Grenze International Journal of Engineering and Technology, Jan Issue

Detecting Dissolved Oxygen Levels in Aquatic Environments using Internet of Things (IoT)*

Dr.T. Hemalatha[1], Mr. K. S. Naveen Raj[2], Ms.T. P. Silpica[3], Mr. S. Surya Prakash[4] and Mr.T. M. Keathareswar[5]
[1-5]Dept. of AI&DS PSNA College of Engineering & Technology, Dindigul
Email: hemashek@psnacet.edu.in, naveenarrora2221@psnacet.edu.in, tpsca12@gmail.com, suryaprakash2020@psnacet.edu.in, keathareswar@psnacet.edu.in

***Abstract*— Pollution of water is one of the main threats in recent times as Marine water is getting contaminated and polluted. The polluted water can cause various diseases marine animals, which in turn affects the life cycle of the ecosystem. The alarming rate of marine species extinction is a significant concern for environmentalists and policymakers globally. The depletion of dissolved oxygen levels in water bodies caused by green algae, pollution, and contaminants is a leading cause of this crisis. In this project, we propose a system that continuously monitors the oxygen, pH, temperature, and turbidity levels in aquatic environments using a range of sensors. Our device employs dissolved oxygen sensors, temperature sensors, turbidity sensors, conductivity sensors, and chlorophyll sensors to measure the water quality parameters accurately. The system alerts the Governmental, Non-Governmental and Corporate Organizations when the oxygen level falls below the threshold, providing real-time data on the location with longitude, latitude, oxygen level, and contamination percentage on the mobile application (Blue Lungs) developed. By taking immediate action, the authorities can prevent the extinction of marine species and protect aquatic ecosystems, contributing to a more sustainable future. The proposed solution has the potential to reduce the death rate of endangered marine species and safeguard the planet's precious biodiversity.**

***Index Terms*— Internet of Things (IoT), Micro Controller, Sensors, Dissolved Oxygen Level, marine species, real time data, mobile application.**

I. INTRODUCTION

There is tremendous potential for monitoring the health of aquatic habitats by utilizing wireless sensor networks in the underwater domain. Our survival depends on the ocean, which makes up 70% of our world, as well as rivers and lakes. Crude oil and oil- related products are being transported around the world in ever-larger vessels as the offshore oil reserve hunt moves into deeper and deeper oceans. Oil spills therefore provide a significant hazard to the ocean's environment. It has been calculated that more than 4.5 million tons of oil are spilled annually throughout the world. Operational discharges from tankers—oil released during cleaning operations—are the largest source of oil pollution in the world's oceans, accounting for around 45% of the problem. These procedures release almost 2 million tons of oil yearly, which is the same as one complete tanker disaster every week [1]. Accidents are only directly responsible for 7% of the oil in the ocean. A significant contributing role also comes from land-based sources including industrial waste and urban garbage that travel down rivers and end up in the ocean (Fig. 1).
Secondary sources of marine pollution are pollutants that enter the water from soils or from atmosphere via rain

Grenze ID: 01.GIJET.10.1.45

or from groundwater systems. Typically, industrial wastes from companies and residues from modern agricultural practices are found in soils and groundwater. Virus, bacteria, pharmaceutical products, pesticides, nitrates, phosphates, radioactive substances, fertilizers, parasites, plastics, and pharmaceutical goods are among the main pollutants of water. These substances might be undetectable contaminants, but they won't always change the colour of the water. In order to assess the water quality, a little amount of water from these resources and marine organisms are analysed.

Poor water quality is bad for the environment, economy, and health. World Bank President Mr. David Malpass issues a warning regarding the impacton the economy, stating that "Deteriorating the water quality is stalling economic growth and exacerbating poverty in many countries." It means that the Gross Domestic Product (GDP) growth of the constituency encompassed by the allied water basins will decline bya third if the biological oxygen demand, the indicator used to quantify organic pollution in water, exceeds the threshold.

Water pollution or poor water quality have the following effects:

- *Destroying the biodiversity*: Water pollution causes a decline in aquatic habitats and starts an unchecked rise in phytoplankton in water supplies.
- *The Food chain contamination*: Using waste waterfor agriculture and cattle husbandry as well as fishing in contaminated water sources can add toxins or other contaminants to food that are harmful to the body after consumption.
- Lack of clean water for drinking, public health, orsanitization will be a problem in both rural and urban regions if water pollution rises or drinking water quality is not maintained.
- *Disease*: The World Health Organization (WHO)reports that over 2 billion people worldwide do not have access to clean water resources and are instead forced to drink water that has been taintedand putting them at risk for a variety of illnesses.
- *Infant mortality*: According to the WHO, diarrheal illnesses linked to poor hygiene cause the deaths of close to 1000 children worldwide every day.

Monitoring of water quality is defined as the collection of data at predetermined or desired locations and at regular intervals to provide data that could be used to describe current water conditions. Smart water quality monitoring systems' goals are to:

- Measure hazardous quality metrics, such as physical, chemical, and microbiologicalproperties;
- Detect deviations in measured metrics and provide prompt warning when threats or hazards are present; and
- Provide real-time analysis of sensor data and suggest appropriate corrective actions.

The need for user participation in preserving water quality and paying attention to other factors including cleanliness, environmental sanitation, disposal, and storage are essential elements in preserving the quality of water bodies.

II. RELATED WORKS

A monitoring system that includes a variety of sensors to measure various quality factors, such as turbidity, pH value, water level in the tank, wetness of the surrounding environment, and water temperature was proposed by Pasika and Gandla [2]. The Microcontroller Unit (MCU) and the sensors are connected, and the Personal Computer (PC) does additional processing. By using the Internet of Things (IoT)-based Think Speak application to monitor the quality of the water being tested, the collected data will be sent to the cloud. The analysis of additional characteristics, such as nitrates, electrical conductivity, dissolved oxygen in the water, and free residual chlorine, should be expanded as a future directive.

An IoT-based Smart Water Quality Monitoring (SWQM) system was created by Mukta et al. [3] to continuously measure the quality of water based on four different water quality parameters: pH, temperature, turbidity, and electric conductivity. In order to feel the quality parameters, four separate sensors are connected to the Arduino Uno. A desktop application built on the .NET framework receives the data gathered from all four sensors, and the extracted data are compared to the standard values. The created SWQM model will effectively assess the water quality characteristics using a rapid forest binary classifier to determine whether the sample of water being tested is potable based on the sensor data that has been obtained.

An approach for creating a Smart Water Quality Monitoring (SWQM) system with a changeable sensor interface device using an IoT environment was put forth by Konde and Deosarkar [4]. The proposed model made use of sensors, a Field Programmable Gate Array (FPGA) board, and a Zigbee-based wireless communication module. Real- time consideration was given to six different water quality parameters, including turbidity, pH, humidity, water level, water temperature, and carbon dioxide (CO_2) on the water's surface. The suggested approachwill help to protect the healthier and more balanced ecosystem surrounding water bodies. The SWQM method reduces the

expense and time associated with assessing the water quality in water resources as part of regulating ecological and environmental balance.
A solar-powered water quality monitoring system using a wireless sensor network was proposed by Amruta and Satish [5]. The fundamental part of wireless sensor network (WSN) technology, which is powered by solar or photovoltaic panels, is the underwater wireless sensor network (UWSN). A unique system design that consists of a base station and distributed sensor nodes is proposed for monitoring water quality in real-time over multiple areas. The Zigbee WSN technology is used to connect every node and base station. It is difficult to design and put into practice a prototype model that uses a node that is powered by solar power and WSN technology. The base station will receive the gathered information from each node, including turbidity, oxygen levels, and pH values from various sensors, over WSN. The gathered data from the various sites can be displayed in a legible format, and base station analysts can perform analysis utilizing a variety of simulation tools.
Sughapriya et al. [6] devised a method for detecting the quality of water utilizing IoT and numerous sensor modules, and it offers a number of benefits including decreased power use, no carbon emissions, and improved limberness. This system measures pH, turbidity, conductivity, and temperature in order to monitor water quality. The sensor data will be accessed by the Arduino controller. The acquired data is analyzed with the help of IoT, and a rigorous procedure may be used to look into water pollution. The created system also notifies and warns the population as well as the responsible authorities about the water quality. Monitoring the quality of the water could potentially be done by those with less training. The target area's proximity to the water resources made it simple to install the water quality monitoring equipment. The suggested designed model is made up of many sensors that compute water quality data in real-time for a prompt response. The developed model is also precise, cost-effective, and labor-intensive.
Nikhil Kedia [7] devised a method for the complete water quality monitoring process, including the sensors, embedded design, information dissipation process, and roles of the government, network operator, and villages in guaranteeing proper information dissipation, which are highlighted in this study. Additionally, the Sensor Cloud domain is explored. At this time, it is not possible to automatically improve water quality, but effective use of technology and cost-effective business practices can help to improve the water quality.
"Real Time Water Quality Monitoring System" by Jayti Bhatt and Jignesh Patoliya [8] explains how real-time monitoring of water quality is necessary to assure the provision of safe drinking water. An IOT-based approach has been suggested for this purpose. In this research, we demonstrate the architecture of an IOT-based system for real-time water quality monitoring. This system includes a number of sensors that detect several aspects of water quality, including temperature, conductivity, pH, and levels of dissolved oxygen and turbidity. The microcontroller processes the sensor-measured values before transmitting them over the Zigbee protocol to the raspberry pi, which serves as the core controller. Finally, using cloud computing, sensor data can be seen on web applications.
"Industry 4.0 as a Part of Smart Cities" by Michal Lom, Ondrej Pribyl, and Miroslav Svitek [9] explains the intersection of the Smart City Initiative and the idea of Industry 4.0 discussed in this essay. The term "smart city" has been quite popular over the past few years, especially since 2008, when the global financial crisis occurred. The Smart City Initiative was founded primarily to build a sustainable model for cities and protect inhabitants' quality of life. The concept of the "smart city" cannot be understood solely from a technical perspective; additional economic, humanitarian, and legal considerations must be made. The Internet of Things (IoT) will be utilized in the development of 'smart' products, according to the Industry 4.0 idea. The product's components have their own intelligence built into them. A product's production process, handling process, and ongoing product lifetime monitoring all make use of additional intelligence. Internet of Services (IoS), which covers intelligent transport and logistics in particular, and the Internet of Energy (IoE), which governs how natural resources are used properly, are other significant elements of Industry 4.0. Smart cities can be thought of as a component of Industry 4.0, while IoT, IoS, IoP, and IoE can be seen as a component that can connect the two.
"QOI-Aware Energy Management in Internet-of- Things Sensory Environments" by Zhanwei Sun, Chi Harold Li, Chatschik Bisdikian, Joel W. Branch, and Bo Yang [10] examines an effective energy management framework for delivering a satisfying QOI experience in IOT sensory environments. Contrary to earlier attempts, it is transparent and compatible with less sophisticated protocols in use, maintaining energy efficiency over time without compromising any QOI levels that have been obtained. In particular, the new idea of "sensor-to-task relevancy" expressly takes into account both the QOI requirements of a task and the sensing capabilities supplied by a sensor to the IOT sensory environments. In choosing the sensors to serve a task over time, a novel notion known as the "critical covering set" of each particular activity is used. A dynamic choice is made at runtime about energy management based on long-term traffic trends and the service delay constraint. Last but not least, a thorough case study focused on applying sensor networks to perform water level monitoring is provided to illustrate the concepts and methods suggested in this research, and a simulation is built to illustrate how well the algorithms perform.

III. PROPOSED SOLUTION

The proposed solution aims to address the issue of declining oxygen levels in aquatic environments, which is one of the main causes of marine species extinction. This issue is caused by various factors such as pollution, contaminants, and green algae. To continuously monitor the oxygen, pH, temperature, and turbidity levels in the water bodies, the system employs various sensors, including dissolved oxygen sensors, temperature sensors, turbidity sensors, conductivity sensors, and chlorophyll sensors. The data collected from these sensors will be fed into a centralized system that can analyze and provide real- time information on the water quality. This system will be connected to a mobile application (Blue Lungs) that can be accessed by the public and government officials. The mobile application will display real-time data on water quality, including oxygen levels, pH, temperature, and turbidity. It will also provide a visual representation of the water body's location through longitude and latitude information. The mobile application will be updated in real-time through Firebase. If the oxygen levels in the water body fall below a certain threshold, the mobile application will notify the users. The notification will include the location of the water body, longitude, latitude, oxygen level, and contamination percentage. This will enable the government to take prompt action to address the issue, preventing further harm to the marine ecosystem.

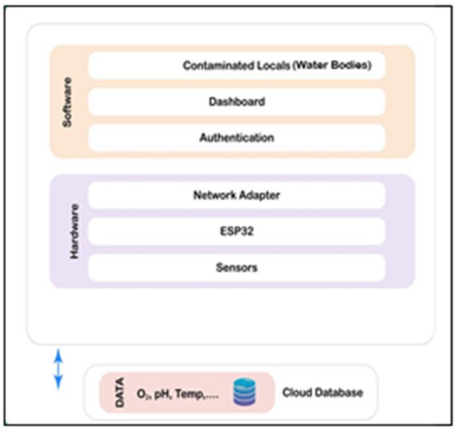

Figure 2. Block Diagram

In addition to preventing the extinction of marine species, this solution has the potential to increase India's Gross Domestic Product in fishing. By maintaining the quality of the water bodies, it is possible to ensure a sustainable and healthy marine ecosystem, which can ultimately benefit the fishing industry. Several sensors (temperature, pH, turbidity, and flow) are coupled to the core controller in the suggested block diagram. In order to transmit data via the internet, the core controller accesses the sensor values and processes them. One of the core controllers is Arduino. On the internet Wi-Fi system, the sensor data can be accessed.

IV. SCHEMATIC ANALYSIS

The entire system's architecture is based in large part on IOT, a recently popularized concept in the field of development. The main components are divided into two categories: hardware and software. The hardware component includes sensors that assist in measuring real-time values, an Arduino atmega328 that transforms analog values to digital ones, an LCD that displays sensor output, and a Wi-Fi module that connects the hardware and software. In terms of software, we created a program using embedded C. At the initial stage of construction, the PCB is designed, and components and sensors are mounted on it. When the system starts, the kit, Arduino, and Wi-Fi all receive dc current. One by one, the water's parameters are tested, and the results are shown on the Mobile application. The app that came with the hotspot provides the precise value of the parameters mentioned. Thus, if the kit is placed near a certain body of water and WIFI is available, we can view its real-time value on an Android phone from any location at any time. And the users receive an
alert notification if the oxygen level of the water comes below the threshold (Table 1).

V. RESULT AND DISCUSSION

The functionalities of the many sensor devices and other modules that make up the appropriate implementation model that we have found are depicted in the figure. ATMEGA 328 with a Wi-Fi module was employed in this implementation model. The embedded gadget (Fig. 3) is connected to the internet through an ADC and Wi-Fi module built in. ADC converts the associated sensor reading to its digital value, and from that value, the related

environmental parameter is evaluated. Sensors are connected to an Arduino UNO board for monitoring. After gathering information from various sensor devices positioned in a certain area of interest (Table 2).
When a proper connection is made with the server device, the detected data is automatically delivered to the web server and the real-time data is shown in the mobile application developed.

TABLE I. WATER QUALITY PARAMETER RANGE FOR WATER

Table 1
Water quality parameter range for drinking water

Parameter	Range
pH	6.5 to 8.5
Turbidity	< 5 NTU
Dissolved Oxygen	6.5 to 8 mg/L
Humidity	40% to 60%
Temperature	-2° C to 30° C

TABLE II. WATER QUALITY FOR DIFFERENT SAMPLES.

Table 2
Water quality parameters for different samples .

Sample	Parameter	Measured Value
Water Sample 1	pH	7.5
	Turbidity	4 NTU
	Dissolved Oxygen	7.2 mg/L
	Humidity	42%
	Temperature	20° C
Water Sample 2	pH	9.3
	Turbidity	5.6 NTU
	Dissolved Oxygen	5 mg/L
	Humidity	60.44%
	Temperature	29.4° C
Water Sample 3	pH	9.72
	Turbidity	5.33 NTU
	Dissolved Oxygen	6.8 mg/L
	Humidity	64.67%
	Temperature	26.4° C

VI. CONCLUSION AND FUTURE SCOPE

The monitoring of water's dissolved oxygen turbidity, PH, and temperature uses a water detection sensor with a special benefit and an existing GSM network. The device can automatically check the quality of the water, is inexpensive, and does not need anyone to be on duty as it notifies the application users using an alert notification. Testing the quality of the water should therefore be more affordable, practical, and quick. The method is very adaptable. Other water quality parameters can only be monitored with this system by changing the required sensors and software programs. The process is easy. It is possible to expand the system to track hydrologic conditions, air pollution, industrial and agricultural output, and other variables. It has a wide range of uses and extension values. By retaining embedded devices in the environment for monitoring, the ecosystem can protect itself (creating a smart environment). In order to achieve this, sensor devices must be placed in the environment for data collection and processing. We can make the environment more realistic by placing sensor devices there (Fig. 3), allowing the environment to communicate with other things across a network. The user will then have access to the gathered data and the analysis' findings over Wi-Fi.

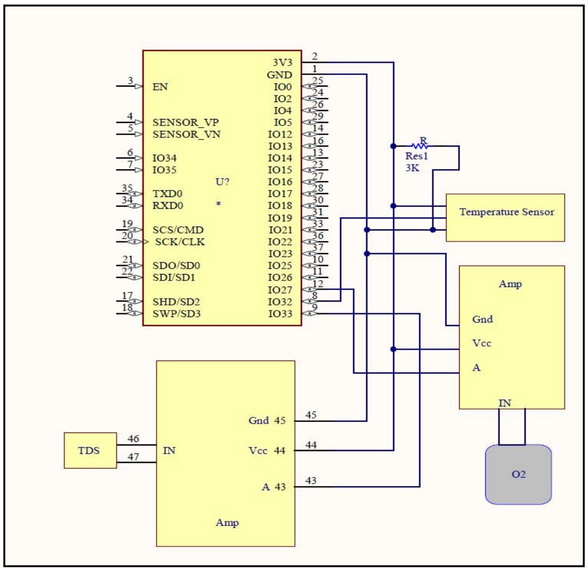

Figure 3. Schematic Diagram

Future Scope

- Detecting more parameters for the most securepurpose.
- Increasing the parameters by the addition of multiplesensors.
- By interfacing the relay we can control the supply ofwater.
- Detecting the types of pollutants in the water.
- Suggesting control measures to reduce the pollutants.

REFERENCES

[1] Remote Sensing Exploration Division ESRIN, “Oil Pollution Monitoring”, ESA Publication Division,

[2] http://www.esa.int/esapub/br/br128/br128_1. pdf..

[3] S. Pasika, S.T. Gandla, Smart water quality monitoring system with cost-effective using IoT, Heliyon 6 (7) (2020), doi: 10.1016/j.heliyon.2020.e04096I

[4] M. Mukta, S. Islam, S.D. Barman, A.W. Reza, M.S. Hossain Khan, 2019, pp. 669– 673, doi: 10.1109/CCOMS.2019.8821742.

[5] M.K. Amruta, M.T. Satish, International Mutli-Conference on Automation, Computing, Communication, Control and Compressed Sensing (iMac4s), 2013, pp. 281–285, doi:10.1109/iMac4s.2013.6526423.

[6] S. Konde, S. Deosarkar, IOT based water quality monitoring system, in: Proceedings of the 2nd International Conference on Communication & Information Processing (ICCIP), 2020 2020, doi: 10.2139/ssrn.3645467.

[7] T. Sugapriyaa , S. Rakshaya , K. Ramyadevi, M. Ramya , P.G. Rashmi , Smart water quality monitoring system for real time applications, Int. J. Pure Appl. Math. 118 (2018) 1363–1369.

[8] Nikhil Kedia, Water Quality Monitoring for Rural Areas- A Sensor Cloud Based Economical Project, in 1st International Conference on Next Generation Computing Technologies (NGCT-2015) Dehradun, India, 4-5 September 2015. 978-1-4673- 6809-4/15/$31.00 ©2015 IEEE.

[9] Jayti Bhatt, Jignesh Patoliya, Iot Based Water Quality Monitoring System, IRFIC, 21feb,2016.

[10] Michal lom, ondrej priby & miroslav svitek, Internet 4.0 as a part of smart cities, 978-1- 5090-1116-2/16/$31.00 ©2016 IEEE.

[11] Zhanwei Sun, Chi Harold Liu, Chatschik Bisdikia_, Joel W. Branch and Bo Yang, 2012 9th Annual IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks.

[12] Varsha Lakshmikantha, Anjitha Hiriyannagowda, Akshay Manjunath, Aruna Patted, Jagadeesh Basavaiah ∗ , AudreArlene Anthony, Global Transitions Proceedings.

[13] Arijit Khan, Lawrence Jenkins, “Undersea wireless sensor network for ocean pollution prevention”.

[14] Vaishnavi V. Daigavane and Dr. M.A Gaikwad, Advances in Wireless and Mobile Communications. ISSN 0973-6972 Volume 10, Number 5 (2017), pp. 1107-1116 © Research India Publications, http://www.ripublication.