Real Time Fish Physical Parameters (length and height) Measurement System

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Abstract

In fulfilling protein demand of human body, fish and fish products plays a predominant role. Demand of fish or fish products is soaring day by day. Fish farmers has to give extra effort to fulfil this growing demand. Length, width and weight determines the quality of fish. To ensure quality of every fish, fish farmer has to measure this quality manually. It takes a lot of time and effort. To make it convenient we have developed an automated real time fish physical parameters detector to attain the fish length and height from underwater without disturbing their individual movements. To edifice our model we have been used dual camera for taking 3D video from underwater and used computer vision model for detecting the region of fish are moving.Later on, we generate the length, height formula to get the height and length of fishes. We have been used six different species of fish to validate our claim.Model is placed before glass aquarium and testing one by one each sample of every fishes. For every species we get about 88%to 90% accuracy in attaining length of fishes and obtain 76% to 80% accuracy in estimating height of each species. The average accuracy rate of our model 89.96% in length estimation and 79.23% in height estimation. So, this system can be a very applicable instrument to our fish farmers as they can easily detect the physical parameters of fishes automatically without any hassle. Our system is very cost efficient as we have use only two cameras to build this model and it also a time efficient object as it count within a the parameters of fishes and this measurement is almost accurate.

Acknowledgements

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Chapter 1

Introduction

This chapter is going to give an overview of our project. It will talk about the motivation, main objective of our project and lastly it will discuss about the outcome of our project.

1.1 Project Overview

Fish is a great source of lean protein and omega-3 fatty acids. It makes huge contribution on fulfilling human protein demand [6]. To cultivate and supply fish efficiently, it is very important to know the size, length, height, weight, width properly [6]. In previous years, it was done manually. So, it took a lot of time and work to measure these parameters. In some cases, it was not possible to find this parameter accurately. Our real time fish length and width measurement system is going to find fish length and width in real time using dual camera and artificial intelligence. It is placed on fish tank of the fish hatchery. It transfers real time data of fish height and width on the computer. It ensures accurate real time data.

1.2 Motivation

In aquaculture, farmer has to ensure the size, height, width properly to trade fish. For this, they use fish measuring board to measure height and width. But is was impossible to find out the height and width of all of the fishes in the fish tank. Only 5-10 fishes were taken randomly to make an assumption on the height and width of all other fish. The size of all fishes are not same in a fish tank. There can be difference in fish size in a same fish pond. Fish size plays an important role in providing fish food. Fish can die from over feeding. Size of all fish in a fish tank should be gathered to maintain the proper health of the fish. It is utterly impossible to observe all fish length manually. Our real time fish length detection system will eradicate all of the above problem and provide accurate data of fish length.

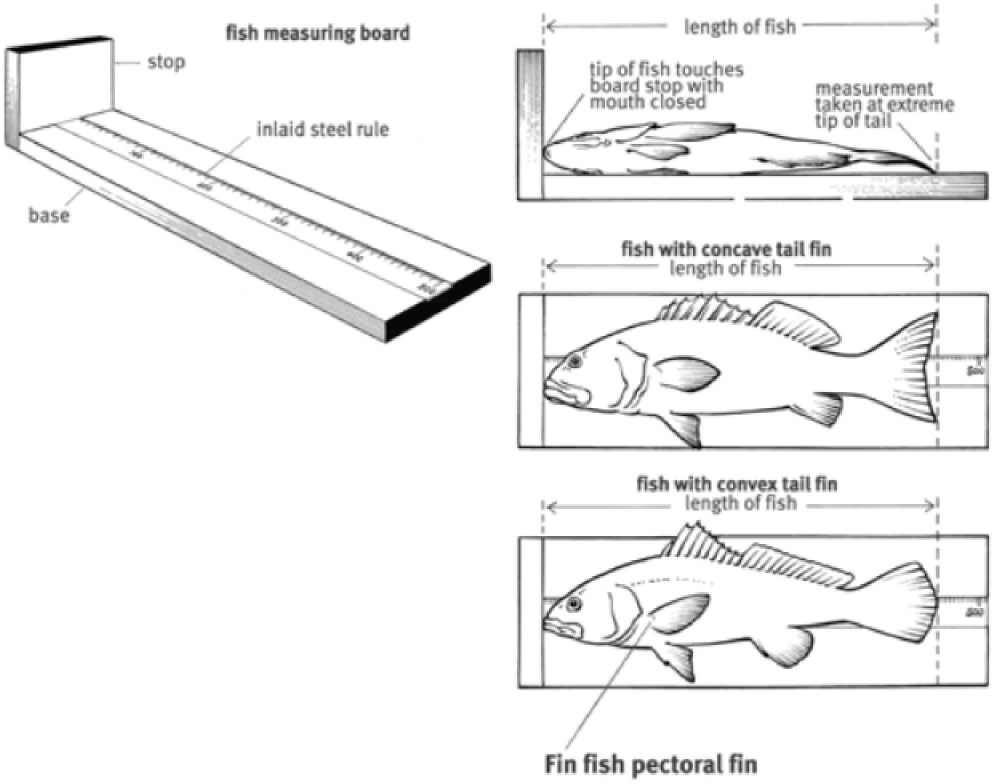


Figure 1.1: Fish measuring board [1]

1.3 Objectives

The primary objective of our research are:

- Analyse and explore the literature in detail of existing projects.
- Develop a research structure for the project.
- Develop an artificial intelligence based program to execute the project.
- Implement hardware to support the program.
- Increase the accuracy of existing technology.

1.4 Project Outcome

The outcome of this project is that the fish farmers will be able to measure length of the fish more efficiently using this system. They will be able to measure the fish length of all existing fish in the fish tank without capturing it by hand and measure one by one on fish measuring board. It will be time and cost efficient and it will also give accurate data.

1.5 Organization of the Report

1.5.1 Chapter 1: Introduction of our project

In this chapter, a brief introduction of our project is described where we tell about the motivation behind the project, key objectives of our work and the outcome of our research.

1.5.2 Chapter 2: Background

In this chapter, we described the analysis of related literature regarding our project and summarized them.

1.5.3 Chapter 3: Methodology and Design

In this chapter, we talk about the methodology and design by providing the basic requirements analysis of our project and showing steps of our work in the diagram.

1.5.4 Chapter 4:Implementation and Results

In this chapter, we talk about the implementation and results of our project. the process of achieving motives, the limitations and process by process the improvements.

1.5.5 Chapter 5: Standard and Design Constraints

In this chapter, We provide a light on the required software and hardware standards that we have used to develop our project. We have also described the constraints that we face in development our project.

1.5.6 Chapter 6: Conclusion

In this chapter, we closed the curtains of our project by summarizing all aspects of implementation. We also described the limitation of our project and the future work of our project.

Chapter 2

Background

This chapter summarizes an overview on previously used technology to measure fish size and why it should update to get better result.This would help the readers to understand the importance of implementing our system and why our system is unique to others.

2.1 Literature Review

Fish farming nowadays becoming a very common affair worldwide.In pace with increasing amount of population, the fish production sectors is also increasing. To increase the production fishes, aquaculture plays a dominant role. Because in a small place a large number of fishes can easily produce. This system is well-known almost in every developed, underdeveloped and undeveloped countries.

	1996-2005(Avg per year)	2006-2015(Avg per year)	2016	2017	2018
Production					
Capture					
Inland	8.3	10.6	11.4	11.9	12.0
Marine	83.0	79.3	78.3	81.2	84.4
Total Capture	91.4	89.8	89.6	93.1	96.4
Aquaculture					
Inland	19.8	36.8	48.0	49.6	51.3
Marine	14.4	22.8	28.5	30.0	30.8
Total Aquaculture	34.2	59.7	76.5	79.5	82.1
Total World Fisheries and Aquaculture	125.6	149.5	166.1	172.7	178.5

Table 2.1: World wide fisheries and aquaculture production [5]

In this table 2.1, Fish productions are in million tonnes. Clearly we can assume that the demand of fish in market. To meetup the increasing demand, people are now interested in fish farming.As culture are developing, with that new technologies are introduced in market to ease the human work, and make a convenient place for them.

L Burwen et al.[7] performed an experiment on estimating length of salmon fish by using an image that is taken by DIDSON Sonar. It is developed by the University of Washington's Applied Physics Laboratory for military application. DIDSON has dual discrete frequencies. One of them constructs a high resolution image by using high frequency. Another one can detect objects in far distance by using low frequency. The dimension of nominal beam of DIDSON Sonar is 29 degree in the horizon axis and 14 degree in the vertical axis. A total of 48 beams are linked that are nominally 0.548 wide and spaced across the formation at approximately 0.608 intervals. They isolated fish from crowded backgrounds and took images by using DIDSON Sonar to measure the fish length manually. But measuring the length manually from a DIDSON image is very time consuming and labour-intensive. So, it is not a practical solution [7].

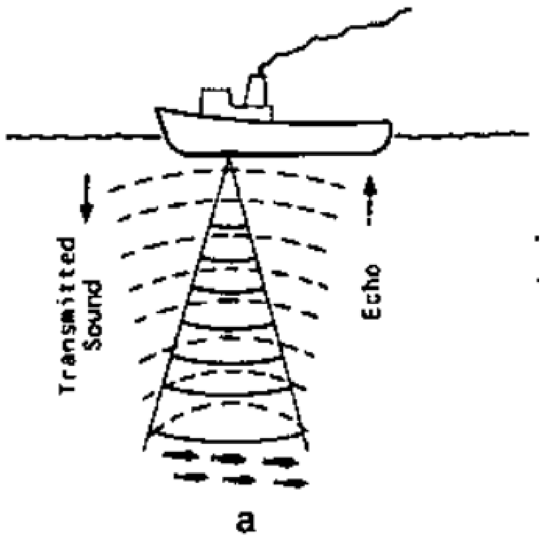


Figure 2.1: Detecting fish using sonar

C Costa et al used dual underwater cameras into his papers to extract fish size and shape from image. This image is generated by merging two images taken by dual underwater cameras. To correct the error of measurement they used neural networking. They developed a geometric algorithm to filter fish image. Two camera was mounted on a bar and synchronise by cable. They extracted geometrical properties(area, major axis length and circularity) of fish by developing a software. They used Artificial Neural Network (ANN) and training data set to correcting positioning data. Image processing is used to get the fish outline. In this process the error in length measurement is approximately 5% of fish real length. The overall approximation of fish length is almost similar as real length [8].

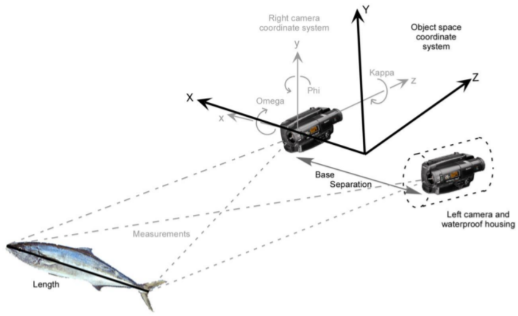


Figure 2.2: Measure fish using dual camera

Ching-Lu et al. proposed a method that gives accurate length of fish from photographs by using a single camera. To perform projective transformation, they developed pc based software. They used a square color palate as a reference to get an accurate length of fish. Proportional relationship of real fish and color palate is considered. This program has manual mode and automatic mode. In manual mode, the fish image will be uploaded first. Then it will point out the four reference points on the color palette. Then it will perform projective transformation. And finally fish length will be estimated. In automatic mode, the image will be loaded first. Then it will convert to a grayscale image. Then threshold value is extracted. Blob analysis is used to remove noise from the image. By performing Hough transformation, a straight line is determined. This straight line is compared with the color palate and finally fish length will be estimated. [2]

Figure 2.3: Measure fish using color palate.[2]

Mingming and Yu et al. conduct a study on the measurement of fish size by machine vision .This paper highlight on how to measuring fish size and describe many type of measuring tools like sonar ,single camera stereo camera. Also describe length measurement in 2D where linear measurement system calculate when fish body can be regarded as a straight line but if fish body is curved this method shown a large error . So in 2D measurement system if the fish body is curved applied nonlinear measurement system. Also described new 3D length measurement system here implement 2 stereo camera which is set up a fixed optical axis. This paper also describe about the area measurement by the fish density and length of fishes. The limitation of this paper is they do not proposed a specific solution rather they discuss about different methods [6].

Rahman et al. in their paper they described the process that they have chosen to estimate the distance of an object. Computer Vision model has been chosen for image acquisition. To capture images they have been using a digital camera that is in RGB color mode. For image color filtering HSV (Hue, Saturation, Value) model has been selected. Then detect to the colored object Moore-neighbourhood tracing algorithms has been used. When the object is represented by the bounding rectangle, they measure the distance of the object using the single point projection principle from the object height in the images. [9]

The aquaculture system is not only provide a place for growing but also plays a major role in farming aquatic species, plants etc. In their paper, Donggil Lee, Seonghoon Kim et at. research on such a thing which can reshape its body. For other existing marine animal can be measure by their two dimensional and three dimensional images. But as sea Cucumber can reshape its body and because of its wet surface the measurement was becoming difficult. And it can't give the accurate measurement. At first they work on the body length and body weight. As they don't consider the thickness the result was still inaccurate. Then they implement a regression analysis. Here they show the correlation between the actual volume and the weight of the sea cucumber was high. The algorithm was used to show the estimate of the weight of the sea cucumber by measuring their volume using vision method. This system calculated the volume of a sea cucumber by assuming its early form as a half oblate ellipsoid. It is more accurate then the past method where line laser and vision system were used by combining. This optimization was done by linear regression analysis between the actual and calculated volume of The Sea Cucumber. [10]

Figure 2.4: Detection of Sea Cucumber[3]

D.J. White et at. proposed method to automated measurement species and fish length by computer vision. They use a catchmeter system to measure the length of fishes. This system includes a conveyor, lightbox,camera and feeder connected with computer and software via the internet. They analysed their system by computer vision. In that catchemeter they placed a fish, and captured its image, from that image estimate the length of fishes by figuring out the key point. To train their system they use seven species and each species they use 100 fishes. Their length measurement had a standard deviation of 1.2 mm for the 413mm fish. Their system recognizes species with up to 99.8% accuracy for those seven species. The limitation of their paper is that their process is very time consuming that it has to place one fish in the catchmeter by another, and the other is their system perfectly measures length for only those 7 species but it may not provide good results for other species of fish [4]

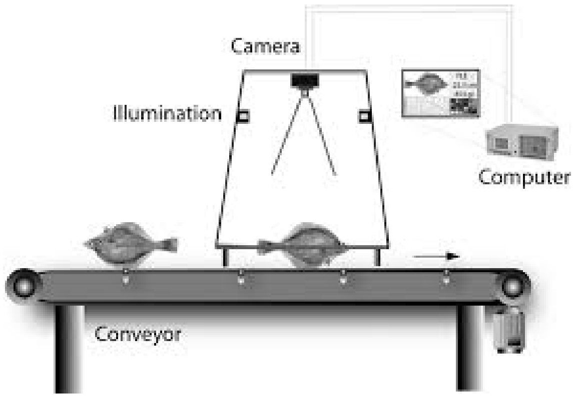


Figure 2.5: Schematic diagram of the CatchMeter system[4]

2.2 Summary

L Burwen et al. described a process to estimate the length of salmon using DIDSON sonar. They use dual frequencies sonar systems by collecting high resolution images.They isolated the fish from the crowded background and took images using high frequency of DIDSON Sonar [7]. C Costa et al used dual camera to measure the length of fish by extracting the shape of fish from the images. To generate the final image they initially collect two images using underwater dual camera. To reduce the error in their system they used widely neural network, developed a geometric algorithm to filter the fish size. They used image processing system to acquire the exact length. The approximation of fish length is 95% accurate in compare with the real length [8]. Ching-Lu et al. proposed a system to measure length of fishes provides accurate data from photographs that capture by using single camera. They developed a software that performs a projective transformation of that image. After converting the image into grayscale images, they perform Hough transformation to determine a straight line.From this straight line finally they estimate the length [2] . Mingming and Yu et al. proposed different type of measurement systems to estimate fish size in their paper. The describe how to measure length in 2D from linear measurement system.They also discuss that 2D measurement provide a good accuracy when fishes are straight and confine in a linear way They also proposed method to estimate length in 3D by dual stereo cameras by fixing a fixed optical axis. The paper also describes the area measurement method by estimating length [6]. Rahman et al. describe the process to estimate the distance of an object. In their process Computer Vision has been widely used for image acquisition. Images are captured in RGB colormode by digital camera, for filtering they choose HSV color mode. To detect objects from filtered image Moore-Neighbourhood tracing algorithm used, from detect object they estimate distance by single point projection principle [9]. Donggil Lee et al. measure the sea cucumber, an aquatic species. It is difficult to measure sea cucumber as it can reshape their body and size.They implement a regression analysis to show the correlation between actual volume and the weight of sea cucumber using Vision. This method provides more accuracy to estimate weight of measuring sea cucumber [10]. D.J. White et at. proposed an automated fish size measurement system by developing a catchmeter using Computer Vision model. Their catchmeter includes a conveyor, light box, camera and feeder system that is connected with computers and software via the internet. They place a fish in their catchmeter and capture images and figure out the key points and estimate the length. They use seven species and from every species they collect 100 fishes to train their system [4].

Chapter 3

Project Design

This chapter discussess about the design of our project. It gives out view of the technology which we choose to use in our project.

3.1 Requirement Analysis

This phase, we discuss the software and hardware requirements that we use to build our project.

3.1.1 Operating System

Operating systems play an important role in running a software. As our system is a development process so we have to choose a better operating system.

Proposed operating system

Linux is being used as operating system to develop our idea.

Linux

We choose Linux for our capstone project because it is faster than any other operating system. Linux provides a built in library that works very well with image processing and machine learning. We are using machine learning in our project and working with real time video. We need the operating system that works well with these things. That's why we choose Linux.

3.1.2 Development Tools

Since our system is a complex problem, we have to choose better development tools where libraries can easily install.

Proposed Tools

PyCharm IDE is selected as our software to develop our tools.

PyCharm IDE

PyCharm supports many programming languages including different versions of python. It supports multi operating systems. Latest developed python can easily integrate in it. We choose PyCharm IDE for our capstone project because to operate OpenCv easily to amalgamate. Installation process is also very easy. And version control for OpenCV is also easy. All the libraries that are needed for our project are available here.

3.1.3 Machine Learning Model

Different type models are being used to make a system comfortable and convenient to its user. These models are used to make the user interface friendly.

Proposed Model

To detect 3D object for measuring distance we use Computer Vision models.

Computer Vision Model

OpenCV is an open source library used for real time computer vision, machine learning etc.3D objects easily can be detected.We choose this framework for our project because it is one of the best tools in using for detecting objects in real time video. Its time consumption rate is contingently fast. We choose this as it is open source to use and its environment is user friendly.

3.1.4 Programming Language

There are many high level languages available to make a system easy to comfortable for its researcher or developer.

Proposed Programming Language

To develop our tools we use Python as our programming Language.

Python

Python is an interpreted, object oriented and high level language. It can be used for software development other than web development. Many dedicated libraries are integrated in it. We use Python programming language to develop our code as it has dedicated libraries for machine learning and deep learning algorithms. Python is faster than any other high level language and it is regularly updated its library to make its interface and libraries comfortable to its users.It is free and wide range of open source. That’s why we choose Python.

3.1.5 Hardware

In our system there are two major hardware devices needed. Dual camera i.e. is the main part of our system and Laser ranging sensor that is used as ground truth for our camera.

Dual Camera

We are using 2 cameras that are synchronised so that it gives one single image. It gives a 3D view of the object. We are using A4TECH PK-910H 1080 Full-HD webcam. It has superior low light performance. It has a view angle of 60 degrees. We mounted this camera in a bar to fix the distance between 2 cameras [8]. The benefit of using a dual camera is that it will give a more accurate 3D image of the object.

Laser ranging sensor

We are using a VL53LOX laser ranging sensor to measure the distance of the object manually to calculate the ground truth. It measure distance to an object based on the time of emitted photons to be reflected and also it is not affected by object characteristics.It provides the accurate distance ranging about 2 m.It has programmable I2C address[11]

3.2 Methodology and Design

This phase we talked about our ideas to build our project. The prerequisite steps that we need to follow to acheive our aim. Design thinking portion, we have cleared the importance of our project on environment and society, the work process that we followed. In methodology we narrate the setting up each tools. Finally, added an activity diagram to summarize the whole work in a nutshell.

3.2.1 Design Thinking

Design thinking is a philosophy and a set of tools that helps to solve a problem creatively. Design thinking focuses on human centered site of solving a problem creatively. Design thinking emphasises basically on major two things that 1) Whom we are designing for and 2) What is their needs are.

Design thinking are basically depends on major 5 steps which are helping to think creatively and helps to understand what is actually need of people.

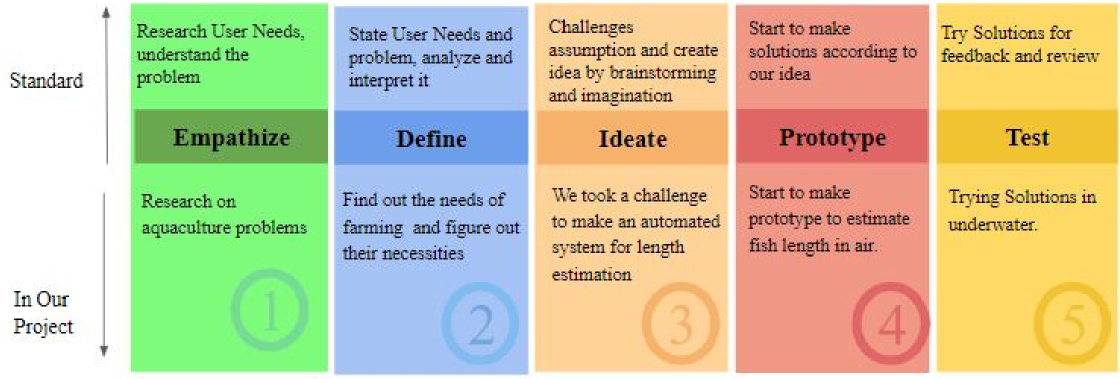


Figure 3.1: Design Thinking and its steps based on our project

Each of steps plays an important role in think in a creative way to understand the problem and finding the solution in a creative way.

Empathize: We have researched on aquaculture system, their working process, their difficulties that they face in continuing their process. We have observed that they took randomly 5-10 fishes estimate their length and based on those fish length they make assumption for other fishes to estimate their length. Consequently, many fishes are wasted as some of them are out of assumption.Those fishes cannot monitor proper way so it cannot transfer for trade in its appropriate time. Some of peasants uses measuring tapes to estimate length. So the process is very time consuming and needs more effort.

Define: From our investigation, we have find out that peasants make an assumption on fish length and based on their assumption they decide the fish ready for trade or not, the feeding amount of fishes as at different length fishes needs different amount of food.

Ideate: We took a challenge for making an automated length and height measurement system without making no harm to fishes. We proposed a solution that we use two camera to estimate distance of fishes from camera from 3D movement of fishes and base on those distance we evaluate the length and height of fishes.

Prototype: According to our idea, we have started to our prototype. At first we find out the accurate distance of object and later on that distance we estimated the length. Based on length we measure the height. Initially, we tested on air medium, as accuracy is increasing we use fish in water medium and finally get the length and height.

Test: As our prototype is working on water medium, as soon as we placed in real biofloc system.

3.2.2 Methodology and design

This phase we talk about our steps of works of the entire system. The first steps begins with a work of setup our basic tools. Setup basic tools are divided into two sub tasks.
Step 1, setting up camera tools: We have to setup camera for collecting data.Before connecting we need to set camera devices like that left and right camera work together on a single object to detect that object. For achieving those purpose The camera we use for collecting data is connected with a Laptop via USB mode.When camera connected in a lucrative way with our developed code, we can see the data in our console. Later on we have collected those data in CSV format. Kindly check figure 3.2 .

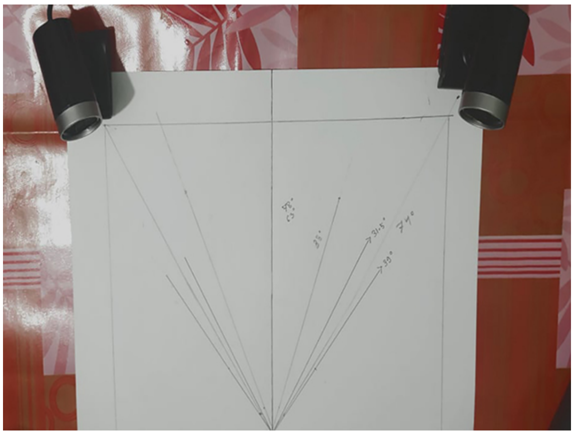
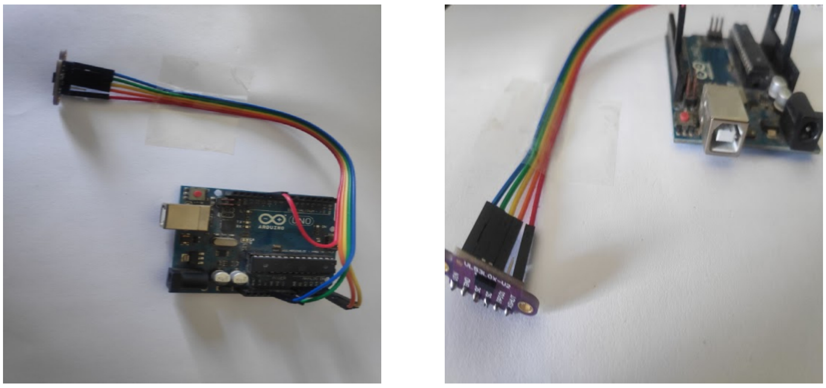


Figure 3.2: Camera setup

In this figure we have shown that how to make the left and right camera work together. In coordinate system (x,y) we use 78-degree on x-axis and 63-degree on y-axis. Next we place camera as demonstrated the i.e lenses is parallel to the x-axis to find its actual focal length on x axis i.e is about 35-degree likewise we estimated y-axis focal length is 31.5-degree. Now we have to set our camera on axis 35-degree and on y-axis 31.5-degree angle to detect a object distance.

Step 2, setting up sensor: Our next task is to set up our lider sensor VL53LOX with an arduino. This sensor use for validate our proclaim. We use this sensor for establishing ground truth because it provides accurate data for up to 2 meter distance.It is a laser sensor having 0.7g weight. For establishing our proclaimation we use different types of object at different distances and we found that then sensor provide almost 90% accurate at providing object distances. For connecting overall the connection between sensor and arduino is a piece of cake. So we choose this sensor for validate our claim[11].By connecting sensor with arduino we can collect data from our serial monitor. When our two basic tools are setup perfectly and provide our data then we have check accuracy. Please check figure 4.4.



(a) Arduino connection (b) Sensor

Figure 3.3: Arduino Setup

These figures (a)we've shown you how sensor is connected with arduino using wires and (b)the sensor. As long as the connection between arduino and sensor are established, the sensor start count the distance in to serial monitor.

Step 3, Validate Camera Accuracy: When our two basic tools have been developed we took several objects (approx. 10) of different length and height to uncover the actual distance from source to different positions. The objects are between 1x1(cm) to 25x25(cm). As we collected data using our sensor, regarding on this basis we have intensifies our camera accuracy to capturing perfect coordinates (x,y,z) of a real time object and distance of that object from source.

Step 4, Measuring Physical Parameters: After procuring distance and completing major three steps, moving forward to detect a fish on a real world,(an underwater fish detection). Later on, we use a formula to get the length of fish. For estimating fish length we use coordinates of fish position. Once we get the length of a single fish, we use another formula to get the height (or width) of that specific fish.Using length and the angle of detecting distance used to generate the formula.

Check figure 3.4

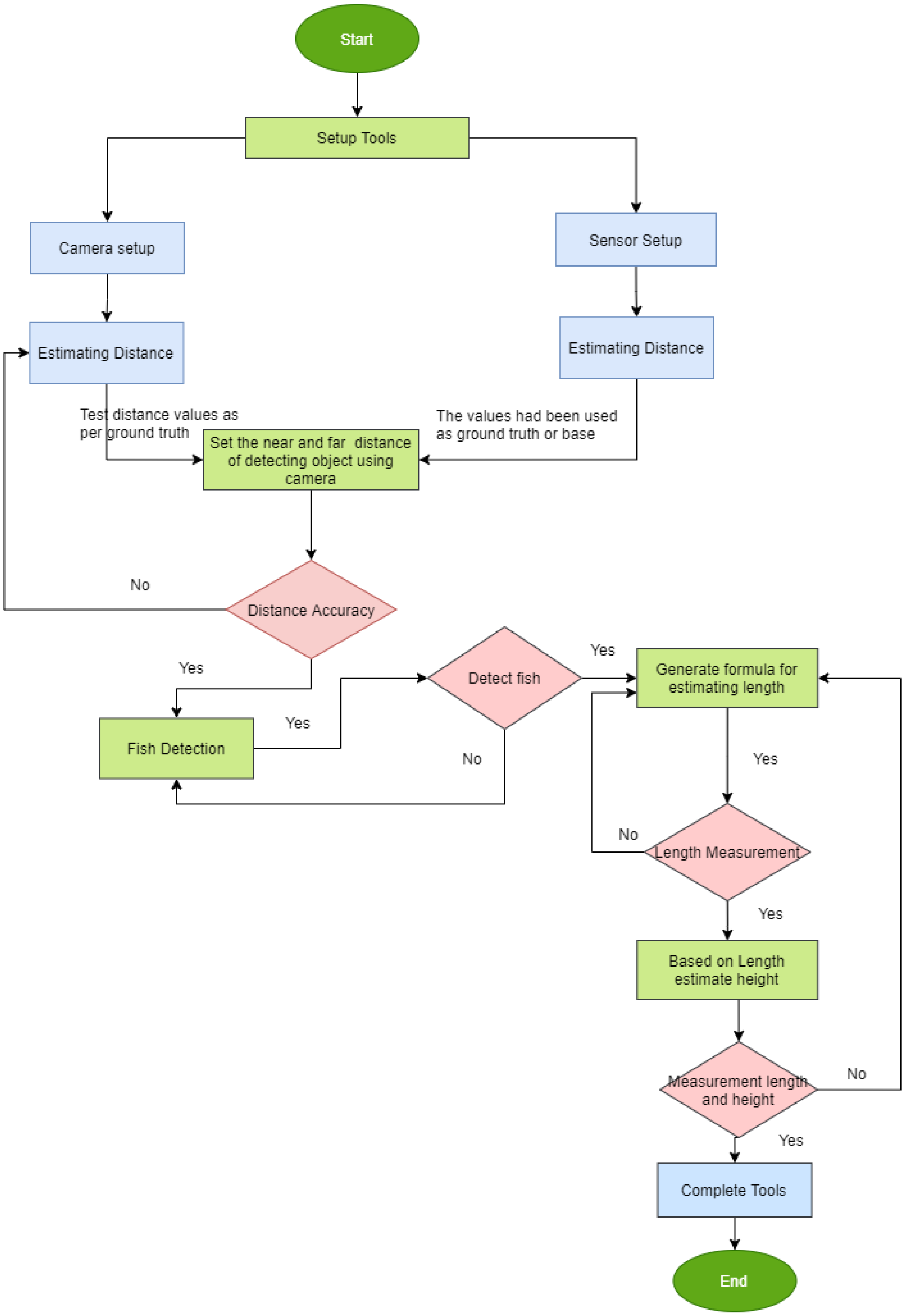


Figure 3.4: Work Flow Diagram

This figure indicates the work flow of our system, the prerequisite steps of obtaining target. Here, camera setup and increase the camera accuracy is our main challenges, after completing that we have generate two formulas to get the physical parameters.

3.3 Summary

As we have made up our aim is to build an automated fish physical parameters detector on real time. As our tools We need to fulfil some requirements of hardware and software like operating system, language as anyone can easily execute further processes, cameras that can capture clear picture of object, sensor to establish our proclaimation. Later, we are started to make our prototype, beginning with camera setup and improving accuracy, and then gradually we moving forward to get length and height of fish. Our product must be connected with a laptop or desktop to see length and height of fishes. To estimating this real time coordinates and distance of object we use computer vision framework. Our project has got astoundingly positive responses as it has a good initiative to the society. To establish our method the requirement we have selected is being discussed earlier in background part. The work flow diagram here are briefly discussed the overall work of our project.This project provides a comfortable ,convenient and hassle free and time saver environment of measuring length and height of aquatic species.

Chapter 4

Implementation and Results

This chapter provide a ray of light on the detailed process of our implementation phases. Here at first we talk about the environment set up which will provide a deep understanding of our work, then we talk about the evaluation of our project and later on we discuss about the result of our project.

4.1 Environment Setup

In order to understand our work deeply need to have a clear understand our setup of instruments.Our major task is that We use two cameras to detect a object's distance. It is very important to accurate as it decides the region when our tools able to collect fish's length and height accurately.

4.1.1 Camera Setup

According to the above illustration,it is important to set camera up perfectly. We have found focal length of both cameras is on x-axis in 35-degree and on y-axis is about 31.5-degree, this position camera is being provide most accurate result. So we have fixed our final camera device plying corksheet in this position. Check figure 4.1

Figure 4.1: Fixing Camera Position

4.1.2 Measuring Distance

As we have already illustrated that distance accuracy is must to evaluate fish body length and height measurement. Initially, we use different sizes object that at first we measure distance on different positions using sensor and later on, we use camera to measure exactly that images on that exactly same positions to check that if our system can measure distance. The sensor data is working as ground value for checking accuracy level of distance.

Object Size	Distance(cm)(sensor)	Distance(cm)(camera)	Accuracy(%)
1x1	min:1, max:40	min:1, max: 27	67.5%
2x2	min:1, max:44	min:1, max: 30	68.2%
5x5	min:1, max:44	min:2, max: 37	84%
7x7	min:1, max:44	min:2, max: 42	95.45%
10x10	min:1, max:50	min:2, max: 47	95.45%
12x12	min:1, max:50	min:3, max: 48	97.43%
15x15	min:1, max:50	min:3, max: 48	96%
18x18	min:1, max:50	min:4, max: 47	94%
20x20	min:1, max:50	min:4, max: 47	96%
25x25	min:1, max:50	min:4, max: 49	98%

Table 4.1: Distance Accuracy of Camera

by increasing objects length, the accuracy (90%(+/-)5%) of distance about (90%(+/-)5%) is larger. so we use minimum >5cm to maximum>50 cm in further procedure.

4.1.3 Length calculation

Now we are moving towards to estimating length. Left and right camera have their individual x-axis location as well as y-axis location. z-axis is using as constant for camera lenses. But moving object has individual co-ordinates(x,y,z). Check figure 4.2.

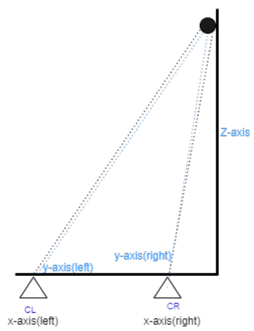


Figure 4.2: co-ordinates of moving object

Our opencv model that we use to measure distance of object, it generates co-ordinates of objects , i.e is the difference of axis

L = $\sqrt{x^2 + y^2 + z^2}$.............(1)

L indicates the fish length.

4.1.4 Height calculation

For the length we have gained, using that length we can easily obtain height using simple formula of tangent. Check Figure 4.3

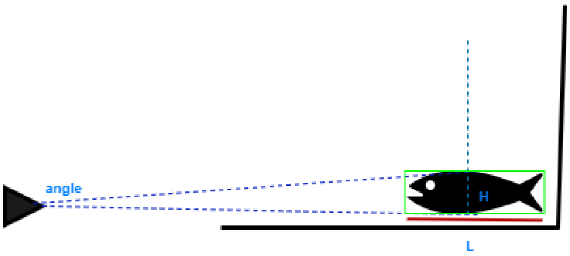
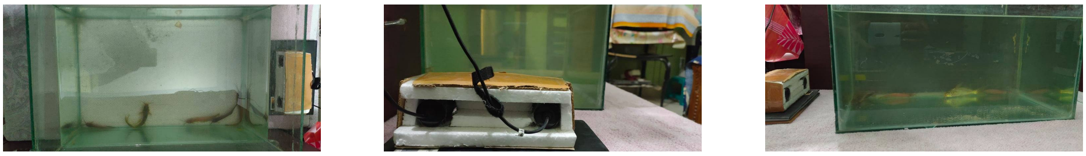


Figure 4.3: Height measurement of object

Formula for height estimation:
tanA= H/L; ....(2)
length(L) we have measured from the coordinates of axis and angle would be camera angle of y-axis, to measure a clear image of that video frame. We use this angle to estimating height. and later on, we check in air medium and by the by water medium length and height of objects.

4.2 Evaluation

This part includes a real time dataset collection. Yet, we have generate formula to estimating length and height of a real time object based on their distance and positions.Before evaluating in water medium we check in air medium to understand that if model is provide length and height perfectly or not.
Initially, we use rectangular shape object of 14(cm) Length and 5(cm) height. And we placed in before our model and our model provides the length is about 12 cm and height is 4(cm). As we have found a good response from our model, then we have tested in water model using fish and at a time we use a fish.
We use 50cm length and 30 width a glass box to contain water to continue our work.The glass box is full of water more than half of itself, we put different species and types of fish. We set our camera model outside the glass box from that point we collect the fish data.



(a) Glass Box aquarium (b) Camera Setup (c) Complete Model Setup

Figure 4.4: Real Time model Setup

Later on, we use some local breeds of fishes of Bangladesh which can easily produce in aquaculture, mostly Asian region people more used to cultivate this fishes. We have manually measure length and height(width) and using our model also to check the accuracy.

Scientific Fish Name	Sample no	Length(original)	Height(original)	Length(model)	Height(model)
Heteropneustes nani	1	15.2	2.5	16	3.3
	2	10.4	2	9	2.4
	3	9	1.9	8	1.7
	4	16.2	3.2	14.4	2.5
	5	12	3.1	13	2.5
	6	14.5	2.5	13	2.1
	7	13.7	2.3	12	3.1
	8	9.8	2.5	9	1.7
	9	9.4	3.1	8.2	3.5
Clarias batrachus	1	8.9	1.7	7.5	1.2
	2	18.1	3.7	17.5	4.2
	3	15.1	2.3	14	2.1
	4	9.4	2.2	10	2.5
	5	12.4	2.9	13	3.5
Ompok bimaculatus	1	12.4	2.7	12.2	2.5
	2	14.8	4.1	16.2	5.2
	3	9	1.9	8	1.7
	4	13.6	3.7	15	2.7
Mystus tengara	1	9.2	1.6	10	2
	2	9.5	2.1	8.2	1.5
	3	11.4	2.6	12.2	3.2
	4	6.2	2.2	6.4	2.9
	5	7.3	2.6	9.2	1.7
Channa punctata	1	9.7	4.9	8.7	5.5
	2	10.4	4.4	11.8	5.5
	3	8.9	3.2	7.2	4.1
Puntius chola	1	6.3	2.3	5.7	2.7
	2	7.9	2.7	6.5	3.1
	3	5.5	2.2	6	2
	4	8.2	2.9	10.3	3.1

Table 4.2: Length and Height of fish using model

As a sample of our model, we use local Stinging fish, Walking catfish, Putinus, Tyangra,Spotted snakehead , yellow catfish. This are very common fish of this region. All of these samples are under Actinopterygii class of different order. In our tables we use scientific name of each species. In table 4.4, shown the number of samples of each species.

Using these physical parameters of these species we figure out the accuracy of model. Simply we use the common formula for figuring out the accuracy level of fishes.
Accuracy = 100 - [(|original value - approximate value|)/ original value x 100] ....(3)
Suppose, we use the first sample of our model i.e is *Heteropneustes nani*. The original length and height of fishes is 15.2 (cm) X 2.5(cm), and we estimate approximate length 16 cm and height approximate 3.3cm. Using formula we get accuracy,
Heteropneustes nani(sample 1) length accuracy is about 94.73% and *Heteropneustes nani*(sample 1) height accuracy is about 80%

Notices table 4.3 to check the length of fishes we have estimated and table 4.4 accuracy we have received for each species by our model.

Scientific Fish Name	Sample No.	Length(accuracy)	Height(accuracy)
Heteropneustes nani	1	94.73%	80%
	2	86.54%	80%
	3	88.89%	89.47%
	4	88.89%	78.12%
	5	91.67%	80.64%
	6	89.67%	84%
	7	87.59%	73.91%
	8	83.67%	68%
	9	81.91%	87.10%
Clarias batrachus	1	84.27%	70.58%
	2	96.68%	72.97%
	3	92.71%	91.30%
	4	93-62%	86.36%
	5	95.16%	75.86%
Ompok bimaculatus	1	90.38%	81.48%
	2	98.38%	73.71%
	3	88.89%	89.47%
	4	89.71%	72.97%
Mystus tengara	1	91.30%	75%
	2	86.36%	71.43%
	3	92.98%	76.92%
	4	87.67%	68.19%
	5	83.97%	73.08%
Channa punctata	1	94.85%	75.50%
	2	90.08%	84.09%
	3	80.89%	71.87%
Puntius chola	1	90.47%	82.61%
	2	82.28%	85.18%
	3	90.90%	90.90%
	4	96.77%	86.21%

Table 4.3: Accuracy of each fish detection

Order	Scientific Name	No of Samples
Siluriformes	*Heteropneustes nani*	9
Siluriformes	*Ompok bimaculatus*	4
Cypriniformes	*Puntius chola*	4
Siluriformes	*Mystus tengara*	5
Siluriformes	*Clarias batrachus*	5
Anabantiformes	*Channa punctata*	3
	Total =	30

Table 4.4: Number of sample fish

Now we will figure out each of species average accuracy, it will leads us to a direction of our project. Table 4.5 provides a light on accuracy of species.

Scientific Name	Length Accuracy	Height Accuracy
Heteropneustes nani	88.17%	80.12%
Clarias batrachus	92.49%	79.41%
Ompok bimaculatus	91.84%	79.41%
Mystus tengara	88.46%	72.92%
Channa punctata	88.61%	77.15%
Puntius chola	90.12%	86.23%

Table 4.5: Average accuracy of each Species

4.3 Results and Discussion

From the model we have implemented, provides a shining ray in determining physical parameters fish. We received a good response of our model. Product can detect each species length almost in 88% to 90% accuracy and height is about 72% to 85% accurately each of species. Our model average accuracy for length detection is 89.96% and average height detection is 79.23% .Height detection of our model is totally depend on length., as long as length accuracy increase, height accuracy will increase proportionally. As we set our model outside the glass box as you can see in figure 4.4 if we use waterproof camera model and perfect lighting setup the accuracy will surely be increase. This project will also work in underwater mode, there will be no transpose though we change model. Using a underwater model and implemented some calibration the values of fish length and height will be more accurate.

4.4 Summary

This phase we have discussed about the internal set up of our product. Initially we have identified the accuracy of measuring distance , it will lead us about the region that it can perfectly measure the fishes length and height. By increasing the quality of camera , range of distance can also increase. After satisfied the distance accuracy, we are focusing of fish detection. We check that is the model can perfectly detect a fish border. Later on, we fixed our camera device on 35-degree x-axis and 31.5-degree y-axis, and fixed that. Later on, we generate the formula of length collection using the co-ordinates of fishes and from that length finding out height of fishes. Therefore, we use some fishes in a water, placed camera outside of it, took the length and height of fishes. outstandingly, we got about 80% to 90% accuracy in attaing length of fish and about 65% to 80% accuarcy to gaining height of fishes accurately using our model.

Chapter 5

Standards and Design Constraints

This chapter in first phase we will discuss about the standard of implementation in our system and in second phase of this chapter we enlighten the disparate impacts and constraints of our project.

5.1 Compliance with the Standards

Here , we focus the light on the Software, hardware that we have used in our project.

5.1.1 Software Standard

- We have used latest PyCharm version 2020.3 as our IDE for developed our tools
- Operating system is used Linux verion 20.4lts.

5.1.2 Hardware Standard

- For camera purpose we have used A4tech 1080P (PK-910H) webcam.
- For sensor we have used VL53LOX distance measuring sensor and arduino UNO.

5.1.3 Programing Language Standard

- To develop our code we have used Python version 3.8.
- For capturing 3D video we have used computer vision , its version is OpenCV 4.1.0.25

Operating System	LINUX
Programming Language	Python Language
MarkUp Language	LaTeX
Data Formats	CSV (Comma Separated Value)
3D video capture	Computer Vision
Hardware	Dual Camera and Sensor

Table 5.1: Required Software and Hardware

5.2 Design Constraints

The constraints that we have discussed here reflects our implemented systems impact on the market. Our implemented system faces different types of constraints like economic, environmental, ethical,health and safety, society etc.

5.2.1 Economic Constraint

In Bangladesh aquaculture system is getting very popular day by day. It plays a huge impact in our GDP. But for some aberrations, they cannot get much profit. Our system provides them a very good opportunity to them to measure the fish length automatically. But as automatic measurement system is a new concept for our country, initially people may not be interested to use this system. So we have to make our system with that much fineness and convenient for the user that they do not face any difficulties or uncomfortable to use this.

5.2.2 Environmental Constraint

Each and every product has an environmental effect. As our system is basically made for fishes, we have to be careful for each life of fish. We have designed our project like that dual camera can estimate the fish length and height. So for some hatchery it may need to attach light to get proper 3D movement. So it has to be carefully check that the heat of light cannot do any harm to fishes. Overall as we use cameras for estimation, it should be regularly monitor that the system cannot consume power much.

5.2.3 Ethical Constraint

As our total system is an automated system, so we cannot compromise with our ethics. We always hidden our formula in market that we have used for finding length. So that no one use this for any illegal means.

5.2.4 Health Constraint

The fish length measurement system is an automated system which is placed on the fish hatchery to estimate the length of fishes. So the system will have to set up in a manner that it does not hamper the real life movement of fishes. In development period it would be our most concerning.

5.2.5 Social Constraint

Everyone who is related in aquaculture system, can use this automated system. But people may not be interested to use this system as they can measure length by hand and make assumption, so they may find this a little bit difficult.

5.2.6 Political Constraint

For development our tools, we always is very conscious that we are abiding by the laws. We do not take any unfair or illegal means to develop our tools.

5.2.7 Manufacturability and Cost Analysis

As our automated system is totally an physically implementation project, we have to went through the costing of our project. We always go through the budget of our project. If the products budget is very high , users may not be interested to use it.

5.2.8 Sustainability

The entire system designed in such a way that system is very tenacious.

5.3 Summary

Our goal is to make an automated length measurement system for fishes. So in our development period we are conscious about the difficulties of each level of users. As our system is a widely range system, it has huge impact on economy, environment, fishes health and above all the cost. We use the latest software and available hardware to implement our system to ensure the quality and convenience of users.

Chapter 6

Conclusion

This chapter closes the system on this report by summarizing the whole project. Later, we have discussed the limitations of our system that can be faced in implementing in real life and explain our future plan.

6.1 Summary

Developing a system is always a tough task. If it is related to the real world scenario, the task is going to be very challenging to complete smoothly and finely, Especially, when there are already existing systems available in this context. Journey of building our project and introducing our technology to our superiors was not a piece of cake. We face huge ups and downs in completing our project. First of all we have to understand the system of aquaculture. The major key points of aquaculture. The problems they face in pursuing their farming. The technology they have used to reduce their working pressure, helps them to monitor their system. Research on the aquaculture system motivates us widely to pursue our project. Later, in our implementation phase we face difficulties in collecting all the required materials. We also have faced some issues in the dataset that we have collected through our cameras. This dataset is facing a lag of accuracy in estimating distance. We have been working to improve the accuracy level by synchronizing our cameras. As soon as we have got our expected accuracy in estimating distance, we moved to our further process. We need to detect a fish, and produce a perfect co-ordinates of fish, and estimate length from that, Later we use another formula of getting height of fish.

6.2 Limitation

Although we are trying our best to make our system free from every loopholes or boundaries, still we have some problems. As we use two cameras to estimate the distance of fish, these cameras has to be same configurations. Otherwise, the focus will not be in the same point. And the vision of camera will not be stereoscopic. And the other limitations of our project is that as we use cameras for measuring distance and then length and width, system needs always adequate power supply to constantly run the devices.Unfortunately, we can estimate one fish length at a time. If we use this model with two or more fishes, it produces lengh and height of all fishes together. Which is difficult for a user to understand which fishes parameters is it. We try our best to mitigate these limitations of our system.

6.3 Future Work

Future work of our system includes the implementation of our project underwater that we use waterproof camera model to place it in water medium. Now our system can work in water the camera model is placed in air medium, from that point it collects data. As our target is to build an automated real time fish measurement system, we set up our tools that work underwater, it doesn't throttle our model. Next we use image processing to our model so that it took each frame of our video, and detect a single fish from a bunch of whole fish and it would be easier to user to understand the specific fish and its physical parameters. So for that reason we have to develop our system for waterproof cameras and connected with a better gpu for approcahing this phase.When we solve all the limitations, we can easily moving forward to plant our model in fish tanks or hatchery in a way that it does not affect the movement of fishes and easily can view the fishes and automatically estimate physical parameters of fishes..

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