Fish Disease Detection System Using Fuzzy Logic Approach

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DECLARATION

I acknowledge that this Bachelor's Degree Thesis is the result of my own efforts and works, except for excerpts and summaries, each of which I have explained the source

January 21, 2022

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ABSTRACT

With recent development of technologies, the scale of aquaculture have been growing steadily. One of the biggest problem with a large scale aquaculture operation is the monitoring and detection of disease. Large operation would need expert knowledge or longer time consumption. Traditional diagnosis require human experts to diagnose the disease and this can be inaccurate. This research aims to solve this problem by providing a system to monitor the fishes remotely and to get a better accuracy of disease detection using the method of fuzzy logic. The system would help the operation to run more smoothly and reduce cost of operation for more profit. 4 common diseases were chosen for the testing of the system which was Dropsy, Fin Rot, Cotton Mouth, and Fish Tuberculosis. The system developed showed a result of 72.25% accuracy for the chosen diseases.

List of Keywords: Fuzzy Logic, Disease Diagnosis, Aquaculture, Fish Farming

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ABSTRAK

Dengan kemajuan teknologi di masa kini, skala industri akuakultur semakin mengembang. Antara salah satu masalah terbesar di dalam akuakultur ialah pemantauan dan pengesanan penyakit. Operasi berskala besar memerlukan pertolongan pakar dan juga memakan masa yang banyak. Pengesanan penyakit cara tradisional memerlukan kepakaran dan mungkin tidak tepat. Penyelidikan ini berusaha untuk menyelesaikan masalah ini dengan menyediakan sebuah sistem yang dapat mengesan dan mendiagnosis penyakit menggunakan cara Fuzzy Logic. Sistem ini akan membantu operasi berjalan lebih efisien dan mengurangkan kos operasi. 4 penyakit dipilih untuk percubaan dan ujian sistem ini iaitu penyakit Dropsy, Fin Rot, Cotton Mouth dan juga Fish Tuberculosis. Sistem menunjukkan keputusan 72.25% ketepatan pada penyakit-penyakit yang dipilih.

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LIST OF ABBREVIATIONS

PCA	**-** Principle Component Analysis
FAST	**-** Features from Accelerated Segment Test
NN	- Neural Network
IOT	**-**Internet of Things
ORB	**-**Oriented FAST and Rotated Brief
LDA	**-**Linear Discriminant Analysis
HOG	**-** Histogram of Oriented Gradients
EUS	- Epizootic Ulcerative Syndrome
UMF	- Upper Membership Function
LMF	- Lower Membership Function
ERD	**-** Entity Relationship Diagram

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CHAPTER 1

INTRODUCTION

1.1 Chapter Overview

This chapter will explain the motivation for the development of the project. It will contain problem statement, proposed approach and the project objective. The problem statement will summarize the need for the development of the system. With the solution explained in the proposed approach and the project objective of the chapter. The chapter will be organized in the order of 1.1 Chapter Overview, 1.2 Problem Statement, 1.3 Proposed Approach, 1.4 Project Objective and 1.5 Conclusion.

1.2 Problem Statement

Technology is always improving and with it, the scale of operation for many things are also getting bigger. One particular industry is the aquaculture industry that is prevalent in Malaysia. Over the past decades, the amount and scale of the industry have been steadily growing. The sector is estimated to consist of 391,000 tons of produce per year with an economic value of over USD 700 million in 2019. Figure 1.1 shows the total capture and aquaculture production statistic from Fisheries Development Authority of Malaysia.

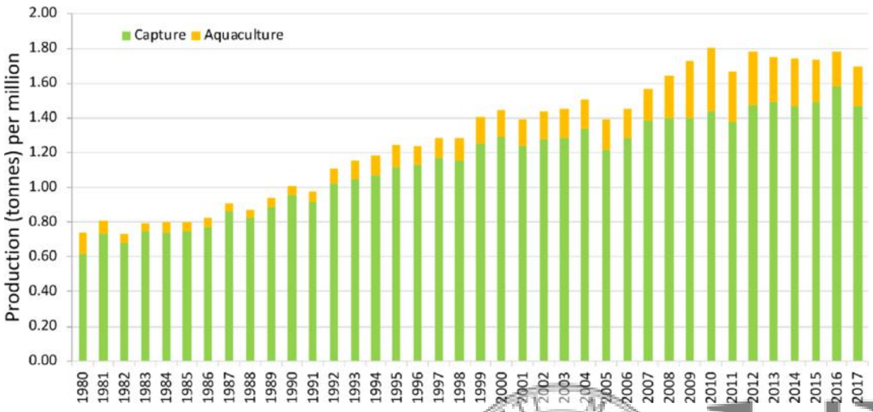

Figure 1.1 Malaysian Total Capture and Aquaculture

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With bigger scale comes bigger problem, especially for risks like fish diseases spread. Traditional diagnosing method that depends on the farmer's knowledge or by another expert can be inefficient and consume more time. This could cause the disease to spread faster in bigger scale operation and can eventually lead to major losses for the farmers.

1.3 Proposed Approach

In this project, the proposed approach is to implement an artificial intelligence system to learn and diagnose the diseases for the user. It will use a the fuzzy logic model which allows the system to diagnose based on the method of blurring the input variable and transforming it into fuzzy sets that are expressed by degree of membership, which is then processed with the fuzzy rule base before it will output the crisp value through defuzzification process. The system will also comprise of several sensors that will monitor the environment of the fish. They are comprised of a pH sensor, temperature and water level sensor. If any of these sensors detect that the input is above a set threshold, it will alert the farmer via a buzzer. This will hopefully act as an extra layer of protection as the farmer can check if the health issue is actually caused by a disease and not just poor environmental condition.

1.4 Project Objective

1. To design a model which can detect fish disease using the fuzzy logic approach
2. To implement the fuzzy logic approach in fish detection system
3. To evaluate the effectiveness and system performance towards fish disease detection

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1.5 Project Scope

- System uses Fuzzy Logic
- The system uses Multivariate Datasets which takes feeding changes, behaviour and body symptoms
- Disease example used are dropsy, fin rot, cotton mouth and fish tuberculosis

1.6 Conclusion

This system will hopefully help in the diagnosis process of the diseases for the fishes. It will be faster than the traditional diagnosis method when doing it on a large scale operation which can take a large amount of time. This can cause losses if the diagnosis are not acquired on time as it could spread even more. Too much losses can be devastating to the farmers, and can cause them to run out of business which is not good for the overall aquaculture industry.

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CHAPTER 2

LITERATURE REVIEW

2.1 Chapter Overview

This chapter describes the multiple core needs of the system to function well. As well as the existing system that have been developed in the past and how it compares to the project. The chapter will include area of concern, overall trends, proposed approach using Fuzzy Logic, existing system and comparison of existing system. Some important needs are explained in the area of concern and the relevant literature and comparison will explain how past systems tackle this problem.

2.2 Area of Concern

Fish disease detection can be difficult in certain ways. One example is accuracy of diagnosis. There have always the problem of getting an accurate diagnosis of a disease, especially if the person trying to diagnose it is not familiar with the disease. There have been attempts to do this through image processing method. By taking pictures of the diseased fish to diagnose it. These also try to mitigate the time consumed to diagnose these diseases. As the time to diagnose is also one major concern in this problem. Manual process such as taking pathological sample from the environment or the fish to be studied in a lab is accurate but consumes more time. Not to mention these method requires expensive equipment such a lab to do the diagnosis.

2.3 Overall Trends

The overall trends of systems in the aquaculture industry about the fish disease problem is mostly to mitigate losses. Trying to find ways to reduce the amount of time to detect and diagnose the disease. As well as trying to get as accurate a diagnosis as they can so the right treatment can be used. Multiple approach have been used but they sometimes lack one of the characteristic to fulfill both these purpose.

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2.4 Existing Fish Detection System

2.4.1 IoT & AI Based System

Bidossessi Emmanuel Agossou (2021) proposed a system using Internet of Things (IoT) and Artificial Intelligence (AI) to improve the management of aquaculture. The system uses sensors that gives real time data to the system, with sensors such as temperature, pH, dissolved oxygen, electrical conductibility, CO2, Ammoniac, and turbidity. These data are then sent to the central processing system where it will be displayed in the form of charts for easy visualization. They also developed an application as well as a web based platform in which the charts are displayed. The sensors will display in real time, data from the environment in the form of charts. These allow the farmers to keep an easy watch of their fish remotely without having to check it one by one. They also installed a remote controlled system where farmers will be able to control things such as oxygen pumps, water heater, water colder, and food feeder without having to physically do it. The application and the web platform will be able to do it remotely if needed.

Qualité de l'Eau / Water Quality

Parametres	Mesures	Decision	Autres
Temperature	22.31 °C	BON	Voir courbe
pH	7.76	BON	Voir courbe
Oxygène Dissoute	0 mg/L ou ppm	PAS BON	Voir courbe
CO_2	408 mg/L ou ppm	BON	Voir courbe
Ammoniac	0 mg/L ou ppm	BON	Voir courbe
Turbidité	2749.04 NTU ou units	BON	Voir courbe
Conductibilité Electrique (EC)	489.55 ms/cm	BON	Voir courbe
TDS	244.77 mg/L ou ppm	BON	Voir courbe
Niveau de l'eau	13 Cm	PAS BON	Voir courbe

Figure 2.1: Sensor data

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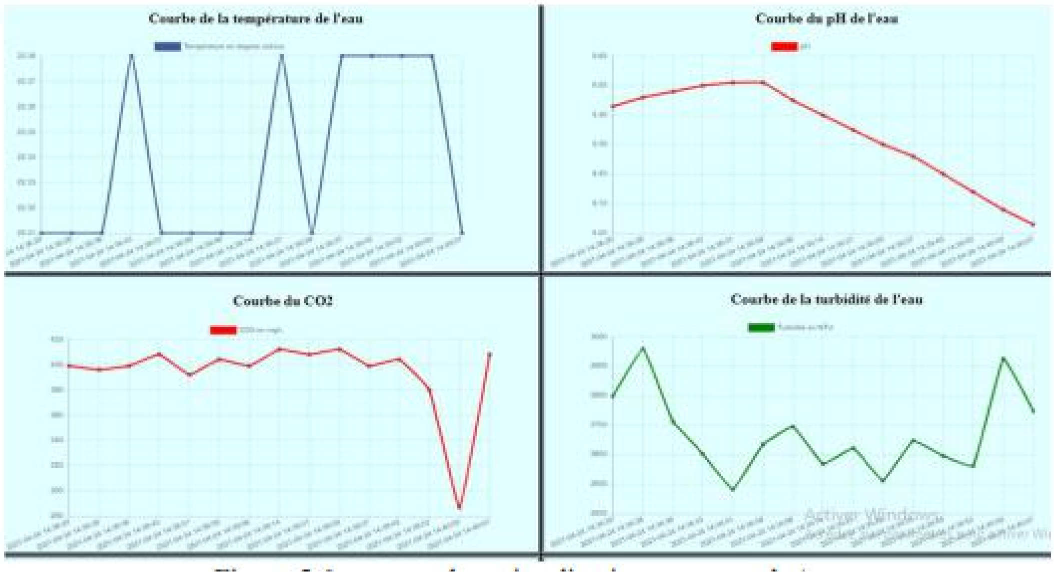

Figure 2.2: Charts Visualization

For the fish disease diagnosis, they did it via image processing via Convolutional Neural Network (CNN). Pictures of suspected fish are uploaded into the system who are then diagnosed and will later be diagnosed with the names, accuracy, and advice on what to do to prevent further infections.

2.4.1.2 CNN

CNN is described as a deep learning algorithm which finds a best set of features in a given data. It processed the data, in this case the pixels in the picture, which is approximate with a set of parameters. It contains multiple functions that acts as layers. Each layers processing the data and refining it before outputting it. The output will then later become the input for the next layer which will further process and refine the output.

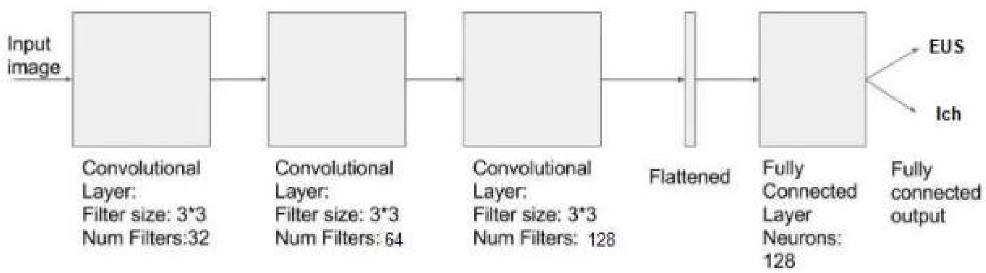

Figure 2.3: CNN System Architecture

The system was programmed to classify two diseases, *Epizootic Ulcerative Syndrome (EUS)* and *Ichthyophthirus (Ich)*. It contains three layer of the

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convolutional neural network, before giving the data to a final fully connected neural network that can process the refined data so it can output the best diagnosis. In the system, this fish disease diagnosis module is implemented in the web platform. During the training for the disease diagnosis system, they managed to acquire an accuracy of 75% out of 1600 training images. During the testing phase however, they found out that this approach was able to gain an accuracy of 55% out of 400 test images.

2.4.2 PCA, FAST and NN

Shaveta Malik, Tapas Kumar, A.K Sahoo (2017) tries to improve on this method by using a combination of Principle Component Analysis (PCA), Features from Accelerated Segment Test (FAST) and feature detector using Machine Learning Algorithm (NN). HOG is described as a feature descriptor that is used in a object detection. This is done via gradient orientation in a localized portions of an image where each image is based on a detection window and then the window is divided. It is then accumulated in a Histogram of Oriented Gradient. The gradient is then computed where its magnitude and orientation of it whether it is horizontal or vertical. It will discovers the shapes within the image and extracts all the features for the region of interest (ROI). PCA is described as a method of finding correlation between features in a data. The method reduces the dimensionality of the data that reduces non-useful information. It works well in image processing and machine learning. It picks the best principle component for the training data set to eventually reduce the transformed data. This reduces the redundant data as it only focuses on the important and the data is compressed. FAST is a corner detection algorithm which is based on intensity in the image. It will detects the corner of the given scheme and interest points in the image. Ideally, interest point should be repeatable in between images. Therefore, detecting a pattern can be useful for detecting disease in a picture.

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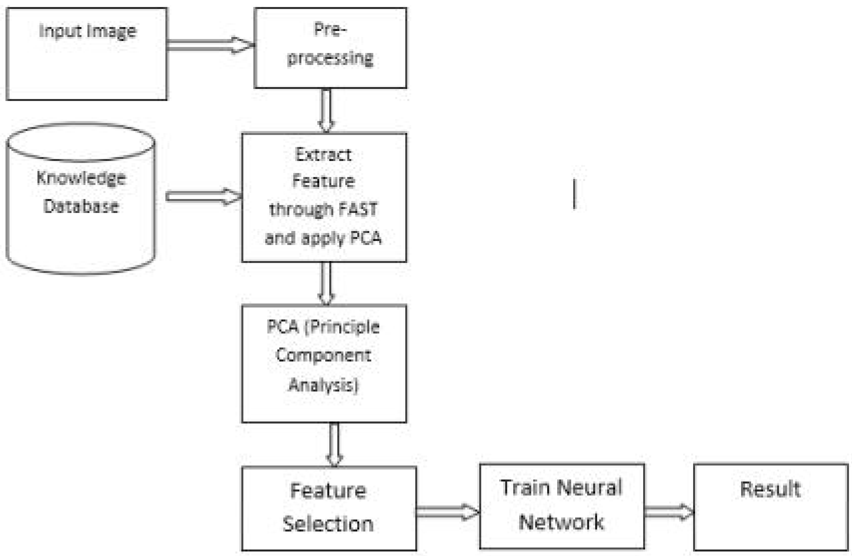

Figure 2.4: System Architecture

The proposed methodology for the system was by first pre-processing the acquired image and then the image contrast is increased, converted to gray scale, and then noise removal and segmentation. After the image was pre-processed, features are extracted using the FAST algorithm. The infected image are then treated by the PCA for better accuracy. This can finally be classified by the system between diseased and non-diseased fish. Based on their simulation, they manage to achieve up to 86% accuracy with their diagnosis. However, this design is only mainly tested on Epizootic Ulcerative Syndrome (EUS) disease which manifest as ulcers on the fish's skin which allows the system to detect it. Different kinds of diseases that have different symptoms may be problematic to use this system on.

2.4.3 FAST and HOG

On another paper, Shaveta Malik et. al. (2017), tried using another method to diagnose the EUS disease. They tried using the FAST and HOG(Histogram of Oriented Gradients) Feature Descriptor instead. HOG functions by extracting feature from every block through gradient calculation which is then normalized after cell histogram. The proposed methodology is almost the same with the previous system. An image is acquired and pre-processed with noise removal, gray scale, and applying the filter to the image. Then features are extracted using HOG and FAST before the image is classified. Combining this with FAST and machine learning they conclude that this method is slightly less accurate compared to the

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previous method of using PCA-FAST-NN with PCA-FAST-NN having a 20.2% better accuracy.

2.4.4 ORB, Decision Tree, and LDA

Eman Mohamed, and Ammar Adl (2019) proposed a system that uses image processing to diagnose diseases. They made a system that uses Oriented FAST and Rotated Brief(ORB), Fisher's Linear Determinant Analysis (LDA) and Decision Tree. The system was programmed to detect Trichodina and Gyrodactylus under a microscope. When an image is inputted into the system, the features from the image is extracted using the ORB algorithm. This method is a fusion of FAST key point detector and Brief descriptor. FAST is used to find the key points in the image. Then Harris corner measure finds the top N points.

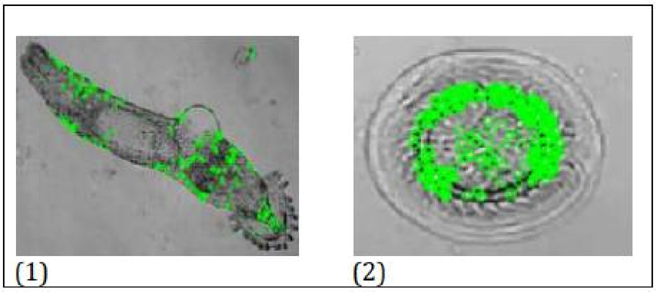

Figure 2.5: Processed Image

LDA is then used to reduce the dimensionality of the data. LDA is a method of estimating the probability of the inputs to each classes. The highest probability will become the output in which it uses Bayes Theorem to calculate the probability. Finally, Decision Tree is used on the dataset to classify the disease. During testing, this method of using ORB-DT-LDA was found to have an accuracy of 87.5% for the two disease tested.

2.4.5 Certainty Factor

Isnar Sumatorno, Diki Arisandi, Andysah Putera Utama Siahaan and Mesran (2017) developed an expert system to diagnose catfish disease using certainty factor method. The certainty factor algorithm is used to measure how confident the analysis of the problem case to achieve the solution. Experts will provide the knowledge base for the system which are then asked to the farmers via the system.

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Tailored questions will be given to the farmer and their answers are used to determine the disease. However, they found out that if the number of symptom is small, accurate diagnose can be hard due to lack of information.

2.4.6 Ontology Based

An C. Tran and M. Fukuzawa (2020) developed a Ontology based Shrimp and Fish Disease Diagnosis system. The system is described as a diagnosis support system relying on semantics. It consist of a rule-based engine and disease ontology. Ontology is an explicit and formal specification of a conceptualization. An ontology contains a finite lists of terms (classes) and relationship (properties). Classes is a way to describe the concept of the domain. An example of this is the class of disease which encompasses all diseases. Properties is the relationship between things in the domain which can be concepts, literals or instances. There can be object properties which is the relationship between instances and there is also data properties which is relationship between instances and data value. Individual is an instance or assertion in a class.

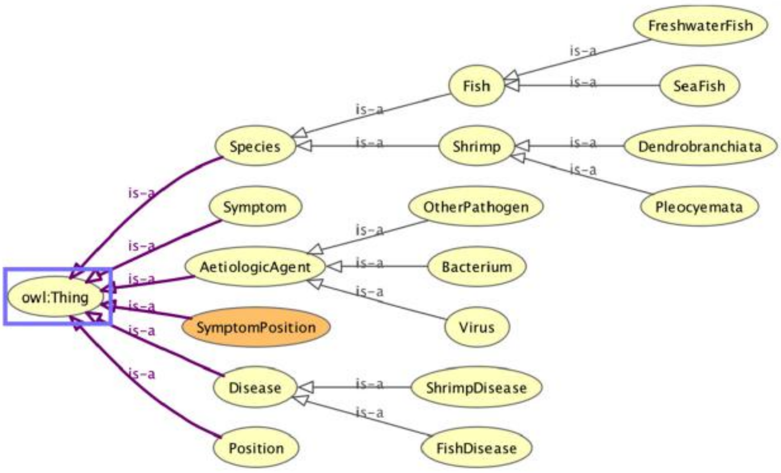

Figure 2.6: Classes in the system

The system uses web based platform to host this ontology disease diagnosis system. They used 5 test cases for the testing phase of the system. Validation result shows that it returned the correct result on all 5 test cases.

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