Crab Monitoring System (CMS) using Internet of Things (IoT's)

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Abstract. Mangrove crabs are one of the leading fishery commodities with high economic value and have the potential to remap the direction of industrial development that combines ecological, social and economic interests. The majority of mud crab demand is met from natural fishing (±61.6%). One of the crises in mud crab production is related to the low cultivation capacity (±38.4%), even though new techniques have emerged in crab cultivations. This IoT-based water quality monitoring system was developed with a transmiting and receiving system. The Transmitting system is equipped with essential sensors needed for crabs to grow, such as sensors for air temperature, water temperature, humidity, pH, DO, and tides. The receiving system can displayed the data and transmit to the cloud and data processed by other users according to their scientific field.

1 Introduction

1.1 Background

IPB University, as the oldest university in the field of agriculture and fisheries in Indonesia, has carried out many research activities on crabs from 1995 to 2020. The information carried out covers many areas ranging from crab habitat, crab diversity, crab biology, crab physiology, crab food, crabs' needs when cultivating (systems, containers, filters and bacteria) [5]. This information is the basis for developing Mangrove Crab Integration fisheries and Ecosystem Restoration for Low Carbon Fisheries. The development of crab fisheries is continuously being developed in various ways, some are carried out in aquaculture ponds, some are carried out on land using artificial locations in the form of crab apartments. This research was developed using modern technology, which currently has many embedded systems integrated into it, using internet of things (IoT's) technology by placing various sensors to detect growth parameters in the cultivated crab habitat [6].

Mangrove crabs (Scylla serrata) belong to the Portunidae family which live in almost all coastal waters, especially on beaches covered with mangroves, shallow waters close to

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mangroves, estuaries and muddy beaches. Environmental factors that can influence the growth of mangrove crabs include salinity, temperature, pH, tides and basic substrate [7]. Mangrove crabs are animals that adapt to mangroves and have a wide distribution area. This is because mud crabs have a wide tolerance to abiotic factors, especially temperature and salinity [8]. The mangrove area is a habitat for various animals including biota that live on hard and soft substrates (mud), one of which is the mangrove crab [9].

Smart solutions for monitoring of water pollution are getting more and more significant these days with innovation in sensors, communication, and Internet of Things (IoT) technology. In this paper, a detailed review of the latest works that were implemented in the arena of smart water pollution monitoring systems is presented [2],[3],[4].

Several researchers have proposed a water quality monitoring system for aquaculture. Reference [2] designed a prototype of water quality monitoring for aquaculture based on ZigBeebased wireless sensor network and the Internet of Things (IoT). Sensing data is transmitted through the ZigBee network and stored in cloud-based database. The cloud-based database provides sensing data visualization of dissolved oxygen, pH and water temperature through desktop and mobile application. Reference [3] also designed a wireless sensor network based on ZigBee for aquaculture monitoring which they deployed in a fish pond for collecting water quality parameters, i.e., dissolved oxygen, water temperature, pH and water level. They provided monitoring software system using LabWindows/CVI for displaying and analyzing acquired data sensors. Reference [4] proposed a smart water quality monitoring system using GSM network to transfer sensing data to a cloud server. The system measures water temperatures, pH, Oxidation-Reduction Potential, and conductivity. Four different water sources were tested to validate the measurement accuracy. In our research work, we developed a water quality monitoring for crab farming since raising crabs requires a great deal of attention to their environment in order to increase survival of crab in the pond.

Table 1. Index water quality for Crab Culture

Variable	Good	Moderate	Bad	Reference
Temperature (°C)	25-35	20-25	<20 & >35	Shelley and Lovatelli (2011), Cholik (1999)
Salinity (‰)	15-25	>25-30	<15 &>30	Shelley and Lovatelli (2011)
pH Water	7.5-9	6.5-7.5	<6.5 &>9	Shelley and Lovatelli (2011), Siahainesia (2008)
pH Substrate	6.5-7.5	(4-6.5) &(7.5-9)	<4 & >9	Susanto and Murwani (2006)
DO (mg/l)	>4	3-4	<3	Shelley and Lovatelli (2011)
Tide	floaded	floaded at high tide	Floaded during full moon	Field Observation

From the table above, can be used as a reference for the quality of the water parameters where mud crabs live. The quality of these waters must always be maintained so that the water quality at the cultivation location remains at the expected threshold.

To maintain water quality, internet of things technology is used which is able to monitor cultivation conditions in real time and quickly. This technology is able to carry out data acquisition quickly so that it will really support cultivator decisions in the field. With data, decisions can be made quickly or called a decision support system (DSS) [10].

Many crab cultivation techniques are used, but control of the cultivation parameters is still done manually. The parameters taken for cultivation activities are good parameters for the growth and development of mangrove crabs both in nature as a place to live and artificially, so it is very important to know the limiting parameters for the crabs to live well. Control and monitoring are carried out to find out the best parameters for mud crabs to live and can be cultivated anywhere, especially if they are cultivated in a controlled manner.

1.2 The aim of research

The aim of this research is to obtain a monitoring system using electronic and internet technology to monitor and control mangrove crab cultivation.

1.3 The benefit

The benefit of this research is to obtain the parameters needed to grow mangrove crabs in cultivation with a controlled system, so that it can increase productivity and increase the income of crab cultivation farmers, apart from that it also obtains real time and continuous data so that it can be used as research by other scientists.

2 Material and method

2.1 Time and place of research

This research was carried out for 4 months from July 2023-October 2023, at the Marine Instrumentation and Robotics Laboratory and in Brebes, Central Java

2.2 Material

The components used in this research are: ESP32 microcontroller, buffer sensor, temperature sensor, humidity sensor, distance sensor (ultrasonic), DO sensor, pH sensor, salinity sensor, router, data plan, computer/laptop, Blynk, system receiver, Arduino IDE

2.3 Method

The internet of things is a concept where an object or object is embedded with technologies such as sensors and software with the aim of communicating, controlling, connecting and exchanging data through other devices as long as they are still connected to the internet [5]. IoT has a close relationship with the term machine-to-machine or M2M. All devices that have M2M communication capabilities are often called smart devices. It is hoped that this intelligent device can help human work in completing various existing affairs or tasks [6]. To create an IoT ecosystem, we not only need smart devices, but also various other supporting elements in it. The following are the various elements that make up the internet of things:

A. Artificial intelligence is an intelligence system owned by humans that is implemented or programmed in machines so that machines can think and act like humans. AI itself has several branches, one of which is machine learning. In IoT, almost any machine or tool can become a smart machine. That means IoT has a huge impact on all aspects of our lives. This AI is tasked with collecting data, designing and developing algorithms, and installing networks.

B. Sensors; This element is the element that differentiates IoT machines from other sophisticated machines. With this sensor, the machine is able to determine

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instruments that can change the IoT machine from being passive to an active and integrated machine or tool.

C. Connectivity is also commonly referred to as connections between networks. In the world of IoT itself, there is the possibility for us to create a new network, a network specifically used for IoT devices, namely the internet network

The block diagram of the method used in this research can be seen in Figure 2, where the stages carried out in the research are explained. In this research, the following stages were carried out:

1. Hardware system design
2. Software system design
3. Product design
4. Network system design
5. System integration
6. Laboratory tests
7. Field trials at mangrove crab cultivators in Brebes, Central Java

Sensor System: Temp Ssensor, pH, DO, Ultrasonic, Humidity

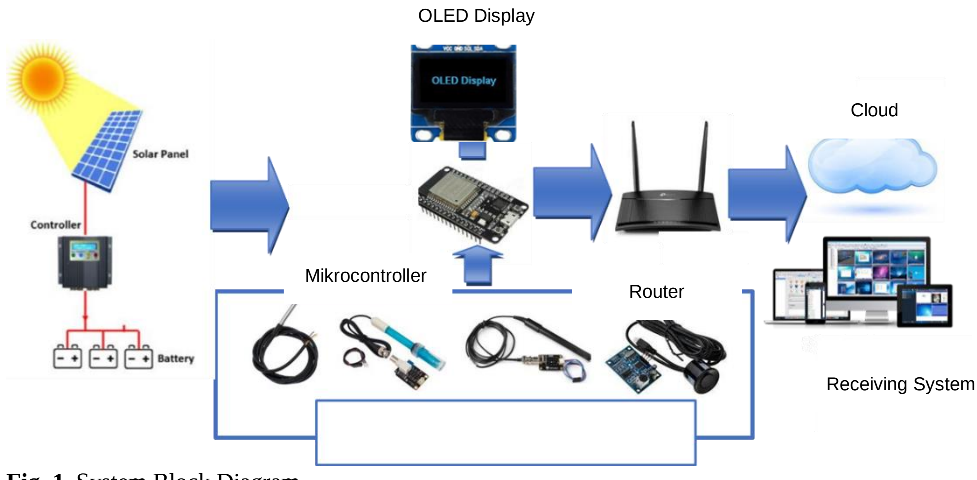

Fig. 1. System Block Diagram

In designing the hardware system, it was decided to adapt to water quality standards for mud crabs by using sensors: Temperature (T), Ultrasonic sensor (Tide), pH sensor, Dissolved Oxygen (DO) sensor and humidity sensor. All of these parameters support mud crab cultivation.

The software design, of course, adapts to the sensors inserted into the system, so an algorithm must be created to get the sensor values. The writing of the C++ programming language was carried out on the Arduino IDE (Integrated Development Environment), there are 2 programming systems, namely the ESP32 and Blynk microcontrollers to display the results of sensor data processing on a PC (personal computer) and on a gadget/cellphone
The product design reflects the finished form of the instrument after the hardware and software system functions properly and this product design will show the data display configuration on the instrument, for example how to display the data, in this study using an OLED display, apart from those displayed on PCs and cellphones.

Network system design is very important, because the system must have an internet network to function properly. This research will use a GSM (global system for mobile communication) modem, so that from this modem a WIFi (wireless fidelity) signal will be generated which will be used by Blynk to forward it to the cloud so that it can be accessed by the internet network. This network system is unique because it is one system, one ID and maintenance must be carried out every month so that the system continues to operate well.

System integration is carried out to integrate all components into one unit and function well. After all components have been successfully assembled, it is necessary to conduct a test in the laboratory to test the reliability of the system before implementing it in the field. This testing includes instrument calibration, battery strength testing, which in this case is supplied by solar panels / photovoltaics, so that its reliability can be tested.

Then, field testing was carried out on mud crab cultivators in Brebes, Central Java, and monitoring was carried out for 1 grow-out cycle in the field, so that we knew for a fact that real-time monitoring was working well and could produce data for the benefit of decision making for mud crab cultivating farmers.

3. Results and conclusion

3.1 Results

This Crab Monitoring System instrument is an innovation for monitoring water quality in mangrove crab cultivation which has high economic value, so that the water quality in cultivation can be monitored and controlled properly.

The system has been done (Fig 2.) and used electromechanical which combines electronic systems as technology that makes it easier to control and mechanics to actuate commands on the mechanical system if the threshold is met.

This water quality control system is important because crab cultivation is currently still carried out using manual methods that do not use modern technology to control water quality in cultivation areas, so with this innovation, water quality monitoring can be monitored in real time and continuously.

Fig 2. Crab Monitoring Instrument

This Crab Monitoring System instrument is an innovation for monitoring water quality in mangrove crab cultivation which has high economic value, so that the water quality in cultivation can be monitored and controlled properly.

The system used is electromechanical which combines electronic systems as technology that makes it easier to control and mechanics to actuate commands on the mechanical system if the threshold is met.

This water quality control system is important because this sending system uses solar energy as a power source, so that the instrument can work autonomously. Of course, before the design is carried out, the load profile is first calculated so that it can accommodate the system's needs. Then the parameters taken are parameters for shrimp pond cultivation, including temperature, pH sensor, DO sensor, salinity and tides (with ultrasonic sensors), can be displayed directly via OLED Display, and can be transmitted via the internet. All system settings are carried out through a microcontroller to be able to regulate all system activities, including sensor system communication, data storage system, data transmission system, data transmission time, data display, and data storage. Basically, this system is low power or requires a small amount of energy, namely around 60-150mA when standby and active, so it requires a battery that is not too large. If the capacity is 150mA x 24 hours, then 3600 mAH is needed, or 3.6Ah, therefore if the autonomy day is 2 days then need a battery with a capacity of 7.2Ah or on the market there are 7.5AH.

In the receiving system, after the data received, it must be transmitted to the cloud via the internet network, therefore, a router or modem is needed, so that the data will be stored in the cloud, then the data is processed and analyzed on a PC (personal computer). The data obtained is raw data, in the form of a CSV file, which can be opened in Microsoft Excel. Data can also be displayed on mobile phones (HP) with Blynk. The data obtained can then be analyzed and plotted according to needs. So the data obtained can be used for monitoring or control purposes, which can be used by experts, including shrimp cultivation experts, water quality experts and others.
The data will be shown in blynk network with the sensor data stored (Shown in Fig 3.)

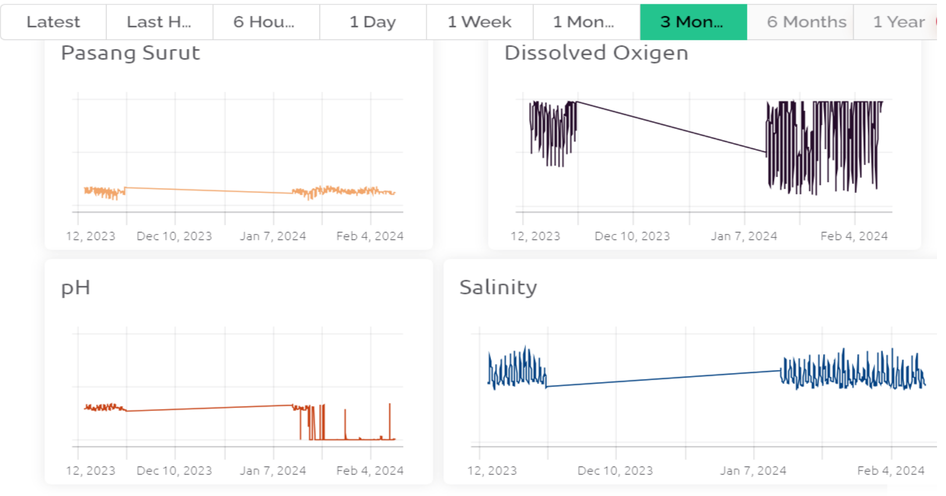

Fig 3. Data shown for 3 month data mining

On a gadget or cellphone, we will see the following display (Fig 4.):

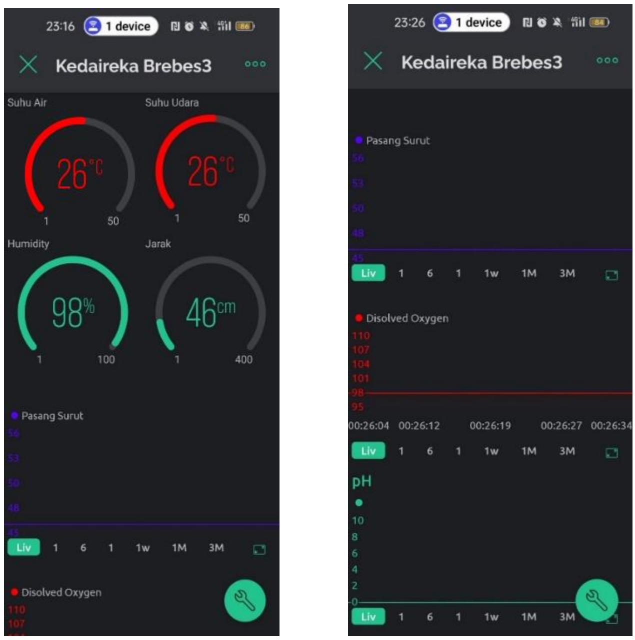

Fig 4. Data shown for Gadget or cellphone

On the gadget or cellphone, all the sensor parameters taken will be displayed, including the water temperature sensor, air temperature sensor, humidity, pH sensor, dissolved oxygen sensor, and tides.

3.2 Conclusion

1. The design of a water quality monitoring system in mangrove crab ponds has been carried out
2. The parameters taken and observed on mud crabs are water temperature, air temperature, pH, dissolved oxygen, humidity and tides. Data can be taken for 3 months and the data can continue to be tracked and developed.
3. The status of the monitoring system still has blank spots due to limited internet signal
4. It is necessary to continue developing the system until the system works well and can work continuously

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