**CHAPTER TWO**

**LITERATURE REVIEW**

**Introduction**

Water quality monitoring will be defined as any effort made to acquire an understanding of the physical, chemical, and biological characteristics of water via data collection.

During the first quarter of the present century, water treatment processes were produced and connected to guarantee that consumable water could be made accessible to the quickly developing urban populaces. The rivers and other watercourses still received the waste discharges, but it was some time before they could no longer assimilate the residual wastes. Some of the challenges posed include, conversion of agriculture land and mangrove areas for aquaculture leads to salinization of surface water and agriculture and, besides causing pollution and diseases. Also, water flowing out of aquaculture ponds carries excessive nutrients, bacteria, pathogens, and other nutrients which harm the surroundings.

With the rapid development of society and the economy, an expanding number of human exercises have gradually destroyed the aquaculture environment affecting the environment-physically, chemically and biologically. Physically a lot of pressure is on water, chemically it is polluted and biologically it introduces pathogens and diseases. Aquaculture is the farming and husbandry of aquatic organisms (marine animals and plants) including fish, mollusks, crustaceans and plants in controlled environments. Aquaculture also varies according to the type of environment within which cultivation takes place and the species cultivated. The main environments are freshwater, brackish water, and marine. Aquaculture goes way beyond food production. Some benefits derived from aquaculture are: the increased production of food for human consumption; the opening of commercially viable business opportunities; the creation of employment, especially in rural areas; increased national exports; and the substitution of imports by local production. Hatcheries provide bait and game for both sport and commercial fishermen. Although aquaculture serves many purposes, the most important one is to supply food for humans. It also supports the food chain at a lower level by producing algae and other plant organisms for animal feed.

Therefore, measuring and monitoring the physio-chemical characteristics of the pond water and soil is extremely important to keep the check on the aquaculture conditions. Marine condition checking is a fundamental issue and has progressively pulled in a lot of innovative work consideration. During the past decade, various marine environment monitoring systems have been developed.

Currently in our country, the water analysis is done in a traditional way by taking the samples from the water sources using research vessel and sent to the laboratory for investigation and analysis. This is expensive and time-consuming and has a low resolution both in time and space. (Pandian D. R. & Dr. Mala K., 2015). This method is also cumbersome and there exist no feature of real time monitoring. Consequently, it not possible to send real time cautioning to the agriculturists to enable avoid any misfortunes.

Internet of Things (IoT) driven water quality checking framework empowers remote and constant observing of information parameters, with applications in aquaculture. Aquaculture and fish farming represent one of the most attractive application areas for the IoT. The main concept behind every IoT technology and implementation is “Devices are integrated with the virtual world of internet and interact with it by tracking, sensing and monitoring objects and their environment “. IOT breaks the limit of traditional computer networks and establishes connections directly with objects in the physical world. The core concept of this phenomenon is that IOT allows for “things” to connect to the Internet. The IOT paradigms can play a significant role in aquaculture. The IOT driven water quality monitoring system employs networked by sensors to simultaneously collect multiple physiological signals and wireless connectivity to share or send gathered signals directly to the cloud diagnostic server and the users for further analysis and review. Further, the IOT enabled remote monitoring applications can significantly reduce labor, cost and time in long-term monitoring applications (Pandian D R, Dr. Mala K & PG Scholar, 2014). In the aquaculture monitoring environment, the IOT has emerged as one of the most powerful information gathering and analysis. In this paper, the core concept is based on IOT, the information sensed from the sensors are gathered and transmitted to the monitoring station through IOT.

With this chapter, the project focuses on some of the related works that have been exhibited in the past 19 years which has led to a successful justification on how monitoring water quality systems can be a powerful tool.

**Related Works**

**Development and Test of Aquacultural Water Quality Monitoring System Based on Wireless Sensor Network.**

This project presents a review on the implementation and design aquacultural water quality monitoring system which uses wireless sensor networks. Not developing a new system but also it analyzes of limitation of existing aquacultural water quality monitoring systems. This system uses sensor nodes to obtain data of water temperature, pH value and dissolved oxygen concentration through RS232 serial port, and present to users. According to the Author, The hardware platform of the sensor node is composed of a processing module, a sensor module, wireless communication and a power module. The processing module uses a MSP430F149 as the processing core. The sensor module uses PHG-96FS pH combination electrodes and DOG-96DS dissolved oxygen electrodes to measure water quality parameters. A signal conditioning circuit was designed to amplify and filter the weak signals to as to meet the requirement of input range of the A/D converter. The wireless communication module uses an RF905 RF chip and its periphery circuits to receive and send data. The power module uses an LT1129-3.3 chip, an LT1129-5 chip, a Max660 chip and their periphery circuits to supply 3.3V and ±5V voltage for the processing module, wireless communication and the sensor module. The system software consists of two parts, the node software and monitoring software. The node software, which is compiled using C Language in IAR Embedded Workbench, can complete data acquisition and processing, wireless transmission, and serial communication. A graphical interface monitoring software, which is compiled using vb6.0, was built to provide users with a visual image of real-time water quality parameters. The core idea behind was to obtain the correct and reliable data thus, minimizing errors rate in a wide range of water types. The results demonstrated that the average packet loss rate is 0.77%, and the relative errors of pH value, temperature and dissolved oxygen are less than 1.40%, 0.27% and 1.69% respectively. (Huang Jianqing, Wang Weixing & Jiang Sheng, 2013).

**Energy-efficient Automatic Monitoring System for Aquaculture based on Wireless Senor Network (WSN)**

This project presents a review on how to build an automatic monitoring and control system of aquaculture using a Wireless Sensor Network (WSN) which is energy efficient. This system was adopted from an optimized protocol of centralized low-power hierarchical clustering (LEACH-C) for a wireless sensor network communication and frequency control aeration system based on a programmable logic controller (PLC). In a LEACH-C communication protocol, cluster heads were selected according to the residual energy of each node by the base station with fixed power supply. From the actual control accuracy of the system, the changes in dissolved oxygen concentration was less than 0.02 mg/L than the value last time, and the corresponding node sent no data to its cluster head for saving energy. The test proved that the lifetime of a network adopted optimized LEACH-C protocol was 33.33% longer than that of a network adopted conventional LEACH protocol. As the concentration increased, the aeration efficiency will be gradually reduced. Therefore, the range of emergency oxygen was set from 4.5 to 5.5 mg/L. Based on measured value of dissolved oxygen content from the wireless sensor networks, a PI-PID algorithm was used in controlling the concentration of dissolved oxygen in the water body. When the error was large, the use of a set of PI parameters could quickly narrow the error; while error-hour, using a set of PID parameters could remain stable. In order to ensure the smooth switching of the two sets of parameters, a hysteresis switching area was set. This would ensure the timeliness and efficiency in oxygen supply when the dissolved oxygen concentration in water was less than 4.5 mg/L, or more than 5.5 mg/L. The dissolved oxygen in water was always suitable for the growth of fish. (Jiang Jianming, Shi Guodong & Li Zhengming, July 2013). The advantage of this system was to save nearly half of the electricity and reduce the costs in labor as scale of aquaculture expands.

**Water Quality Monitoring System Using Zigbee Based Wireless Sensor Network**

This paper describes the application of wireless sensor networks (WSN) for a water quality monitoring system using Zigbee Based Wireless Sensor Network. It is composed of a number of sensor nodes with a networking capability that can be deployed for continuous monitoring purpose. Zigbee is a technology of data transfer in wireless networks. It has low energy consumption and it is designed for systems such as multithermal control systems alarm systems and lighting control, home automatic devices. It has a unified standardize unit data transfer. Zigbee is more economical than Wi-Fi and Bluetooth as it consumes less energy. The parameters involved in the water quality determination such as the pH level, turbidity and temperature is measured in the real time by the sensors that send the data to the base station or control/monitoring room. The use of wireless system for monitoring purpose will not only reduce the overall monitoring system cost in term of facilities setup and labor cost, but will also provide flexibility in term of distance or location. In this paper, the fundamental design and implementation of WSN featuring a high power transmission Zigbee based technology together with the IEEE 802.15.4 compatible transceiver is proposed.

This project focuses on the use of multiple sensors as a device to check the level of water quality as an alternative method of monitoring the condition of the water resources. Several sensors that are able to continuously read some parameters that indicate the water quality level such as chemical substances, conductivity, dissolved oxygen, pH, turbidity etc will be used to monitor the overall quality level. As the monitoring is intended to be carried out in a remote area with limited access, signal or data from the sensor unit will then be transmitted wirelessly to the base monitoring station.

A currently becoming popular and widely used technology based on wireless sensor network is extensively used in this project as it is able to provide flexibility, low cost implementation and reliability. A high-power transmission with a relatively low power consumption Zigbee based wireless sensor network technology is applied in this work. Zigbee is a communication standard for use in the wireless sensor network defined by the Zigbee Alliance that adopting the IEEE 802.15.4 standard for its reliable communication. It is chosen due to its features that fulfill the requirement for a low cost, easy to use, minimal power consumption and reliable data communication between sensor nodes.

The development of graphical user interface (GUI) for the monitoring purposes at the base monitoring station is another main component in the project. The GUI should be able to display the parameters being monitored continuously in real time. Several measurement and performance analysis to evaluate the reliability, feasibility and effectiveness of the proposed monitoring system are also presented.

The development of the system mainly comprises of the hardware design and the software design.

The hardware design is made up of the sensor unit, wireless sensor node and a base monitoring station. The sensor unit is basically consists of three sensors – pH sensor, temperature sensor and turbidity sensor, used to detect the predetermined parameters that indicate the quality of water. The pH sensor senses the acidity of basicity of the water, the temperature sensor and the turbidity sensor are used based on phototransistor. All the sensors was being powered by battery. When the information are being detected by the sensors they are converted into electrical signal passing via the signal conditioning circuit which makes sure that the voltage or current produced by the sensors is proportional to the actual values of parameters being sensed. After the information passed through the signal conditioning circuit, it then get to the microprocessor that processes the information into a human readable and understandable form. The wireless sensor node were connected to all the three sensor unit. The microprocessor has the function of signal digitizing, data trasnmision, networking management and radio frequency transceiver for communication at he physical layer. The base monitoring station consists of a Zigbee module which was programmed as coordinator the receives data sent from the sensor node and sent to the GUI using the RS 232 protocol.

The software design part was developed using Borland C++ Builder programming that is able to interact with the hardware at the base station. The sensors were set for connection to the coordinator with one of them linked through the router to further extend the monitoring distance. A connection was created from the coordinator(router) displaying the data parameters on the GUI screen.

Overall, important fact of this system is the implementation of high power Zigbee based WSN for water quality monitoring system offering low power consumption with high reliability is presented. Another, is the easy installation of the system where the based station can be placed at the local residence close to any person with minimal training at the beginning of the system installation. (Zulhani Rasin & Mohd Rizal Abdullah, 2009)

**Real-time remote monitoring system for aquaculture water quality**

This paper presents a view on the development of a real-time based remote monitoring system for aquaculture water quality. This system is a multi-parameters monitoring system based on wireless network was set up to achieve remote real-time monitoring of aquaculture water quality, in order to improve the quality of aquaculture products and solve such problems as being difficult in wiring and high costs in current monitoring system

According to the Author, the components used were solar cells and lithium cells for power supply, sensor detection part, controller, data transmission part, remote monitoring center and aerator. The sensor detection part comprises the YCS-2000 dissolved oxygen sensor, pH electrode, Pt1000 temperature sensor and ammonia nitrogen sensor to monitor the parameters of aquaculture water quality. The controller is made up of STM32F103 chip and its peripheral circuits responsible for processing data acquired by the sensors and controlling the whole system to work properly in order. The data transmission part is composed of Zigbee wireless data transmission module and GPRS module, which transmits the parameters detected by the sensors to the remote monitoring center. The remote monitoring center is made up of upper computer, which can realize real-time display, saving, analysis of monitored water quality data. If the controller detects that the dissolved oxygen concentration is lower than the preset lower limit, it will send instructions to start up aerator. When it detects that the dissolved oxygen concentration is higher than the preset upper limit, it shuts down the aerator. The core concept was based on reducing labor intensity, improving the quality of aquatic products and the protection of water environment. (Luo H. P., Li G. L., Peng W. F., Song J. & Bai Q. W., 2015)

**Automatic monitoring & Reporting of water quality by using WSN Technology and different routing methods**

This paper describes the different data routing techniques and WSN technology for checking the water data and furthermore gives security there is no loss of data, because of which it is possible to control water pollution and gives appropriate water resource management. The Design of Wireless sensor based on zigbee and arm7. We designed a system for a Lake. The system provides the online auto monitoring of water temperature, turbidity, water level, and salinity value environment of an artificial lake by using Zigbee modules. According to the   
Author, the readings was collected through live graph as well as on LCD display. There is a set point for each parameters when these particular parameter Crosses its set point the alarm is created then we comes to know that water is contaminated or polluted and after every one minute time SMS sends on management mobile which contain the readings of measured water parameters, due to which it is possible for that management person to take Appropriate action in emergency. In this way we can control or reduce water contamination as well as we successfully provides water resource management using WSN Technology. This system provides the reading automatically. The project focuses on the distinctive routing methods for monitoring water report. The monitoring system thus promises broad applicability prospects. (A. C. Khetre & S. G.Hate, 2013).

**Air and water quality monitoring through iot by using aquatic surface drone**

This project presents the review on the design and prototype of air and water quality monitoring through IOT by using aquatic surface drone. It describes Air and Water quality monitoring system on Aquatic form is based on Arduino platform and a multi cannel sensor variables are interconnected and in which the certain sensing parameters of temperature , humidity, gas and salt are measured and as well as ultrasonic sensor is measured with the underwater obstacle. The system was made up of Arduino UNOR3 board, five sensors for air and water quality monitoring in which variables are temperature, humidity, salt, gas, ultrasonic sensors have 2pins VCC, GND as common. The system was developed using Arduino IDE compiler using Embedded C language scripts to get the values from the sensors with the help of Arduino UNOR3 micro controller. C programming was used to read the values from the sensors. This aim of this project to the aquatic form for air and water quality monitoring to develop the abilities of executed system to provide the information to a different sensing parameters for an extended area.. (Ch. Pavan kumar & S. Praveenkumar, 2018).

**Smart Device to monitor water quality to avoid pollution in IoT environment**

This project provides a review of a small device to monitor the quality of water to avoid pollution in IoT environment. The water quality monitoring sensors gather data from water, and forward that data to Arduino IDE for binary to digital conversion. The Arduino IDE forward that data to concentrator module through Zigbee module for remote transfer of data to the lab. The data concentrator which is located in each and every lake, send that data to the cloud configured server which is located in the testing laboratory. The department employees monitor this data remotely and securely provide this data to the requested users which is stored in the cloud. Water quality parameter data is stored in the cloud, will be securely provided to requested users using the cryptographic techniques. (Pandian D R, Dr. Mala K)

**Applications of wireless sensor networks in marine environment monitoring: a survey**

This paper provides a comprehensive review of the state-of-the-art technologies in the field of marine environment monitoring using wireless sensor networks. According to the author, it first describes application areas, a common architecture of WSN-based oceanographic monitoring systems, a general architecture of an oceanographic sensor node, sensing parameters and sensors, and wireless communication technologies. Then, it presents a detailed review of some related projects, systems, techniques, approaches and algorithms. It also discusses challenges and opportunities in the research, development, and deployment of wireless sensor networks for marine environment monitoring. (Guobao Xu, Weiming Shen & Xianbin Wang, 2014)

**Application of gprs in water quality monitoring system**

This project presents the design and implementation of application of GPRS in water quality monitoring system. Water quality parameters were collected by multi-parameter water quality probe are transmitted to data processing and monitoring center through GPRS wireless communication network of mobile. According to the author, the multi parameter sensor was directly placed above the water level. GPRS and micro-controller was used to monitor data collected at any instant of time. The water quality parameters were monitored with using Visual Basic Software. It collects, transmit and processes data automatically for efficient production and economy benefits. (V. Ayishwarya Bharathi, S. M. Hasker, J. Indhu, M. Mohamed Azarudeen, G. Gowthami, R. Vinoth Rajan & N. Vijayarangan, 2014)

**Labview based water temperature measurement & control**

This project presents a review of a proposed LabView based water temperature measurement and control. The components used Relay((JQC-3FC/T73), LM-35(Temperature Sensor), Op Amp IC- LM 358, Single Phase Transformer(AC230V/12-0-12V), Regulators( IC-7805,IC-7812), Heater(500w), Resistors(1k,100k,5k), Capacitors(1000uf, 470uf, 1uf, 0.1uf) and Diodes. The LM35 is one kind of commonly used temperature sensor that can be used to measure temperature with an electrical o/p comparative to the temperature (in °C). LabView was a program development application which basically has for four operations which were virtual instruments, front panel, block diagram, and icon and connector. The amplified output of the LM-35 is given in to the analog input card (AI0) of the compact RI0 chassis. When the measured temperature is above or below the desired temperature set in the

LabVIEW relay controller will be closed or open depending on the requirement. The output from the digital output card (DI 0) actuates the relay. The voltage generated by the relay contact makes ON/OFF the heater. The temperature of the water is sensed by the LM-35. The main focus was to build a system that to measure and control temperature of water based on lab view. (Dayanidhi Yadav, Ranjeet Kumar & Pankaj Kumar, 2018)

**Multi-sensor based water quality monitoring in iot environment**

This project describes the review of water quality monitoring in IoT environment using multiple sensor. The system consists of turbidity sensor, pH sensor, temperature sensor which was interfaces with Arduino mega board 2560. It used a microcontroller for collecting the data from the sensors. The system main concept was to design a low cost and robust system to monitor water quality problem for drinking water and online multisensory measurements at the local level were developed to assess the water contamination risk. (Arun Pandi T, Sakthi Vel S B, Veerappan, Senthil Rajan, Amutha Priya N, 2018)

**Design and development of iot based framework for aquaculture**

This project presents a review of an IoT based framework designed and developed for aquaculture. The architecture of the proposed system consists of number of sensor nodes spread across different ponds. The sensor nodes measured the physio-chemical parameters of the water and transmit the values to the nearby base station. The monitoring station was accessed by mobile devices, laptops or desktop wirelessly to make analysis and conclusion making and if the readings violate the threshold then a control command if sent to the base station for the physio-chemical parameters of water to be adjusted. A monitoring unit was developed using the Intel Analytics Cloud Platform where the sensor data get stored. (Zeenat Shareef & SRN Reddy, 2016)

-----------------------------template------------------------

This paper presents the design and prototype of … the system includes / features…. It focuses on implementing…

------------------introduction for literature review----------------

----------------------------end of template-----------------

REFERENCES

Guobao Xu, Weiming Shen & Xianbin Wang (2014). Applications of Wireless Sensor Networks in Marine Environment Monitoring: A Survey. doi:10.3390/s140916932.

Ch. Pavan kumar & S. Praveenkumar (2018). Air and water quality monitoring through iot by using aquatic surface drone. Retrieved from http://acadpubl.eu/hub.

Luo H. P., Li G. L., Peng W. F., Song J. & Bai Q. W. (2015). Real-time remote monitoring system for aquaculture water quality. doi: 10.3965/j.ijabe.20150806.1486 \*\*\*

Jiang J., Shi G., Li Z. & Huan J. (2013). Energy-efficient automatic monitoring system of aquaculture based on wireless sensor networks. Transactions of the Chinese Society of Agricultural Engineering (Transactions of the CSAE), 2013, 29(13): 166 －174.

Huang J., Wang W., Jiang S., Sun D., Ou G. & Lu K. (2013). Development and test of aquacultural water quality monitoring system based on wireless sensor network. Guangzhou 510642, China.

The zigbee alliance website. Available: http:// [www.zigbee.org/](http://www.zigbee.org/)

Zulhani Rasin & Mohd Rizal Abdullah. Water quality monitoring system using zigbee based wireless sensor network. IJET Vol: 9 No: 10, Malaka, Malaysia, 2009

Luo H P, Li G L, Peng W F, Song J & Bai Q. W, 2015. Real-time remote monitoring system for aquaculture water quality. Int J Agric & Biol Eng; 8(6): 136－143.