A Literature Review onSmart Pond Management System:A Lead to Better Aquaculture

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ABSTRACT

During the course of years fish/prawn cultivation has been a very neglected subject in India. The paper presents a literature review in the field of aquaculture mainly focusing on prawn cultivation. As the name suggests smart pond management which is an electronic system designed to measure the critical environmental conditions such as pH, temperature, dissolved oxygen.The system allows the users to get the updated data online based on sensors. The paper also includes the Zig-bee communication which is used for a wireless data transfer from sensors to cloud.It also gives an overview and a clear path to achieve the smart pond management system.As the system was conceived after intensive discussion with Indian farmers; theirneed and their requirements and problems faced by them. This system will be very beneficial to the Indian farmers as their concerns are met in this system. However, wireless communication will let farmers experience a better aquaculture and less loss of cultivated products which were damaged because of unavailability of better resources.

Keywords: Aquaculture,DO,Internet Of Things (IOT), Smart pond management, Wireless transmission,Zig-bee

I.INTRODUCTION

The fish/prawn cultivation has remained highly traditional in India while one considers aquaculture. Most of prawn farmers are currently using a traditional approach in culturing their prawns which hereby leads to inefficient farming. Hence, the amount of production/hector is quite low than ones achieved after using efficient technologiesFreshwater species often tolerate poorer water quality than saltwater species along with ready access to an abundance of water, makes freshwater aquaculture accessible to local people and communities. These species need to tolerate poorer water quality than saltwater species, they also need to tolerate higher density and need to survive in smaller areas also there isn't any automation build for the Indian farmers to have a higher quality yield, the healthiness of the fish/prawn can be very highly improved by continuous monitoring the critical parameters of the pond and maintaining the parameters by keeping them in limits in which they can be healthy [1].Farmers nowadaysdo not use quality measurement test kits to measure the level of dissolved oxygen (DO),pH and temperature, the farmers normally use the color of pond water to indicate the water quality measurement.This method isn't reliable and can only be done by highly experienced farmers and is also very inefficient and can only be done twice or thrice by farmers whereas prawns require continuous monitoring of environmental parameters [2].Many previous work suggests the use of wireless sensor technology and controlling the quality of pond water. However,these works only focus their attention on the design of a smart aquaculture based on wireless sensor networks (WSN) and not by implementing the needs of farmers. Unlike the previous works, our study leads a way to better aquaculture by implementing a smart pond management system which gives data to the farmers online which is accessible from anywhere. This system sends data to cloud wirelessly by using a zig-bee to zig-bee communication and ESP8266 Wi-Fi module. The smart pond management system has a vast purpose and allows many benefits to aquaculture: (1) As and when the population increases the demand for supply also increases hence by this management the origin of production can be met to the market demand.(2) By continuously monitoring the critical parameters the quality and quantity of prawns can be increased to a larger level as suggested by UN based Food and Agriculture (FAO) in 2030 the consumption of fish will be 16.7kg per person per year hence the needs can be fulfilled through this.(3) As there will be better yield of prawns with lesser losses the production costs will decrease and the profits will increase.(4) By continuously monitoring the environmental parameters we can be prepared for major losses caused by natural calamities/disasters [3]. The rest of this paper is organized as (2) presents the design of smart pond system that is used to carry out the study of efficiency improvement. The setup, proposedafter reviewing every aspect isillustrated in (3),finally we conclude in (4).

II.SMART POND MANAGEMENT SYSTEM

In developing the system, following things were taken into consideration 1) Operability 2) Portability 3) Adoptability to different pond sizes and 4) User friendliness 5) Wireless Communication. The entire system comprises of A) Programmable pond water sampling system B) Sensing Chamber C) Sensors D) Wireless communication E) Operators interface system is further fitted on a trolley to keep it movable from one pond to another being wireless the data can be sent from far too.

2.1 Hardware requirements

a) Temperature Sensing Module

The temperature sensor used is DS18B20.The core functionality of the DS18B20 (Fig.2.1.1) is its direct-to-digital temperature sensor. The resolution of the DS18B20 is configurable (9, 10, 11, or 12 bits), with 12-bit readings the factory default state. This equates to a temperature resolution of 0.5°C, 0.25°C, 0.125°C, or 0.0625°C. It has Unique 1-Wire interface requires only one port pin for communication It has acapability that simplifies distributed temperature sensing applications which is multidrop and it also requires no external components.

Figure 2.1.1 DS18B20

b) pH and amount of dissolved oxygen sensing module

The pH sensor used is SEN0161 shown in (Fig.2.1.2) which has a BNC connector attached to it. pH stands for power of hydrogen, which is a measurement of the hydrogen ion concentration in the body [3]. The total pH scale ranges from 1 to 14, with 7 considered to be neutral. A pH less than 7 is said to be acidic and solutions with a pH greater than 7 are basic or alkaline.The sensor measure the pH and sends it to BNC which then converts it into voltage.

The dissolved oxygen sensor used, is by Atlas scientific as shown in (Fig.2.1.3) which ranges from 0.01 − 100+ mg/L, 0.1 − 400+%saturation and has an accuracy of +/– 0.05 mg/L.

Figure 2.1.2 pH sensor - SEN0161 **Figure 2.1.3 Dissolved oxygen sensor**

c) Zig-Bee pro s2b and Wi-Fi module

The Zig-Bee used is XBee PRO S2B as shown in (Fig.2.1.4) which is used for wireless communication of data sent by sensors to another Zig-Bee which will then send it to the cloud through ESP8266 the Wi-Fi module as shown in (Fig.2.1.5).

Figure 2.1.4 XBee PRO S2B Figure 2.1.5 ESP8266

2.2 System Architecture

The system uses Arduino Uno as a Microcontroller the wireless communication of data is held by ZigBee and the data is further sent to the cloud by ESP8266 Wi-Fi module and for further efficiency we can also connect

GSM module (RS232) which can send messages to the farmers cellphone as shown in (Fig.2.1.6). Power supply can be further adjusted depending on different user preferences or sensing the environment.

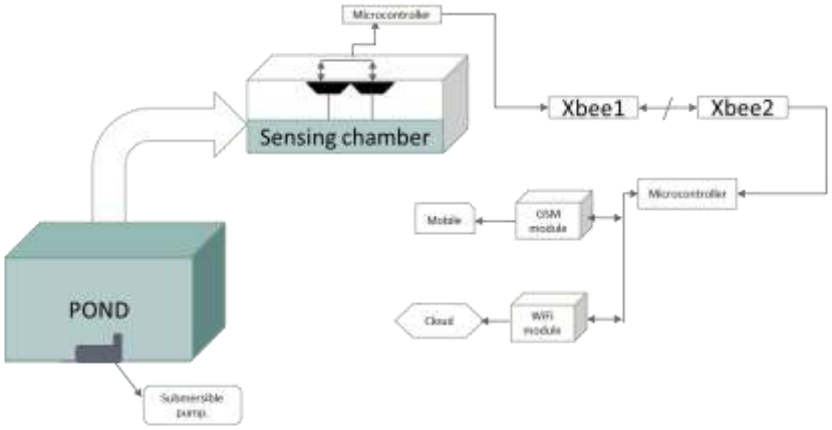

Figure 2.1.6 Hardware architecture diagram

2.2 Approach Towards Smart Pond Management System

The basic block diagram of Smart Pond Management System is shown in (fig.2.2.1) which basically shows the path to build this system. The working of this system is as follows:

1)Starting with the water in pond a submersible pump is attached, a waterproof pipe is attached to it whose other end is connected to the inlet of sensing chamberthe pump further sends the water required for testing to the sensing chamber which is air tight or vacuum contained as no environmental factors should disturb the critical parameters of the water to be tested [1].

2)The inlet pipe sends the collected water from pond to air tight sensing chamber where the sensors are attached; these sensors are designed as such that they are capable to work in worse conditions too and give a higher efficiency with accurate readings. The sensors attached further are dipped into the water collected these sensors are attached to respective connectors through which they measure and convert the readings into respective voltages. These voltages are sent to the microcontroller controlling the behavior of sensors as and when the readings are continuously measured after a period which is different with respect to size of ponds (in hector).

3) The voltages that are sent to microcontroller are further converted into actual readings by a specific formula as listed below w.r.t to three sensors installed in sensing chamber [7].

a) For temperature sensor DS18B20: for Celsius = (float)raw / 16.0; for Fahrenheit = Celsius * 1.8 + 32.0; where the raw value is the voltage received.

b) For pH sensor SEN0161: voltage = averagearray(pHArray, ArrayLength)*5.0/1024; pHValue = 3.5*voltage+Offset where the pHArray is the analog value read.

c) For DO sensor: The Sensor directly sends the digital value through the connector for which the range ranges from 0.1 -100+ mg/L.The microcontroller reads the values and processes them accordingly through the program written for each sensor respectively.

4) The readings are then sent to other microcontroller which is connected to main controlling computer the respective sensors have respective readings which are sent wirelessly through a zig-bee to zig-bee communication as shown in (fig.2.2.1)

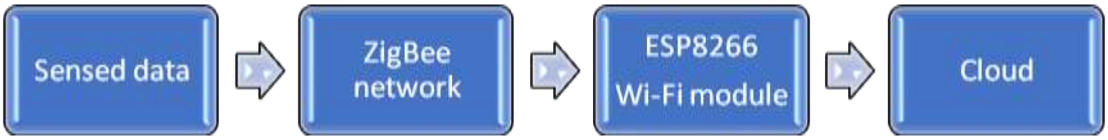

Figure 2.2.1 Overview of system architecture

The ZigBee network can also be used extensively if the number of ponds increase, by having a routing protocol. Thus, choosing what kind of routing protocol becomes essential as a slight mistake can cause serious issues and will not send the data further to cloud. There a lot of communication topologies such as star topology, tree topology, ring and mesh topology etc. as shown in (fig.2.2.2). A full mesh topology is efficiently implemented to control all the nodes in network topology. Compared to other topologies mesh topology has more advantages in increasing the redundancy, reliable as well as ease of troubleshooting [5]. Thus, mesh topology is usually referred to as self-healing and this is also the reason why mesh topology is chosen for data transmission in this work.The mesh topology with node types is defined as follows a) end devices (for sensor nodes and control nodes) b) routers (assign at the cluster head at each pond) c) coordinator (for base station node).

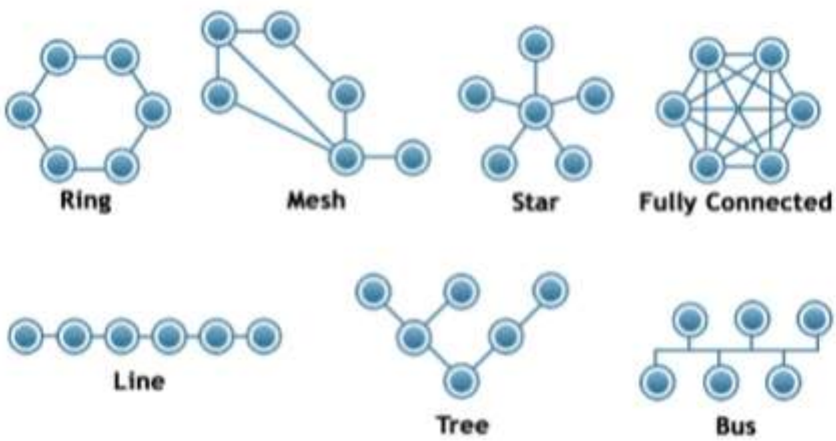

Figure 2.2.2 Different types of topologies

5) The receiver end of this system consists of a microcontroller which sends the data through ESP8266 (Wi-Fi module) to cloud where a user interface is created for accessing the data online from anywhere in the world. The data achieved through this process is processed in form of statistical charts. Internet of things as widely concerns a vast use in achieving this kind of smart pond management system. A graphical user interface can also be the end platform to thissystem, using software like MATLAB, Lab View etc. [4]. Which can also be used offline as the data can be sent easily.

III.SYSTEM PROPOSED AFTER REVIEWING PAPERS

After surveying various papers published before and doing a literature review on them the system which needs to be built. The water collected from the pond will be sensed in the sensing chamber through different sensors i.e. pH, temperature and DO. The data will be sent through a wireless communication for which we will use zig-bee to zig-bee communication which gives feasible range. The collected data or information will then be sent to cloud via ESP8266 which works as a Wi-Fi module.Hence,the data will be available online and can be accessed from anywhere a RS232 GSM Module should also be connected for warnings and alarms if certain parameter needs to be measured urgently through which this management system is user friendly and also feasible for different sizes of ponds.

IV.CONCLUSION

Having a look at different systems and the problems faced by farmers making such a system is the need of the day, as proposed by different farmers that for better aquaculture the need of this system is increasing day by day as the air and the harmful chemicals also affects water of the pond and makes it worse. Thus, this study has been successfully proposed a versatile and a low power consumption solution to monitor and manage industrial prawn/fish farms and prawn cultivating local farms. As can be seen that from the study, the variation of temperature is 3^0C which is suitable for prawns survival. There are many advantages to this system low power consumption, easy availability of critical parameters in a very less time, better quality prawn cultivation and a vast amount of increased production leading to better profits economically.The limitations to this system are very few as such only if a software or sensor fails then information wouldn’t be available, but it happens rarely the possible applications to it are very much it can be used in aquariums too with a slight change in values and prawn/fish cultivation is the main goal of it,this type of system can be used wherever cultivation takes place inside water as for example rice, water chestnut, fox nut etc. Further with some advancement we can also use RF antennas for wireless communications for a number of ponds with hectors bigger in size.

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