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# Assessment and Analysis of Water Parameters for the Sustenance of Aquatic Ecosystems

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## ABSTRACT

*In order for all natural processes to function and thrive as well as to ensure the survival of all life-forms, water is indispensable. Water quality refers to the physical, biological, chemical and radiological properties of water. Water pollution due to environmental degradation is a common occurrence these days, with pollutants directly or indirectly being discharged into water bodies. A system to measure water parameters is important for researchers in ecology, hydroculture and geology to study the habitats, survival probabilities of aquatic organisms, possibility of harvest and capitalization of aquatic resources as well as for others interested in the data collected from the water. In this paper we discuss a system to measure physical water parameters and view the data over the internet using IoT technology. The core controller for our proposed system is NODEMCU(ESP8266) which collects and aids in the analysis of the data. A warning system for observed anomalies is presented. We also discuss the results obtained after cloud storage and review the capabilities of the system as well as the possibilities for scalability.*

***Keywords: Water quality assessment, Water parameters, Internet of Things, Aquatic ecosystem monitoring***

## 1. INTRODUCTION

Water is the most precious and valuable of all natural resources. It is essential for the proper functioning and sustenance of all natural processes on this planet. In recent times, due to heightened human activities, this resource is being threatened by contaminants and pollutants. Hence there is a need for better methodologies to monitor the quality of water.

The project aims to design a practical method to assess the quality of water by measuring various parameters such as temperature, ambient humidity, turbidity and level using interfaced sensors and IoT technology. IoT refers to the networked interconnection of everyday objects, which are often equipped with ubiquitous intelligence. IoT will increase the ubiquity of the Internet by

integrating every object for interaction via embedded systems, which leads to a highly distributed network of devices communicating with human beings as well as other devices. The core controller in the process, NodeMCU, is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The open-source Arduino Software Integrated Development Environment (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux but for this paper, we discuss the operation of the board on the Windows OS. NODEMCU(ESP8266) can be interfaced with arduino IDE for ease of programming. Cloud computing is an information technology (IT) paradigm that enables ubiquitous access to shared pools of configurable system resources and higher-level services that can be rapidly provisioned with minimal management effort, often over the Internet. Cloud computing relies on sharing of resources to achieve coherence and economies of scale, similar to a public utility. Mosquito is used as the MQTT broker to enable the viewing of the logged data. This paper provides a solution to manage and study aquatic ecosystems when they need to be closely monitored. The forthcoming sections discuss the system in detail.

## 2. Related Work

‘The internet has changed human lives and IoT has laid the foundation for connecting devices, sensors and other technologies. IoT gives an immediate access to information about physical objects and leads to inventive service with high efficacy and productivity **[N Vijayakumar and R Ramya, 2015].** Environmental sensor nodes have also evolved from passive logging to ‘intelligent’ sensor nodes to enable the integration of the collected data with other datasets. Although they do have some drawbacks, they could potentially change the method of research and become a standard tool in environmental monitoring by combining sensor nodes and a cyber infrastructure while providing a ‘virtual connection’ to the environment **[Jane K. Hart and Kirk Martinez, 2006].** Early detection of environmental hazard could minimize threat in many cases. There have been attempts to measure water quality parameters before, using techniques such as a field portable fluorometer attached to a smartphone **[Md. Arafat Hossain et al., 2006].** There have also been significant advances made in the field of drinking water quality measurements and these findings present immensely valuable data to the international study involved in the development and deployment of online drinking water quality systems. There are different tools to measure various parameters and provides examples for some online data handling software such as CANARY etc. A range of software has been developed to assist in the detection of water quality anomalies or events within water systems and the handling of large volumes of water quality data. Event monitors such as ‘Hach Event Monitor’ and ‘scan Water Quality Monitoring Station’ are generally supported by proprietary event detection software and some software like CANARY are not **[Michael V. Storey et al., 2010].**

Owing to the development in wireless technology, environmental data can be realistically monitored.

This is particularly important in remote or dangerous environments where many fundamental processes have rarely been studied due to their inaccessibly. There have been suggestions of the development of sensor networks from three technologies namely sensing, computing and communication **[C.Y. Chong and S.P. Kumar, 2003].** Sensor networks are designed to transmit data from an array of sensors to a data repository on a server **[Kirk Martinez et al., 2004].** A GSM module can be used to transfer the data to a server. The data can also be processed and uploaded into a database. The system can be made completely autonomous, without need for manual checks. They can also be configured to operate autonomously and adjust their mode of operation depending on the circumstances **[Karl Crowley et al., 2005].** A two-way transfer and display of collected data can be achieved between the field site and a remote location, a concept referred to as field data streaming. Data analysis and sharing is currently achievable by integrating environmental and geo-location sensors with mobile, wireless computers **[Richard Camilly and Enrique R. Vivoni, 2002]**. Even though sensor networks provide a virtual layer where information about the physical world can be accessed by a computer system, there is a question as to whether complete integration of sensors to the internet is advisable because of security concerns **[Cristina Alcaraz et al., 2010].** The main challenge when it comes to designing sensor nodes for environmental water quality assessment is finding low-cost sensors that are reliable. This is done through market research. More reliability can be achieved by using low-cost sensors in a small space because of large spatial availability. Due to the large spatially distributed deployment and the possibility of correlating the quality measurements from various consumers **[Theofanis P. Lambrou et al., 2012].** If all the concerns related to design and security and addressed to a certain extent, a low-cost but effective system to measure water quality can be designed. Although many systems already use various methods to measure water quality, they do not use ESP8266 with the inbuilt WiFi module and most of them do not store the logged data in the cloud for ease of access. The water parameters such as temperature, ambient humidity, level and turbidity are measured. The Core controller, ESP8266, enabled with a WiFi connection collects the data collected and it can be viewed over the internet via cloud. In case accepted ranges are exceeded, alert is sent to the concerned party. This model is cost effective, flexible and can be interfaced to a variety of platforms.’

## 3. Proposed System- Water Quality Assessment System

The system presented in this paper consists of the sensors in direct connection with ESP8266. The sensors used are the Dallas Temperature Sensor DS18B20, Air and Humidity Sensor DHT11, Turbidity sensor SEN0189 etc. The system can be scaled to accommodate various other sensors as per the need. The Architecture diagram is shown in Figure 3.1

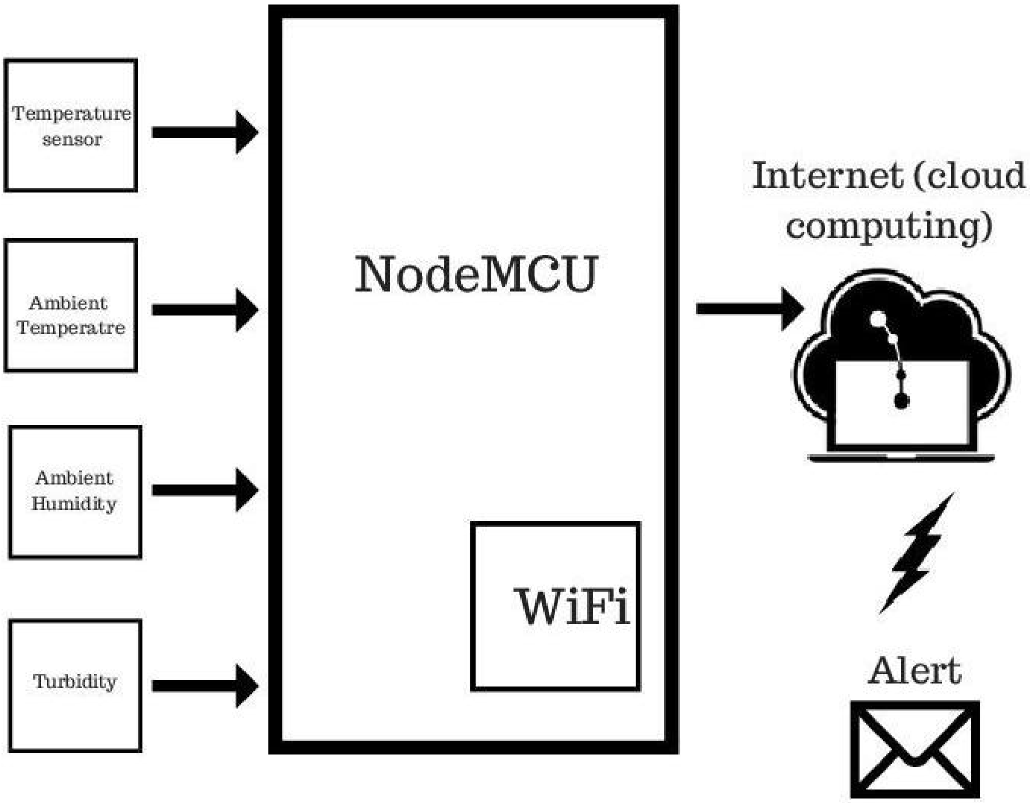


**Fig 3.1**

The Arduino IDE is used as the programming environment after the ESP8266 is interfaced to work on it. The ESP8266 is connected to WiFi to enable the access of data via the MQTT protocol used. The MQTT broker used for the purpose of this project is Mosquito. Once the program is compiled and loaded onto the board, the data is logged continuously and can be viewed by subscribing to the specific topic. The data collected is also interfaced with ThingsSpeak for storage and visual analysis. ThingsSpeak is an open source IoT platform with MATLAB analytics. Various operations can be performed on this data, to study and derive information from the values collected by the nodes. While coding on the Arduino IDE, threshold limits can be set for certain parameters for the concerned party to receive and alert when anomalies are observed.

**3.1 Pseudo Code**

INCLUDE required library functions DEFINE sensor pins used

INITIALIZE variables to read WiFi parameters INITIALIZE variables to read MQTT broker used DECLARE PubSubClient

START the program INITIALIZE the delay CONNECT to WiFi

IF(no Connection) RECONNECT

PRINT the WiFi status Connect to MQTT client

IF(Connection fails) Try again

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WHILE(Connected) PRINT connect status
LOOP
READ Sensor value CHECK conditions PRINT values
CONNECT to Server
IF(no Connection) RECONNECT
/*Repeat for Each Sensor*/ SEND Values to fields

**Performance**

To analyze the performance of the system, various factors are considered:

1. The amount of storage space the program to measure the data uses (%)- The entire code uses only 42% of the available memory space for ESP8266.
2. Low Power Consumption(Watt)- ESP8266 Consumes much less power than the Traditional Arduino Board.
3. Built-in Wifi Module(Grams)- The built in Wifi Module eliminates the requirement of any additional parts and does not contribute to any additional weight. This makes the system portable and enables set-up efficiency.
4. Time to compile and load the program( Seconds)- However, since the ESP8266 is not native to Arduino IDE, it takes a little longer for the translations to occur.
5. Cost (Currency)- This system is cost efficient.

## 4. Results and Discussions

The code was implemented to collected the data via ESP8266 and run on the Arduino IDE. The following results ( as illustrated by Figure 4.1) were observed for the sensors that were implemented.

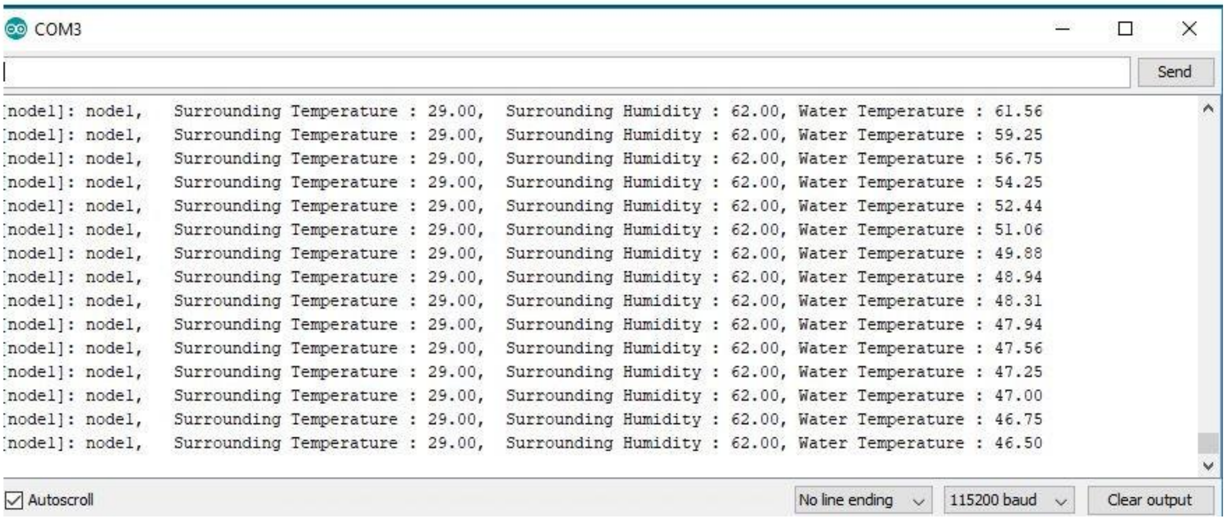


**Fig 4.1**

The sensor values were read continuously. The data that was logged can be made available on a wide range of devices using the MQTT broker as shown by Figure 4.2.

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**Fig 4.2**

The collected data is also stored on the internet using public or private servers, as illustrated by Figure 4.3, 4.4 and 4.5.

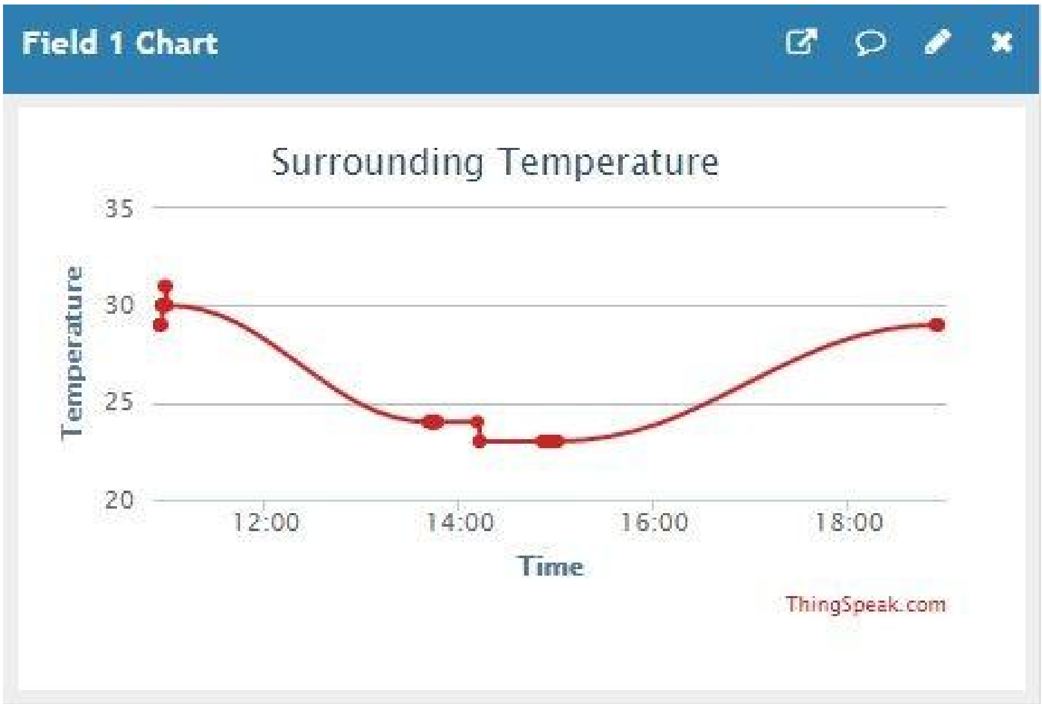


**Fig 4.3**

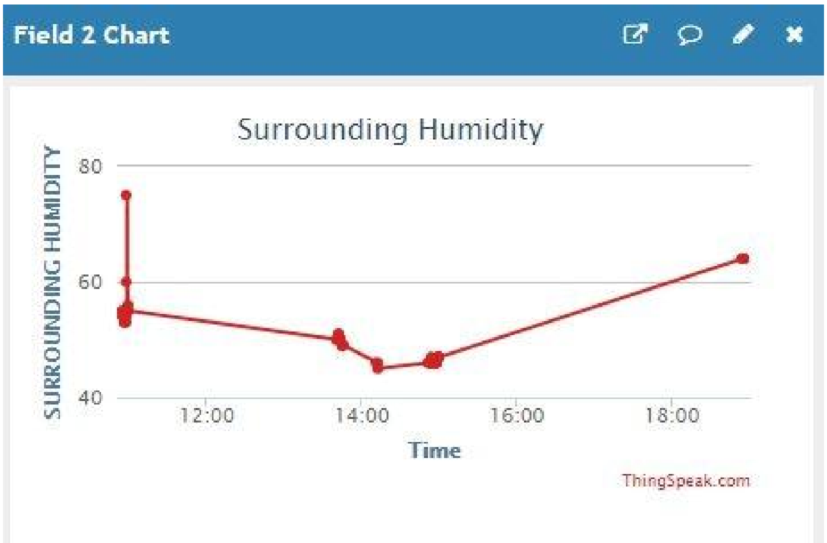


**Fig 4.4**

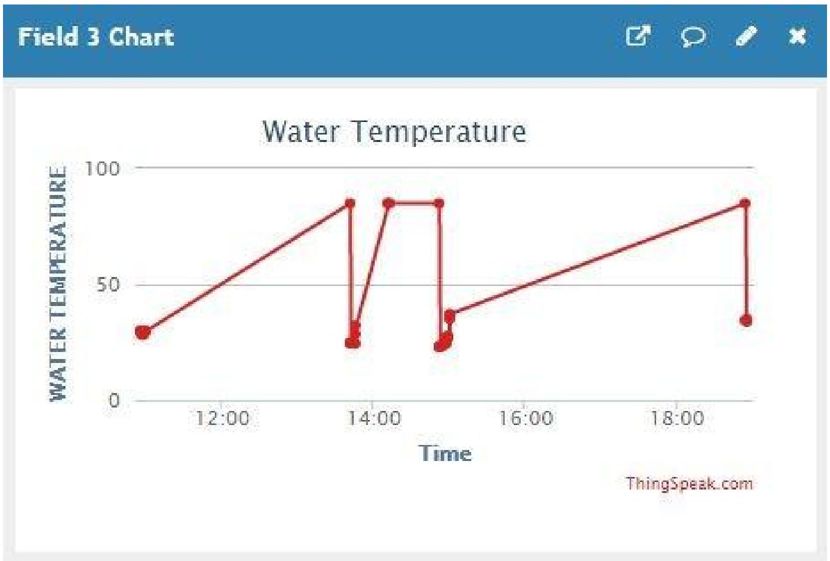


**Fig 4.5**

Variations were observed in the value as the sensors were tested with experimental data. When a particular given threshold value was crossed, an email and SMS alert was sent to the concerned party interested in the particular trigger via the IFTTT application. The data is also stored in a public cloud by assigning a separate IP address for ease of access and storage.

## 5. Conclusion

This paper discusses a low cost albeit efficient method to measure various physical parameters associated with water. Although this prototype implements only a few sensors, this model can be scaled to accommodate any number of sensors. There is ubiquitous access to the data owing to this system. It also helps to solve problems in places where there is a continuous need for the knowledge of water parameters for research purposes such as hydroculture, for personal gains

and terrain studies. The proposed system using ESP8266 in the Arduino IDE was very efficient but a little slow in execution. For future work, improvements in the algorithms and choice of sensors will be considered to enable faster execution and access.

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