makers in determining the economic viability of implementing the floating-based approach for detecting diseased spot fishes in an indoor fish farming setting.

<u>Epizootic Ulcerative Syndrome[Red Spots]</u>

Epizootic Ulcerative Syndrome (EUS), a damaging ulcerative disease affecting freshwater and brackish water fish, has been observed in various regions, including Japan, Australia, parts of South-East Asia, some areas of the eastern USA, and more recently, in Africa. The outbreak of EUS has resulted in significant destruction, causing a loss of vital dietary components for many rural communities. This disease is attributed to infection by a primary fungal pathogen. While over 100 fish species have been impacted by EUS, only a few cases have been confirmed through the demonstration of key diagnostic features[1].

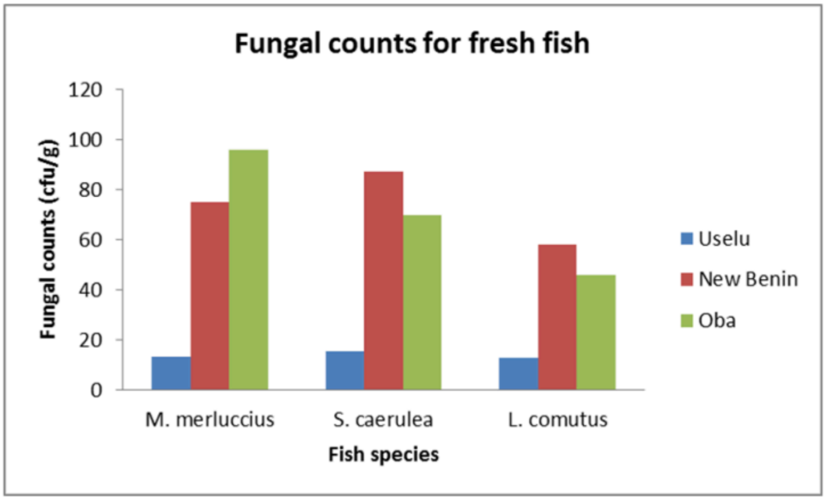


Fig 5.0: Fish species affected by fungal disease

As our proposed system was successful in identifying the diseased spot(EUS) over fishes as result it can also work in identification of any fungal disease present over fishes as they almost share a similar pattern and shape.For that we need to train our model with more samples of fungal affected diseased spots which will ensure its effectiveness in early detection.Therefore it will help prevent spread of the disease onto other fishes.Moreover, this system can significantly contribute to the economic analysis of the overall project.Here's how:

1. **Market Value and Competitiveness:** To check how much people would pay for the fish that are grown using the new system. If the fish are healthier and better quality, more people might want to buy them. This could make the fish more competitive in the market, meaning they have a better chance of being sold compared to other fish.

2. **Resource Optimization:** Analyse how the system optimises resources such as manpower, time, and materials. The remote controlled mechanism of our device and its real-time monitoring capabilities will reduce labour-intensive tasks and improve resource allocation.

3. **Operational Efficiency:** Evaluate how the proposed system enhances operational efficiency in fish farming. For instance, early disease detection can lead to timely intervention, reducing the need for extensive treatments and mitigating potential losses.

4. **Data-Driven Decision-Making:** The system's data collection and analysis capabilities enable informed decision-making, contributing to better farm management and potentially reducing costs associated with reactive measures.

5. **Environmental Impact:** The prototype's non-intrusive approach towards fishes will make it less stressful for fishes while monitoring sessions.At the same time sustainable and environmentally friendly practices may have economic implications and market value.

6. **Long term sustainability:** Considering the long-term economic sustainability of the fish farming operation with the proposed system it is adaptable to future technologies advancements and changing market conditions.

8.3 Cost benefit analysis

Cost can be determined by A. **Production Cost/Direct Cost**
B. **Non-production Cost/Indirect Cost**

A. Production/Direct Cost: Is the total budget that was spent on creating **Floating Robot Approach Design(Design 1)**

Table 6: Production Cost

	Components	**Quantity**	**Price**
1	**RFL PVC PIPE**	1	150 Taka
2	**90 Degree Elbow,Circular Box,Electric Tee,RFL Equal Tee,RFL Cross Tee**	10+2+9+4+2	1286 Taka
3	**PVC Pipe Cutter & Hammer**	1+1	793 Taka
4	**Plastic sheets,cable ties,glues,plastic box**	2+20+10+2	1500 Taka
5	**Clamps**	4	800 Taka
6	**Thrusters**	2	6000 Taka
7	**ESC**	2	1060 Taka
8	**Servo Motors**	1	150 Taka
9	**Raspberry Pi 4 Model(4GB)**	1	16500 Taka
10	**Underwater Camera(Akaso EK 7000) MicroSD card(Transcend 64 GB)**	1+1	11700 Taka
11	**Rechargeable Lipo Battery**	1	2700 Taka
12	**Wires & Cables**	1	300 Taka
13	**Remote Controller**	1+1	450 Taka
14	**Power Bank**	1	1500 Taka

B. **Non-production Cost/Indirect Cost:** The cost which is required for testing our prototype after seeking permission from fish farmers,generally requires a fee for testing in their fish farm/fish tank.

Benefits

1. **Financial gain:** The revenue increase from implementing a floating robot approach for detecting diseased spots on fishes in an indoor fish farm is driven by several key factors. Early disease detection ensures prompt intervention, reducing mortality rates and promoting a healthier fish population. This not only improves fish quality but also minimises the need for extensive and costly treatments, positively impacting the cost structure. With a healthier and disease-free fish population, the overall productivity of the farm increases, leading to higher yields and enhanced market competitiveness. Good quality fish, coupled with the potential to access premium markets through certification, can command higher prices, contributing to increased revenue. Moreover, the system's adaptability to market trends and its ability to instil customer confidence further support sustained revenue growth. The operational efficiency gained through automated monitoring processes can streamline farm operations, potentially reducing costs and optimising resource allocation. As a result the floating robot approach not only enhances fish health but also represents a strategic investment that can positively impact the financial performance of the indoor fish farm.

2. **Labour Efficiency:** The use of this system can enhance labour efficiency by handling repetitive and time consuming tasks.Workers may need to acquire new skills related to the operation, maintenance, and monitoring of the robotic system. Training opportunities can lead to skill enhancement and professional development. Workers may be involved in analysing and interpreting data collected by the robotic system. This involves a shift toward more analytical and decision-making roles, requiring a different skill set than traditional manual labour. Therefore, the workers can manage a larger fish population more effectively leading to increased productivity of the fish farm.

8.4 Evaluate economic and financial aspects

Economic Aspects

1. **Cost-Benefit Analysis:** Conduct a comprehensive cost-benefit analysis to assess the financial implications of the project. Identify and quantify both the costs (development, implementation, maintenance) and benefits (increased fish yield, disease prevention, operational efficiency).

2. **Labour Efficiency and Costs:** Analyse the impact of the project on labour efficiency. Assess whether the automation leads to labour savings or requires additional skilled personnel to manage and maintain the technology.

3. **Market Value of Enhanced Productivity:** Consider the potential increase in fish productivity and its impact on market value. If the project leads to healthier fish and higher yields, assess the economic value of the enhanced product in the market.

4. **Social Impact:** Consider any economic benefits derived from positive environmental and social impacts. For example, if the project contributes to sustainable practices, it may enhance the farm's reputation and market positioning.

Financial Aspects

1. **Cost Estimation:** Assess the initial costs involved in designing, prototyping, and developing the floating-based robot. Include expenses for technologies and materials used. Consider ongoing operational costs, including maintenance, energy consumption, and any necessary software updates.

2. **Long-Term Sustainability:** Evaluate the project's long-term financial sustainability by considering its adaptability to evolving technologies, market conditions, and environmental factors.

3. **Accessibility to Funding Opportunities:** With support from government initiatives, securing funding becomes easily attainable. Government financing serves as a substantial means to lessen dependence on external investors, loans, or grants, thereby ensuring the sustained progress and expandability of the project. This government-backed endeavour is in harmony with the overarching objective of promoting environmental preservation and advancing public well-being.

4. **Operational Expenses:** The costs associated with powering the robotic system, including electricity or any other energy sources required for its operation and also the expenses related to regular upkeep,repairs and servicing of the robotic system to ensure optimal functionality and longevity.

8.5 Conclusion

The project's success is gauged by evaluating the feasibility of manufacturing electronic components, ensuring the precision of image processing, and assessing its overall impact and sustainability. A thorough economic analysis is instrumental in enhancing sustainability by dissecting various economic aspects. Exploring into additional research allows for the identification of detailed aspects contributing to the project's growth. Conducting comprehensive research on economic factors not only adds significant value but also helps connect threads and elements that contribute to the project's overall success and longevity. This approach highlights how important it is to keep exploring and understanding how money works. This helps make the project strong and ready for future improvements.

Chapter 9: Ethics and Professional Responsibilities

9.1 Introduction

We had to protect the rights, dignity, confidentiality, and well-being of participants or subjects involved in the research. It established guidelines to prevent harm or exploitation of individuals who contribute to the project. Ethical research practices contribute to building trust between researchers and the public, as well as among fellow researchers. This trust is essential for collaboration, dissemination of knowledge, and the broader acceptance of the project's outcomes in society. Assessing potential risks and benefits to participants and other stakeholders needs to be studied beforehand. It aims to minimize any potential harm that could arise from the research process or its outcomes. Ethical research takes into account the broader societal implications and long-term consequences of the research. This consideration helps in ensuring that the research contributes positively to society.

9.2 Ethical issues and professional responsibility

Privacy Concerns: Handling live action camera data raises ethical concerns regarding the privacy of individuals near or within aquatic environments. Respecting privacy and ensuring data anonymity becomes crucial.

Environmental Impact: Deploying monitoring systems might impact aquatic ecosystems. Mitigating the environmental footprint by minimizing disturbance to natural habitats is essential.

Data Security: Handling sensitive data acquired through live cameras demands stringent data security measures to prevent unauthorized access or misuse.

Stakeholder Inclusion: Engaging stakeholders, including local communities, researchers, and regulatory bodies, in the project's development and implementation ensures inclusivity and addresses diverse perspectives and needs.

Transparency: This includes Clearly defining and articulating the purpose and objectives of the Remote Control Fish Monitoring System. Explain how it aligns with their problems, goals, and values. Highlight the benefits it brings, such as improving efficiency, ensuring sustainability, or enhancing data collection. Describe in detail how the system works, its key features, and how it will aid in fish monitoring. Explain the technology involved, such as sensors, data transmission methods, and remote access capabilities. Provide demonstrations or visual aids to help stakeholders understand its functionality better.Encourage stakeholder involvement and input throughout the process. Invite feedback, suggestions, and concerns from relevant parties, such as environmental agencies, fisheries, research institutions, and local communities. This collaborative approach can foster trust and support for the system.

Sustainability: One of the biggest questions when coming up with the concept of this project was its sustainability. The technological, privacy-wise, and overall usefulness of the machine.Is the technology used in the system sustainable, both in terms of its production and disposal or not? This includes considering the energy sources, materials used, and the lifecycle impact of the technology.Protecting the data collected by the system to maintain privacy and prevent unauthorised use. Ensuring data security contributes to the long-term sustainability of the system's credibility and functionality.Regular maintenance and timely upgrades are essential to ensuring the longevity and effectiveness of remote monitoring systems. This includes considerations for software updates, hardware replacements, and system calibration.strategies. These systems allow for quicker responses to changes in fish populations, environmental conditions, or threats, facilitating more effective conservation measures.Remote systems can also facilitate educational opportunities by providing accessible data and insights into fish behaviour and aquatic ecosystems, raising awareness about the importance of sustainability.

9.3 Apply Ethical Issues and Professional Responsibility:

Data Encryption and Access Control: Implementing robust data encryption methods and access control mechanisms to safeguard collected data respects individuals' privacy and addresses data security concerns.

Environmental Impact Assessment: Conducting thorough environmental impact assessments and employing non-invasive monitoring techniques minimizes disruption to aquatic habitats.

Transparency and Stakeholder Engagement: Regularly communicating with stakeholders, obtaining consent, and addressing their concerns ensures ethical practice and inclusivity throughout the project lifecycle.

9.4 Conclusion

To make sure the floating robot monitoring project goes well, as the person in charge, you have to do a lot of important things. This includes planning carefully, managing risks, handling the budget, making sure the work is of good quality, leading the team, talking to everyone involved, managing contracts, and following the rules and being fair.If you do these things well, the project can reach its goals, provide accurate information, stay within the budget, and finish on time to make the people involved happy. This can also help farmers to look after fishes with ease, use resources wisely, and support practices that are good for the environment.To sum it up, to make the system successful, you need to be good at managing different parts of the project, like using the technology, managing resources, talking to people involved, and handling money. By doing these things well, you can help the project succeed and make a positive impact on fish farming.

Chapter 10: Conclusion and Future Work

10.1 Project summary/Conclusion

The project focuses on the development of an innovative floating-based system designed for monitoring diseased fish spots within an indoor fish farming environment.The system is meticulously constructed, incorporating eco-friendly materials that align with or commitment to environmental sustainability.They key focus lies in detecting diseased spots(EUS) on fish and also to enhance the accuracy of image processing, ensuring the manufacturability of electronic components, and emphasising the sustainability and economic feasibility of the overall solution.The project's success depends on always looking at how money works, making the project strong, and finding things that help it succeed now and in the future.We've thoughtfully weighed the pros and cons of different designs to explain why we believe the **Floating Based Robot Approach** is the best option for this project.Moreover, to ensure the success and effectiveness of this project, we engaged in extensive research and utilised various software tools.

10.2 Future work

There is room for enhancements. We can boost the efficiency of the system and reduce its power usage through different adjustments. Additionally, refining the image processing and machine learning components with more data can enhance their accuracy and responsiveness. Here are some potential modifications:

Autonomous Monitoring System: For that we can develop a path planning algorithm that allows the system to autonomously plan its route based on the desired destination and environmental conditions. Utilise machine learning algorithms to enable the system to learn and adapt its navigation patterns based on previous experiences and environmental changes.

Communication Protocols: Prioritise data security by incorporating encryption and authentication measures. This is essential to protect sensitive information from unauthorised access or tampering, especially when the robot is transmitting data over potentially insecure channels.We can also select a communication protocol that is reliable and robust in different environmental conditions and ensure that it can handle potential challenges such as signal interference, varying water conditions, and other factors specific to the aquatic environment.

Enhanced Real Time Monitoring: We can train our model with more images using the algorithm that we have developed and increase the number of epochs to get better accuracy.Moreover we can also choose sensors that can provide data in a format suitable for real time processing.

Adaptive learning algorithm: Developing such algorithms is essential for enhancing the system's intelligence and responsiveness over time. These algorithms enable the robot to continuously improve its performance based on acquired experience and evolving environmental conditions.Adaptive learning algorithms empower the robot to adjust its behaviour, decision-making processes, and navigation strategies as it encounters diverse scenarios, making it increasingly adept at fulfilling its monitoring objectives.By continuously learning from its experiences, the system gets better at its job. It becomes more efficient, meaning it can do things faster and smarter. This helps a lot in making sure the fish monitoring project works well over a long time, making it a success and ensuring it can keep going without any problems.

Chapter 11: Identification of Complex Engineering Problems and Activities

11.1: Identify the attribute of complex engineering problem (EP)

	Attributes	Put tick (√) as appropriate
P1	**Depth of knowledge required**	☑
P2	**Range of conflicting requirements**	
P3	**Depth of analysis required**	☑
P4	**Familiarity of issues**	☑
P5	**Extent of applicable codes**	
P6	**Extent of stakeholder involvement and needs**	☑
P7	**Interdependence**	

Table 7: Attributes of Complex Engineering Problems (EP)

11.2: Provide reasoning how the project address selected attribute (EP)

Depth of knowledge required

For this project it is crucial to have expertise in machine learning and image processing,with a specific focus on learning python programming and knowing how to implement them on Raspberry pi. There are some other areas as well where we needed to acquire knowledge:

Power Systems: Familiarity with power systems, battery technologies, and energy-efficient design principles is necessary. This knowledge ensures the system's sustained operation and optimal power consumption. The choice of power source can tell how long the system can operate before requiring recharging.

Image Processing: Proficiency in Python programming is essential, as YOLOv8 implementations often rely on Python libraries for seamless integration. A solid understanding of convolutional neural networks (CNNs), particularly the architecture of YOLO models, is crucial. Familiarity with deep learning frameworks like TensorFlow or PyTorch is also required for model training and customization.Therefore, a solid understanding of fundamental principles in computer vision and object detection is indispensable for comprehending and fine-tuning the outputs generated by YOLOv8.

Computer Aided Design Tools: Expertise and knowledge is required for working with such tools. One of such tools that we worked with is **Fusion 360** commonly used for 3D modelling, product design, and creating detailed plans for manufacturing processes. Additionally, Fusion 360 provides features for simulation and analysis, helping users validate and optimise their designs before the manufacturing phase.

Depth of analysis required

In the first part of the project, we took a close look at many things like how the hardware should be designed, what the software should include, and the specific details and needs (specifications) of the project. We thought deeply about how the project should work, what it should do, and the important requirements it has to meet. This careful examination was crucial to make sure we understood everything well and could plan the next steps of the project effectively.

Familiarity of issues

To finish the project, we're acquiring a bunch of new knowledge. Many of the tasks involved in this project are unfamiliar to us, and we haven't received previous training to solve these kinds of problems.

Extent of stakeholder involvement and needs

The extent of stakeholder involvement and understanding their needs are crucial aspects for the success of the mentioned project. Stakeholders, which may include end-users, clients, project sponsors, and those impacted by the project, play a pivotal role in shaping its direction. By actively engaging stakeholders and comprehending their needs, the project team can ensure that the final product aligns with expectations and addresses relevant challenges. Regular communication and collaboration with stakeholders also provide valuable insights, enabling the project team to make informed decisions and adjustments throughout the development process. This involvement is essential for creating a solution that not only meets technical requirements but also satisfies the broader objectives and expectations of those invested in the project's outcomes.

11.3 Identify the attribute of complex engineering activities (EA)

	Attributes	**Put tick (√) as appropriate**
A1	**Range of resource**	☑
A2	**Level of interaction**	☑
A3	**Innovation**	
A4	**Consequences for society and the environment**	
A5	**Familiarity**	☑

Table 8: Attributes of complex engineering(EA)

11.4 Provide reasoning how the project address selected attribute (EA)

Range of resource: This project utilises a variety of resources, including image recognition algorithms, cameras, Raspberry Pi, and more. The range of resources involved in this project is extensive, covering a diverse set of tools and technologies essential for its implementation and success.

Level of interaction: Stakeholders have been consistently engaged at every stage of the project, ensuring ongoing communication and collaboration. Moving forward, our project aims to directly involve stakeholders in active participation, seeking their valuable input, feedback, and contributions.

Familiarity: We did a lot of research by reading many journal papers. The ideas for our project come from what we learned in these papers. Other researchers have shared their thoughts and findings, and we're using that knowledge to guide our project. This helps us build on what others have already discovered and use the best ideas for our work.

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Appendix

Log Book 400C

Date/Time/Place	Attendee	Summary of Meeting Minutes	Responsible	Comment by ATC
05.09.23(ATC Meeting 01)	Rakesh Zainab Abrar Emon	Showed progress that we made during the semester break	Rakesh Zainab Abrar	Bring road map for the project
06.09.23(Group Meeting 01)	Rakesh Zainab Abrar	Discussed about how we are going the works among ourselves		
12.09.23(ATC Meeting 02)	Rakesh Zainab Abrar Emon	Showed the road map of our project on how we will divide our works	Rakesh Zainab	
14.09.23(Group Meeting 02)	Rakesh Zainab	Started working with the algorithm	Rakesh Zainab	
19.09.23(ATC Meeting 03)	Rakesh Zainab Abrar Emon	Discussed about how we are going to build the prototype	Rakesh Zainab Abrar	Think more
26.09.23(ATC Meeting 04)	Rakesh Zainab Abrar Emon	Discussed about the algorithm that we created for image processing	Rakesh Zainab	
27.09.23(Group Meeting 03)	Rakesh Zainab Emon Abrar	Start building the prototype and work more on the algorithm created		
3.10.23(ATC Meeting 05)	Rakesh Zainab Abrar Emon	Discussed about how to make the system floatable	Rakesh Zainab Abrar Emon	Make changes in components
8.10.23(Group Meeting 04)	Rakesh Zainab Abrar	Took the prototype in lake to check whether it is floating or not	Rakesh Zainab Abrar	
10.10.23(ATC Meeting 06)	Rakesh Zainab Abrar Emon	Prepare slides for progress presentation		
15.10.23(Group Meeting 05)	Rakesh Abrar	Started building the food dispenser		

24.07.23(ATC Meeting 07)	Rakesh Zainab Abrar Emon	Showed the progress of our prototype	Rakesh Zainab Abrar	
01.11.23(ATC Committee)	Rakesh Zainab Abrar Emon	Progress Presentation	Rakesh Zainab Abrar Emon	Discuss more about the disease with ATC panel
08.11.23(ATC meeting 08)	Rakesh Zainab Abrar Emon	Discussed about progress presentation	Rakesh Zainab Abrar Emon	Start writing report
10.11.23(Group Meeting 06)	Rakesh Zainab	Added more components to the system	Rakesh Zainab	
14.11.23(Group ,Meeting 07)	Rakesh Zainab Abrar Emon	Took the prototype for Trial 1	Rakesh Zainab Abrar Emon	
21.11.23(ATC Meeting 09)	Rakesh Zainab Abrar Emon	Discussed about the trial of the prototype	Rakesh Zainab Abrar Emon	Need more research
25.11.23(Group Meeting 08)	Rakesh Zainab Abrar	Took the prototype for trial 2 Collected videos of the trial		
30.11.23(Group Meeting 09)	Rakesh Zainab	Took the prototype for trial 3 Collected videos of the trial		
01.12.23(ATC Meeting 10)	Rakesh Zainab Abrar Emon	Showed all the videos that we collected from the trials	Rakesh Zainab Abrar	Prepare poster for final presentation
05.12.23(Group Meeting 10)	Rakesh Zainab Abrar Emon	Poster making and completion of the prototype	Rakesh Zainab Abrar Emon	
14.12.23(FYDP Committee)	Rakesh Zainab Abrar Emon	Final Presentation	Rakesh Zainab Abrar Emon	
28.12.23		Final Report Submission	Rakesh Zainab	