CHAPTER 1

INDTRODUCTION

In this section, we will explain the reasons for choosing the topic of numerical computing to calculate dissolved oxygen levels in aquaponics

1.1 Rationale

The term Internet of Things (IoT) has received much attention from academic researchers, industries, and governments in recent years. IoT aims to connect people and physical objects. It can communicate to improve the quality of life [7]. This IoT can be implemented in various fields such as smart home, smart building, smart agriculture, smart E-health, and military IoT [8].

IoT can also be implemented in aquaponics, such as in research [8] that has been carried out for automated process control and supervision to reduce human interaction in monitoring and controlling [9] aquaponic systems. Aquaponics is a combination of aquaculture and hydroponics (growing plants without soil), which in certain types, they do not require soil for plants. Plant energy resources are obtained from excess nutrients from fish feed. This method can reduce water resources and become an alternative solution for fish farming or farming in limited areas. In the implementation of aquaponics, balance, and supervision are needed to maintain the water quality [10].

The growth of fish and plants is affected by water quality. Seven parameters must be considered: temperature, pH, salinity, phosphate, nitrate, ammonia, and Dissolved Oxygen [11]. If the water contains too many toxins, it will most likely cause fish death in the aquaponics system. Several studies have been conducted to analyze the best time to take water samples in aquaponics systems [12], as shown in Table 1.1 However, this system is too expensive for small-scale aquaponics entrepreneurs to measure ammonia and dissolved oxygen levels using devices available in the market [13].

According to research [14], dissolved oxygen can affect the physical size of fish. Table 1 indicates that the main factor in aquaculture or pond fish cultivation is the need to maintain the stability of water quality. Another factor that can help fish breed properly is that the dissolved oxygen in the water must remain stable. Good fish growth can be evaluated with regular and measurable feeding.

Rozie's research [15] has conducted an aquaponics system to control two critical parameters of temperature and ammonia using fuzzy logic as a decision-making control method for AC motor water pump speed. Meanwhile, the author cites many related works on aquaponics systems. Most of the studies focus on simple aquaponics systems without artificial intelligence. As to support IoT 5.0, IoT devices must be added with artificial

1.2 Problem Formulation

Based on background, the problem can be formulated as follows:

1. Water quality should be controlled and monitored to obtain the best fish and plants growth.
2. In general, the DO measuring system available in the market is costly for small-scale aquaponic farming, and their internal circuit diagram structure is too complicated to develop the products [11]. The problem is whether to use a computational model to estimate DO and NH3 to substitute DO and NH3 sensors.
3. The process of validating the estimation value of both DO and NH3 with the actual sensors?

1.3 Objectives

Based on problem formulation on Based on the problems formulation section **??**, the research objectives can be divided into several parts:

1. To Estimate the value of unionized ammonia uses the Emmerson formula, and the estimation of the value of dissolved oxygen concentration uses the Benson-Krause model. Dissolved oxygen sensor and Ammonia Sensor will not used on this research. Only use temperature, ph for low cost system.
2. To Validate is using Seneye sensor that have a capabilities for read a Dissolved oxygen value, temperature, ph, and free ammonia value.

1.4 Hypotheses

The proposed study aims to design and develop IoT architecture for smart aquaponics, where real-time monitoring and decision support in aquaponics can reduce the negative impacts on the growth of animals and plants. The hypothesis of this research are as follows:

- Premise 1: The Benson-Krause[17] formula can be used as an alternative to determine the value of dissolved oxygen concentration without using a measuring device.
- Premise 2: Smart aquaponics systems can be used in aquaponics to notify when the water quality is inferior and dangerous for animals and plants and prevent or reduce losses.
- Premise 3: Fuzzy logic can help provide good water quality decision-making for the growth of fish and plants.

The system designed and developed proposes for smart aquaponics. This system has several sensors which aim to take the value to be used to estimate the water quality estimate and the dissolved oxygen concentration value and develop smart aquaponics with smart environmental monitoring and control systems.

1.5 Scope of work

A validation device is needed that is already available on the market or has been frequently used by some aquaponics or aquaculture owners, namely Seneye Reef. The device has the advantage of providing NH3 values, temperature, pH, dissolved oxygen. It helps validate the estimated dissolved oxygen value obtained using the Benson-Krause formula and also the estimation of the NH3 value using the Emmerson formula.

1.6 Research Methodology

The methodology used in this research as follow:

1. Problem Identification
   The literature study is conducted in the problem identification stage by reviewing previous research with similar research fields to this study, such as water quality parameters in aquaponic. This step is also to find problems in previous research to produce the solutions to overcome them.

2. Requirement Identification
   Requirement Identification consists of two parts, namely research needs, and system requirements. This process is carried out to identify the materials and methods needed in this study.

3. Model Development
   The purpose of system design is to classify all work into parts so that the implementation process can be carried out perfectly and obtain research results according to the objectives.

4. Data Collection
   At this stage aims to retrieve data that has been prepared, data in the form of temperature, pH, nh3 and other parameters.

5. Study Experimental
   At this stage aims to process the required data and perform a comparative analysis between the estimated value and the actual value.

6. Report and Analisys
   At this stage aims to provide analysis obtained from the previous stage and make a report related to this research.

1.7 Systematic Writing

The systematic of the final report writing in this study consists of five chapters as follows:

1. INTRODUCTION
   This chapter describes the background of research, problem formulation, objectives,hypothesis, problem limitation, research methodology and systematic research writing.

2. LITERATURE REVIEW
   This chapter discusses previous research related to water quality in aquaponic systems.

3. RESEARCH METHODOLOGY AND SYSTEM DESIGN
   This chapter describes the research methodology and system design in building the system of this research.

4. STUDY EXPERIMENTAL AND ANALYSIS
   This chapter describes the results of system testing and analysis of the results based on the testing scenarios in this study.

5. CONCLUSIONS AND SUGGESTIONS
   This chapter describes the conclusions obtained from this study and suggestions for further studies.