IFish Farm: Monitoring and analysis of fish anomaly behavior in ubiquitous environment

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Abstract

Monitoring fish farms as controlling water quality and anomalies inside fish pond are one of the most costly and difficult task to do for fish farmers. Usually, fish farmers are doing these tasks manually which can cost them time and money. The only system for water quality monitoring that exists doesn't include the most critical attribute in water quality which is what this system will focus on. We propose a system that automates the monitoring of the fish farm to reduce costs and time for the fish farmers and to help in producing more fish for industry.

1 Introduction

1.1 Background

Throughout time fishing has evolved in multiple ways until humans reached the idea of growing there own fish and that was the birth of fish farms which have become important in the modern life as they have a huge contribution to the economy and ensures a reliable supply and wide distribution of fish all over the world. Fish farming is a costly and tedious process which needs a lot of labor work. More than 67% of the costs of a fish farm goes to the labor work especially in the tilapia fish which is most commonly farmed in Egypt [1]. Our system aims to aid fish farmers with a solution to their most time/labor intensive tasks to help them focus on their fish production and other more important tasks.

1.2 Motivation

1.2.1 Market Motivation

Since the country is putting a lot of focus on fish farms in the mean time for economical growth, they suffer from many problems as they have to check the water quality frequently, they need continuous surveillance over the fish ponds to check if the fish are dying due to any cause, while keeping track of fish size.

They also need to track fish behaviors so a system is needed to monitor fish health, size, count, feeding times, and check the water quality. According to Shaalan et al. [2] the aquaculture business in Egypt provides about 77% of national fish production and provides about 580,000 jobs for workers in this part. In addition, The estimate for aquaculture fish production exceeds USD 2 billion annually, as shown in figure 1.

Fish species	Production value (USD 1000 /year)
Nile tilapia	1,039,056
Carps	449,150
Mullets	303,484
Gilthead seabream	90,558
European seabass	50,731
Penaeus shrimp	48,103
Catfish	22,933
Meagre	19,539
Total	2,023,554

Figure 1: Fish production value in Egypt

1.2.2 Academic Motivation

J. Boom, X. Huang et al. developed a tool that analyzes footage that counts the population of the fish underwater by automatic video processing software [3]. Rodriguez et al. proposed a computer vision based system that uses image processing algorithms to study fish behavior and size in the pond [4].Luo , Li et al. present a precise and automatic algorithm for the recognition and counting of fish in video footage of fisheries activities [5]. Parra et al. propose a system using sensors to control the water quality and fish behavior in fish ponds [6].

1.3 Problem Definitions

Reducing the time and costs needed to maintain a fish farm by offering real-time feedback on water quality, while predicting various causes of fish behavior in the pond at a decent accuracy.

2 Project Description

Providing real-time detection of fish behavior in the fish farm pond while checking water quality for toxicity to reduce fish diseases or deaths in the pond.

2.1 Objective

The primary aim of the project is to offer an easy to use application that can help the fish farmers to monitor their farm in more efficient and easy way. The

application will notify the farmers of any changes by offering cheap and real-time observation of any anomalies in the fish pond as speed and size while checking water quality for any toxic ammonia that causes fish death.

2.2 Scope

The system will cover a number of things within its scope:

1. System will check on ammonia levels using image processing techniques.
2. System will detect any anomalies in fish pond.
3. System will monitor relative fish sizes for separation.
4. System will alert farmers after predicting any type of abnormal behavior.
5. Alert to farmer on detecting toxic level of ammonia.

2.3 Project Overview

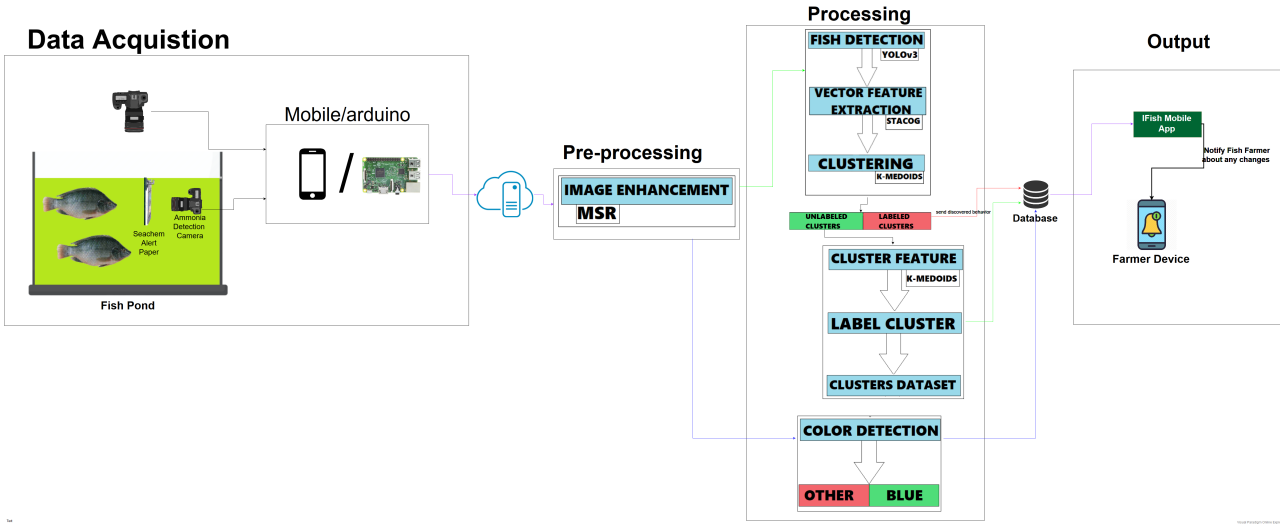

Figure 2: System Overview

Firstly, the two cameras, a camera for detecting toxic ammonia and a camera for detecting anomalies in the pond, will be connected to a mobile device/ arduino device. The device will send the raw data to the cloud storage. The cloud storage then sends the data to be pre-processed. In pre-processing, the image will be enhanced to remove any water turbidity. Our code will be written and converted to an API so we can use it on the device to provide real-time monitoring. After the API gets the image and video it will be divided into two

sections. The first section is for processing the video footage. Firstly, the video will be analyzed then the behavior will be detected after that the behavior will be clustered as normal or abnormal, and speed, abnormal size .. etc will be detected. The second section is for processing the image to detect toxic level of ammonia. The color will be detected and classified as toxic or not toxic. All of these processed data will be sent to a database. Our application then uses this database to retrieve the data and then notify the farmer on his device about any abnormal events that happen in the farm.

3 Similar System Information

1. Efficient underwater image and video enhancement based on Retinex [7]:
    - They wrote this paper to enhance turbid underwater images to get a nearly natural color of the image.
    - Their primary issue was that pictures and videos are generally rather poor in the marine settings with a low contrast, colour degradation and non-uniform illumination due to the marine enviorment.
    - They proposed an image enhancement method called "IMSRCP" which enhances images under different underwater conditions.
    - They compared their algorithms with other 4 enhancing algorithms and found out that their method is better and faster than other algorithms in most of the cases.
    - This paper is important as it gives us an underwater image and video enhancement algorithm which we can use it.
2. Development of Automatic Fish Feeding System based on Gasping Behavior [8]:
    - This paper aims to reduce fish death caused by either starvation or water pollution.
    - The problem with manual feeding is that excessive portions of food pollute the water and produce toxic levels of ammonia while reduced portions of food cause starvation.
    - The researchers developed prototype that feeds the fish automatically based on gasping behavior using a gyroscope sensor that detects water ripples.
    - The system was successful and it released accurate amounts of food when the fish was hungry.
    - This paper inspires us to use ripples caused from gasping as a feature to detect with image processing, and predict other causes for gasping behavior.
3. Fish Tracking and Counting using Image Processing [9]:

- The motivation of this paper is to rely on computer vision to count fish as manual counting is a very difficult process.
- The problem with manual fish counting is that it consumes much time and causes eye fatigue.
- The researchers used image processing techniques (blog analysis and euclidean filtering) to automate the process of counting fish.
- The system sometimes had over counting or under counting. Over counting was caused due to lighting conditions.
- This paper is helpful because it provides a good basis for counting fish from the same camera position we will use.

4. Underwater image enhancement using guided trigonometric bilateral filter and fast automatic color correction [10]:

    - The researchers wanted to create a new and fast algorithm to enhance images underwater by reducing noise level, improving global contrast ... etc.
    - Taking images underwater is challenging as it always suffer from light disortion and scattering.
    - They proposed a model consisting of trigonometric bilateral filters which is responsible for noise removal and edge preserving and ACE-based technique that colors the distorted images.
    - They compared their model with other models and found out that their model gives better result than others with better computational complexity.
    - This paper is helpful as it introduces a fast and reliable algorithm which can be used to enhance images.

5. Detecting abnormal fish trajectories using clustered and labeled data [11]:

    - they wrote this paper to analyse fish trajectories and classify them into normal trajectories and abnormal trajectories.
    - the problem with traditional way of analyzing fish behavior (human visual inspection) makes this task time consuming and limits the number of processed videos.
    - propose an approach to detect abnormal fish trajectories using an outlier detection method which is based on cluster cardinalities and a distance function.
    - their system showed 71% accuracy as average of class accuracies which is the best in this area as they say.
    - This paper is useful for us as it gives us the first steps to be able to detect ABNORMAL fish behavior in water.

6. Real-time abnormal event detection in crowded scenes [12]:

- they have presented this paper as Surveillance cameras have become ubiquitous by reason of growing security matters and low costs of equipment.
- Conventional visual surveillance relies on human analysis of videos which is ineffective with big number of cameras and causes fatigue due to long monitoring.
- they developed a system that depends on spatio-temporal representation of videos and STACOG descriptor to identify abnormal events.
- the proposed system processing time is faster than the best competing system by 26% .
- this paper is helpful as it presents algorithms to detect abnormal behaviors in videos.

7. Fish Monitoring and Sizing Using Computer Vision [4]:

   - The researches have done this paper to study biological changes on fish such as size change based on a stereo system using image processing algorithm.
   - Their main problem was getting an accurate accuracy in estimation of fish size in pond as it may indicate many factors in fish.
   - Firstly, They detected the fish by using distance map obtained by stereo-vision system using an image processing algorithm. Then, they estimate the size of the fish by a segmentation technique to detect sh in the region of the RGB space corresponding to location in the disparity map.
   - They got only 10% error rate in estimating fish size and 90% precision rate.
   - This paper helps us in detecting fish size as we can use some techniques provided to reach an accurate fish size estimation.

8. Long-term underwater camera surveillance for monitoring and analysis of fish populations [13]:

   - In order to study the effects that climate change and pollution has on the environment so Long-term monitoring was needed.
   - Long-term monitoring of the underwater environment is labour intensive work and other ways of data collection is also labour intensive.
   - they offered a system that detects and tracks fishes then recognize the fish using its color and other attributes.
   - The system is not yet fully operational, but so far the system shows a detection and tracking rate of 79.8% with a 11.8% false detection rate.
   - this paper inspired us the idea to track, count and monitor fish in the ponds.

9. Automated fish counting using image processing: [14]:

    - They wanted to automate counting fish in a pond to help giving accurate feeding as counting fish for humans is time-consuming and is subjected to errors.
    - They wanted to find an easy method with high accuracy and less computational complexity that can count fish.
    - Firstly, they used the background estimation technique to obtain the initial blob. Then, they remove the noise from the image. After that, the remaining blobs are only fish so to detect a single fish they used median area of all blobs.
    - Out of 30 frames only one frame got an error in counting of 2 excess fish.
    - This paper inspires the idea of fish counting and gives some specific details on improving images to get accurate counting of fish.

10. Amalgamation of Video Description and Multiple Object Localization using single Deep Learning Model: [15]:

    - The researchers wanted to create a model that can automatically describe the video through object detection algorithms.
    - Self-describing the content of a video is an easy task for a human being to make but for machines it's very complex and hard task to do.
    - They used YOLO object detection algorithm as a base for the proposed system. Moreover, they used other transfer learning algorithms.
    - Their proposed model gives better result compared to other two models as it's faster and got less memory overhead.
    - This paper though it's far from fish domain but gives us YOLO object detection algorithm which we can use it to detect fish size , count ,.. etc.

3.1 Similar System Description

A system called "Nilebot" got the same idea of monitoring water quality but its based on sensors. It gets pH, temprature and salinity reading from the water and gives alert to the farmers through SMS.

3.2 Comparison with Proposed Project

Comparison points	Method	Parameters checked	Training samples	Behavior analysis
Nilebot - Water Quality Monitoring system	Sensor readings	Check on water Saltinity , pH and temprature	Not mentioned	Not available
Seneye	Sensor readings	Checks on pH, temperature, water level, light level, kelvin and ammonia levels	Not mentioned	Not available
Osmobot	Sensor readings	Checks on dissolved oxygen, pH, Ammonia and Temperature.	Not mentioned	Not available
Our proposed system	Image processing and machine learning algorithms	Check on toxic ammonia and detect anomalies in pond	-	Available

Figure 3: Comparisons

3.3 Screen Shots from previous systems

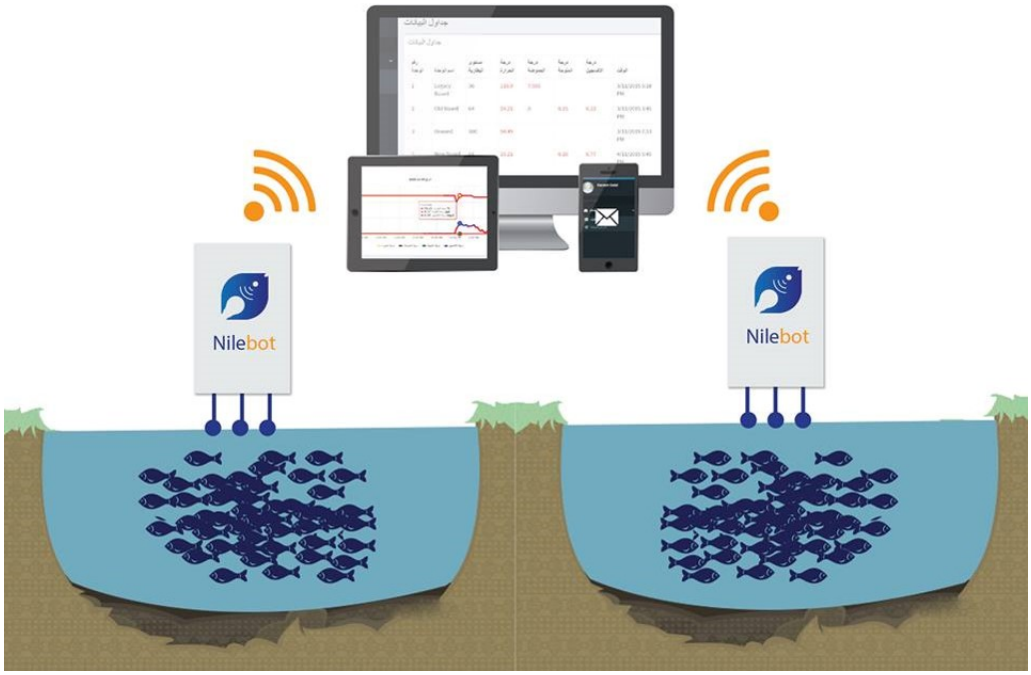

Figure 4: Nilebot system

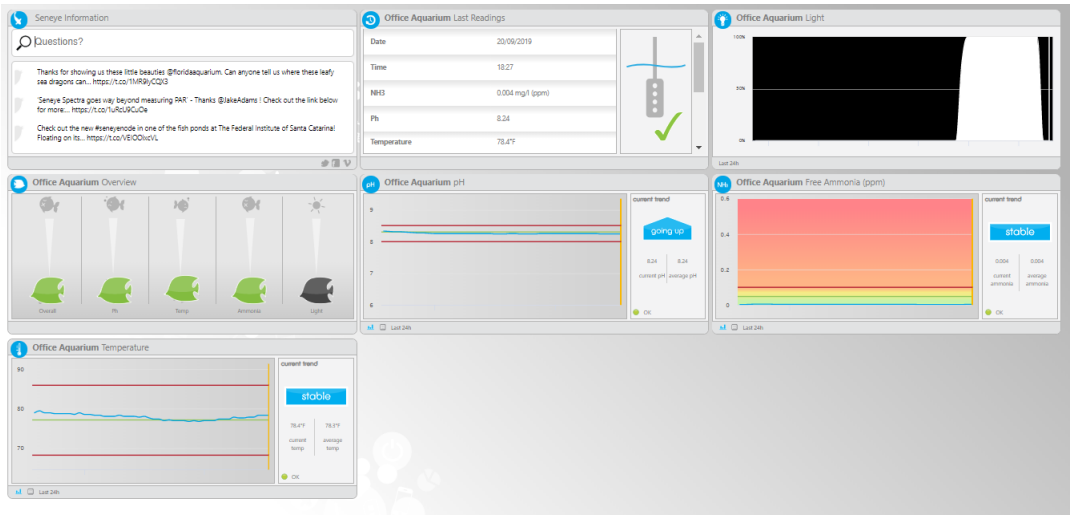

Figure 5: Seneye system

Figure 6: Osmobot system

4 Project Management and Deliverables

4.1 Tasks and Time Plan

Task	Start Date	End Date
Idea discussion	07/07/2019	28/07/2019
Idea research	29/07/2019	26/08/2019
Proposal presentation	01/10/2019	01/10/2019
SRS writing	20/10/2019	07/12/2019
SRS evaluation	08/12/2019	08/12/2019
Delivring 1st Paper	27/12/2019	27/12/2019
SDD writing	08/01/2020	14/02/2020
SDD evalution	15/02/2020	15/02/2020
Implementing prototype	15/02/2020	25/03/2020
Prototype Evaluation	26/03/2020	26/03/2020
Techinical evaluation	01/05/2020	01/05/2020
Delivring 2nd paper	05/06/2020	05/06/2020
Final Thesis	20/06/2020	20/06/2020
Final presentation	24/06/2020	24/06/2020

Figure 7: Time Plan

4.2 Budget and Resource Costs

Endoscope camera: 25 USD
Wireless webcam: 40 USD
Fish pond: 25 USD
Fish pond equipment: 25 USD

4.3 Supportive Documents

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