Smart Aquaponics Design Using Internet of Things Technology

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Abstract. Smart Aquaponic is a system of planting plants and maintaining fish in one container with integrated Internet of Things technology. Aquaponic is the process by which plants utilize nutrients derived from fish feces which, if left in the pond, will become toxic to the fish. Plants function as a filter of vegetation which will break down these toxic substances into substances that are not harmful to fish. Plants also supply oxygen to the water used to maintain fish. With this cycle there will be a mutually beneficial cycle between plants and fish. This system is very profitable, because the land used will not be too large. The purpose of this study was to develop a smart aquaponic system using Internet of Things technology. In this system aquaponics are equipped with sensors that function as monitors and actuators. Actuators can be controlled by users using smart phones. Sensor monitoring can be observed by users using smart phones. The method used in this study uses the Microsoft Solution Framework (MSF) with the waterfall system development method and Object Oriented Development (OOD) method. Stages in this study includes problem identification, preliminary planning and design, piloting and implementation. Conclusion: This smart aquaponics design is ready to be implemented in small scale trials.

Keywords: Aquaponic, Internet of Things, Smart Aquaponic System

1. Introduction

Indonesia is known as an agrarian country where the majority of the population is earning a living by farming. In general, agriculture is carried out on people who live or live in villages because they have enough land to carry out crop cultivation activities. Different things are felt in urban areas. In the era of the industrial revolution 4.0 agricultural land in the urban areas increasingly narrowed. Urban communities who want to grow crops are constrained by the narrowness of their agricultural land. According to [4], Limited land for agriculture, yard and water is a problem that occurs in urban and dense residential environments. Narrow yards restrict the community's activities to cultivate vegetables and fruits with the aim of supporting the improvement of family nutrition and supporting food independence. Based on this, we need a farming method that can utilize narrow land. Suitable farming methods are farming using the aquaponic system. According to [1][2], Aquaponics is a sustainable method of raising both fish and vegetables, with this type of indoor farming, you grow

substantially more food with less water, land and labor than traditional agriculture. Aquaponics, the combined culture of fish and plants in recirculating systems, Aquaponic systems offer several benefits. Dissolved waste nutrients are recovered by the plants, reducing discharge to the environment and extending water use.

In addition, the dense urban community activities can also limit the farming using aquaponic systems. Monitoring is needed that can be done anytime, anywhere without limited space and time. The solution that can be offered is to integrate IoT technology with aquaponic farming systems. Integration of IoT with aquaponic produces smart aquaponic. IoT can defined as an interconnection system among the Internet and other sensing and actuating devices which be able to operate information across various platforms via a unified framework such as cloud computing with seamless information representation, data analytics, and ubiquitous sensing [3]. It is expected that with smart aquaponic able to overcome the narrowness of existing agricultural land.

2. Literatur review

The research by [5] describe that integrating the agriculture field with Technology will make sound. Automatic soil features and condition fetching and decision taking can be done by using sensors and actuators, growing the seed and getting the yield is not the only thing, we can also provide security to farm land as well as to the product(obtained yield).

Presented [7] utilizing internet of things (IOT) model for agriculture, by victimization the projected approach, received updated info permits the farmers to address and even get pleasure from these changes. It's extremely difficult task that must give such data as a result of extremely localized nature of agriculture information specifically distinct conditions. The whole period of time and historical atmosphere info is anticipated to assist to attain economical management and utilization of resources

In the study conducted by [6], tell that the future of agriculture depends on strong partnerships between all stakeholders in the food producing industry. Developments related to agricultural research and smart technology must continue to advance in the fields of genetics, breeding, crop management, conservation and environmental protection as strategies to develop solutions to the increasing challenges of feeding the planet.

The research by [8] purpose to explore the possibility of applying IOT for agriculture to trace and track food quality and safety. Mobile application for food freshness investigation was successfully developed and the results showed that consumer mobile camera could be used to test the freshness of food. By applying the IOT technology this information could be shared with all the consumers and also the supervisors

3. Smart Aquaponics Infrastructure

Smart Aquaponics is one of the innovations that will be developed in UPY laboratory. The infrastructur is the main key of the smart aquaponics. The data of Smart Aquaponics can be accesed from mobile phone or other gadgets. Smart aquaponics consists of hardware and software. Hardware consists of water density sensor, light sensors, control for pumping motor, humidity sensor, power supplies (solar panels), wifi modules. The software consists of microcontroller programming software and user interface via the smartphone. Control system consists of atmega 328 microcontroller and ESP8266 module for wireless communication. Power supply consists of solar panels, batteries and control panels. The power supply for this system uses solar panels.

4. Proposed Work

4.1. Proposed Method

The communication in smart aquaponics consists on IoT unit that uses ethernet module with the capability of receiving and sending wireless connection. The component of IoT consists of hardware, software, cloud service. The design of hardware platform is built based on the needed. The hardware consists of microcontroller board that equipped by sensor module, ethernet module, water pump. The sensor module that being used water density sensor, light sensors, control

for pumping motor, humidity sensor. Information being sent from the sensor, then being processed and saved in cloud that transmitted to android application. The application provides information data to the users about condition in smart aquaponics system.

4.2. System Design

The system design of smart aquaponics which described in figure 1 below. The sensor consists of a light sensor, humidity, and water density sensor. The water pump is used to circulate the water circulation in the system. The water pump can be controlled with a smartphone. Power supply uses solar panels. Water density sensor is placed in the pool to determine the condition of the water in the pond. Control system uses a microcontroller that is connected to the Ethernet module. Users can find out the status of light intensity, water density through a smartphone or other device.

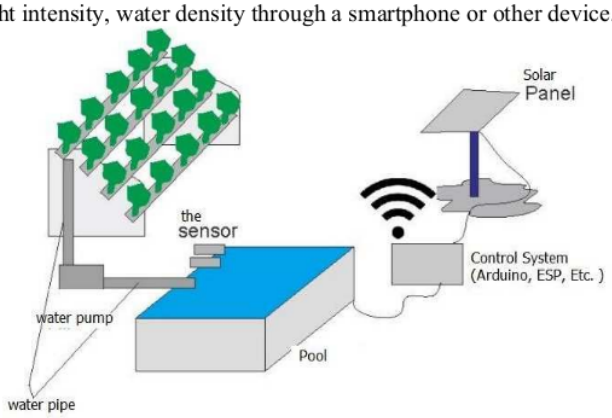

Figure 1. Design of smart aquaponics system.

4.3. Interface design

The interface design is made to facilitate users in observing information provided on the smart aquaponics system. This interface is designed according to the smartphone display. The interface consists of light information, water density, and can also control water pumps. The interface design is shown in Figure 2 below.

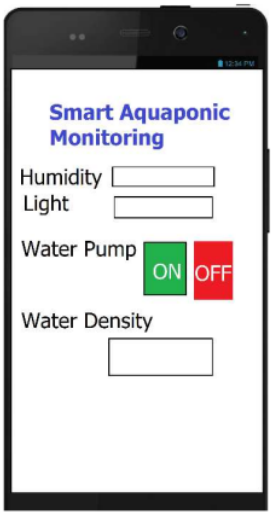

Figure 2. Interface design

5. Conclusion

IoT technology can be developed in agriculture field. The smart aquaponics system design consists of hardware and software systems. The hardware system consists of sensors, water pumps, control systems, and Ethernet modules. The software system consists of a mobile interface that functions as a user interface with the system. users can find out information from the smart aquaponics system via a smartphone. The results of this study are smart aquaponics system designs that can be tested and implemented on a small scale.

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