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An IoT Based Smart Water Monitoring System for Fish Farming in Bangladesh

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Abstract: Bangladesh is considered one of the most suitable regions for fisheries in the world, with the world's largest flooded wetland and the third largest aquatic biodiversity in Asia after China and India. Fish farming has brought significant changes in the economy of the country. But due to water pollution fish farming has become challenging nowadays. It is very urgent to take necessary steps to monitor and prevent the water pollution for fish farming. This paper proposed an IoT based smart water monitoring system for fish farming in Bngladesh. It is a sensor network which will efficiently measure the water quality parameters such as dissolved oxygen, nitrogen, pH,water temperature, nitrite, ammonium, Co2. There will be an Arduino UNO microcontroller to receive the data from different sensors and process them. A mobile application has been proposed to display the measured water quality parameters on the Mobile Phone. This system will help us to monitor the parameters of water quality and pollution level of water which can help to prevent the water pollution. This IoT based smart water monitoring system will help fish farmers to increase the quality and production of fishes.

Keywords: IoT; sensors; mobile App; fish farming; Bangladesh; pH; oxygen; real time monitoring; fish health; Ammonia; nitrogen

1. Introduction

Fish farming in Bangladesh is playing a significant role in the total national earnings of this country. Bangladesh is a south Asian country and there are barely any areas in the country where a river or any other water source is not available. Bangladesh is surrounded by rivers and various types of water sources like ponds, streams, lakes etc. A major part of the total population of this country are directly or indirectly involved with fish or fish related business [1]. But it is a matter of great sorrow that most of the owners of the fisheries in our country are not well educated enough or they don't have enough knowledge about the firm water. So every year a large number of fisheries count losses in business due to the death of fishes for non-suitable water in the firm. In 2018 total 1200 tons of fishes died in 4 districts of Bangladesh reported by the fisheries and livestock secretary; see Figure 1(b). The fish might have died for various reasons, including water pollution and falling oxygen level in water due to the formation of ammonia gas after green paddy got rotten following the flash flood [2].

The quick growth of the economy brings new problems for our environment. One of the main problems we are facing is the water pollution [2-3]. Water quality is a term that reflects the overall ability of culture water to provide optimal growth conditions for the species of interest. The most water quality factors are dissolved oxygen, total ammonia nitrogen, nitrite, PH, Alkalinity, Co2, salinity, iron, chlorine, hydrogen. These parameters have certain standard values for the fishes to live in the water. If the dissolved oxygen is below the standard value the fishes cannot survive in water. Another parameter is ammonia in the water and it has to have a certain standard level for the fishes to live, else fishes will die in one night. The temperature of the water is also an important parameter for the fishes to live. Another important parameter is the PH level which has to have

standard value for the fishes to live as well. The main reason for fish death is considered to be due to lack of standard values of the parameters in water as mentioned earlier [4].

In our country the water of most of the rivers and ponds close to Dhaka city are seriously polluted. The main reason for this is the waste materials of the industries. This is usually noticed near Dhaka city and other city areas of Bangladesh. In our country, there are many leather processing companies near Dhaka and other districts which are close to Dhaka. These companies don't process their waste materials properly. Due to not proper processing technique and management the waste materials and contaminated water of these industries fall into the rivers and nearby ponds which pollute the rivers and pond's water seriously; see Figure 1.a [5]. In addition, our country has nearly 7000 garment factories. They also don't properly manage their waste materials although there is pressure from proper authority but it is not possible to control this issue by the authority. The waste polluted water from the garments industries are not purified properly. Therefore waste materials and contaminated water from different industries fall into the rivers and nearby ponds which pollutes the water. The ingredients of the waste contaminated water from garment industries, leather processing industries and other industries pollute the water which have very bad effects on aquatic creatures and also human health [6]. Due to the above mentioned reasons the quality of the elements of water such as dissolved oxygen, Nitrogen, pH ,water temperature, nitrite, ammonium, Co2 do not have standard value. This causes serious problems for the fishes to live in the water. It also has a bad effect on the environment and human health. It is very urgent to take necessary action to monitor and prevent the water pollution.

In this paper an IoT based smart water monitoring system for fish farming in Bangladesh is proposed. This IoT based smart system will efficiently measure quality parameters of the water. It is a sensor based network which has the ability to sense the quality of the elements of the water such as dissolved oxygen, Nitrogen, pH ,water temperature, nitrite, ammonium, Co2, and it will be sent the measured data by sensors to a mobile via a mobile application. Looking at the measured values of water quality factors in the mobile phone, fish farmers can take necessary steps to solve this.

(**a**) Factories discharge wastewater directly into the river [5].

(**b**) Fishes died from water pollution [2].

Figure 1. (**a**) Factories discharge wastewater directly into the river. (**b**) Fishes died from water pollution.

2. Materials and Methods

Figure 2 shows the system architecture of IoT based smart water monitoring system for fish farming. In this paper we have used two sensors to measure pH level and temperature level of the water. However we are working to integrate more sensors with the whole system. Table 1 lists the water quality factors, commonly used monitoring procedures, and preferred ranges for fish culture. It is noted from Table 1 that temperature of water is species dependent. The standard pH value of water needs to be in the range of 6-8 for fish to live healthy. For fish farming water quality can be maintained if we keep pH, dissolved Oxygen, Nitrates and Ammonium and Temperature in control. Figure 3 shows the block diagram of the proposed system. The pH sensor measures the pH level of water and temperature sensor measures the temperature of the water. Figures 4 (a) and 4 (b) show the temperature and pH sensors. A pH sensor helps to measure the acidity or alkalinity of the water

with a value between 0-14. When the pH value dips below seven, the water starts to become more acidic [7].

An Arduino UNO microcontroller has been used to receive and process the data from different sensors. Figure 4 (c) shows the Arduino Uno microcontroller that has been used in his paper. Arduino is an open-source platform usually used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on the computer, used to write and upload computer code to the physical board. In this paper Arduino Uno microcontroller has been used as the controller unit for each sensor and action. It is working as a mother component for the proposed system. This Arduino Uno microcontroller maintains all the sensors and processes the data and takes the action based on the data. This Arduino Uno microcontroller is programmed and worked based on the algorithm. Arduino Uno has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs), a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (ICSP) header, and a reset button [8]. Wireless module has been integrated with the system. With the help of the wifi module, data will be sent to the cloud. Figure 4 (d) shows the wifi module used in this paper. The processed data will transfer to the server using an API (application program interface). Then our android will receive the data and show it to the user. An android mobile application has been developed for this system which will show the measured pH and temperature levels of water on the Mobile Phone.

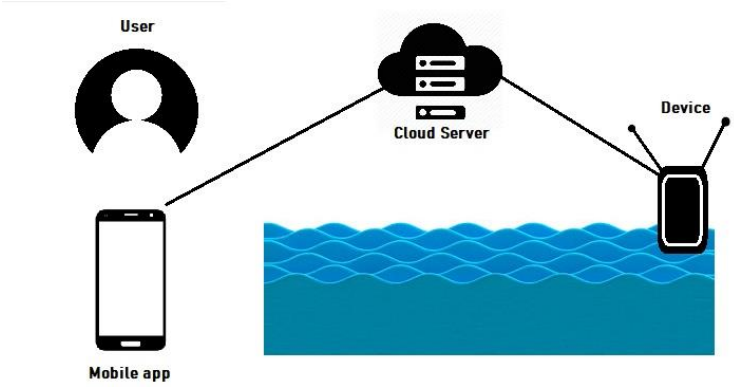


Figure 2. System Architecture of IoT based smart water monitoring syetm for fish farming.

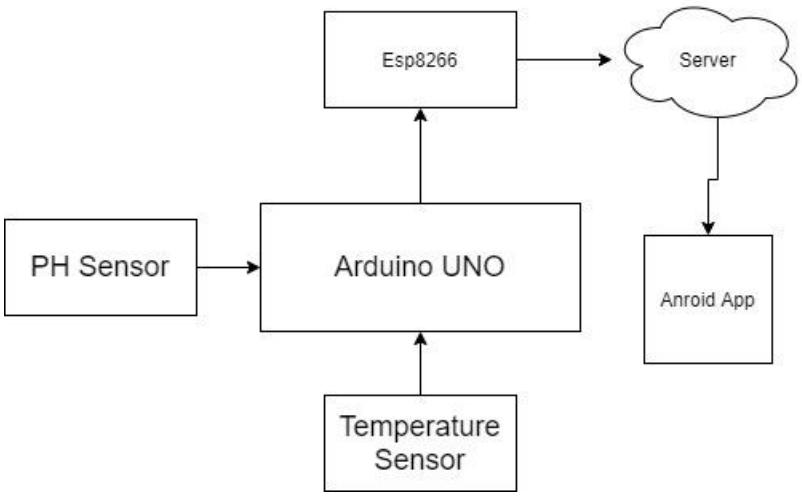
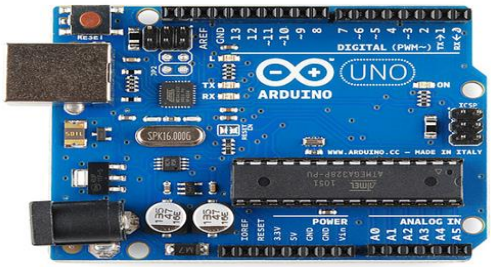


Figure 3. Block digram of the system.

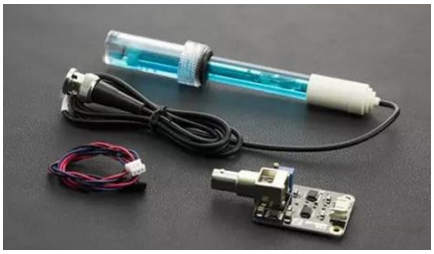
Table 1. Water quality factors, commonly used monitoring procedures, and preferred ranges for fish culture.

No	Water Quality Factor	Preferred Ranges for Fish Culture
1	Temperature	Species dependent
2	Dissolved Oxygen	>4–5 ppm for most species
3	pH	6–8
4	Total ammonia-Nitrogen	<0.02 ppm
5	Nitrite	<1 ppm; 0.1 ppm in soft water

(**a**) Temperature sensor.



(**b**) Arduino Uno microcontroller.



(**c**) pH Sensor.

(**d**) Wifi Module.

Figure 4. The harware components (a) Temperature sensor, (b) Arduino Uno microcontroller, (c) pH sensor (d) Wifi Module**.**

Required Hardware Components:

- Android studio
- Arduino programming IDE
- Firebase
- Database knowledge using SQL
- Laravel (PHP framework for website management)

3. Results and Discussion

The IoT based smart system has been developed to measure temperature and pH levels of the water. The hardware system has been integrated with the mobile application. The developed system

has been tested placing the sensors inside the water and the whole system is working fine. Figure 5 shows the mobile application showing the temperature level of the water on the mobile phone. Due to page and space limits more details technical discussions are not provided in this paper. However, the author of this paper is integrating other sensors like dissolved oxygen, ammonia sensor , nitrite sensor with the whole system. By using the device users will get real time information about the water quality factors on their mobile phone and can take proper steps to make the water quality better so that fish can live there without facing any problems. Mobile application will have many features added for advance monitoring and action plan. The data also can be displayed on the website.

Author is currently working for the implementation of this. Author is preparing an article with the results of the whole new system and it will be submitted in MDPI Water Journal. For fish farming water quality can be maintained if we keep pH, dissolved Oxygen, Nitrates and Ammonium, temperature in control. Ammonia is harmful for fishes as it comes from the waste products of the fishes so regularly eliminating it off the water is essential. The application of this proposed system is not only limited to fish farming in Bangladesh but it has other applications in many areas. Our future plan is to scale up this system and apply to other areas as well to monitor water pollution.

Figure 5. The developed mobile application shwoing temperature level of the water**.**

This system can be used to the places of the industries where the waste materials and water passes to monitor the quality of the water in real time and proper authority can take legal action to prevent it. However, in this paper authors proposed to use this IoT based smart water monitoring service for the application of fish farming in Bangladesh. This IoT based whole system will help fish farmers to increase the quality and production of fishes.

5. Conclusions

An IoT based smart water monitoring system for fish farming in Bangladesh has been propsed in this paper. Currently the system has integrated two sensors to measure the pH level and temperature of the water. A mobile application has been developed for the fish farmers to monitor the water quality factors on their mobile phone in real mtime and take action plans based on the reading of the sensors. Proposed device will be set into the water of any ponds, lakes or any source of water in the fisheries so that it can monitor the condition of the water in real time and the parameters will be sent to the mobile application of the users. Users will be able to control the device through that mobile app and take treatment measures by observing the situation. There will be other advanced features integrated with the app. The IoT based sensor device will be movable so it can move every place in the water of a pond, rivers or lakes to monitor the oxygen level and other parameters in water because the level of oxygen is not equal to all places in the water. Different

fishes stay in the water at different levels of water. This system will be very helpful for the fish farmers of our country and eventually the country will be benefitted by exporting fishes abroad and earn foreign currency which will help to develop the economy of the country. Our future plan is to make the system more efficient so that sensors can go inside the water and come back on the surface of the water. In this way, the device can sense not only what the water condition is at the top, but also at every level of the water and notify the user about every inch of the water. Data accuracy will be verified and optimised also in future machine learning approaches will be applied in this system.

Acknowledgments: Author would like to thank Electrcical and Computer Enginering Department of North South Univeristy.

Conflicts of Interest: "The authors declare no conflict of interest."

Abbreviations

The following abbreviations are used in this manuscript:
IoT: Internet of Things
App: Application
PHP: Hypertext Preprocessor
pH: Potential of Hydrogen

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