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Implementation of Water Grade Inspection System using Multiple Sensors

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Abstract*: Water is very crucial for healthy living. A large portion of the irresistible maladies are because of tainted water which prompts a huge number of contaminants consistently. Water quality testing is imperative since it recognizes contaminants and counteracts water-borne ailments. There is necessity to build up Water quality checking framework to confirm whether the measured water quality is reasonable for expected use. Basically, water quality observing ensures that water is safe and meets nearby and global water norms. Different water sampling techniques and technology to determine the level and amount of chemicals present in water can be used for water quality testing. Water utilized for human and animal use must be tested for safety. Along with household water, recreational and agricultural water also needs to be tested. In this paper, an IoT based water grade inspection system is proposed, in which water quality in terms of Turbidity and Temperature is measured with the help of sensors. NodeMCU ESP8266 board is used here. It has a built in onboard Wi-Fi module that facilitates to send alert message when the turbidity and temperature of water exceeds threshold values. The alert notifications are obtained in ESP Notify app.

Keywords: IoT, Real time monitoring, Wireless Sensor Networks, Zigbee technology, GSM.

I. INTRODUCTION

India is one of the developing nations and furthermore second most populated nation of the world. There is a critical change in the way of life, and the quick increment of the economy has led to wide acknowledgment all around the globe. Beside the extensive accomplishments made by India, yet various genuine natural issues have surfaced, which is influencing solid development of India. Water contamination has developed radically in recent decades. Water bodies like rivers and lakes are getting exceedingly contaminated. Rivers in India are getting dirtied by different sources, for example, sewer, modern, farming and mining waste. The contamination of water bodies can have brutal long lasting consequences on the human wellbeing. Drinking or utilizing defiled water can result in serious ailment or demise [21].

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As per estimation of WHO, about 3.4million people die every year due to water related diseases. Hence it is crucial to make sure that water used is clean, safe and free from harmful chemicals. A large portion of the fresh water assets situated close to urban zones are polluted because of the discharge of hazardous chemicals from industries and also due to the waste disposed by people. In case of Overhead tanks, it is seen that primary cause of decay in water quality is because of the re-growth of microorganisms in overhead tanks, use of old pipes for very long without replacing, corrosion of pipes.
There is a prerequisite for steady and continuous inspection of water quality parameters, since large amount of contaminants can cause critical health problems. In the usual and traditional method of water quality testing, water samples are collected from different areas and further testing is done in laboratories, which is a tedious, expensive job, which may not permit concurrent and appropriate examination of water [6]. Hence, a Water grade inspection system using IoT is proposed. In this system, Turbidity and Temperature sensors are used that continuously monitor the Turbidity and temperature level of water samples. The ESP8266 Wi-Fi module of NodeMCU is used to send alert messages whenever water quality deteriorates i.e., turbidity and temperature found above threshold level.

II. PARAMETERS AFFECTING WATER QUALITY

This section highlights the effects of Turbidity and Temperature on water quality [22]

A. Turbidity

Turbidity of water is a parameter that measures its transparency due to the presence of suspended particulates. Higher is the turbidity for large amount of suspended particles in water. Resuspended sediments, phytoplankton, erosion sediments, growth of algae are some of the parameters that causes turbidity in water. The turbidity of water is measured by the intensity of light scattered by the suspended particles in water. More the particles are present, more the light will be scattered and hence higher the turbidity. In this way, total suspended particles and turbidity are related. Turbidity is measured in NTU: Nephelometric Turbidity Units. As per the guidelines of WHO, the turbidity of drinking water shouldn't be more than 5 NTU, and should ideally be below 1 NTU.

B. Temperature

Water temperature determines the magnitude of hotness or coldness of water. Temperature is an imperative factor to be considered while evaluating water quality.

Temperature also influences other properties like photosynthesis production, metabolic rates, dissolved oxygen, conductivity, salinity, water density, pH, and can also alter other physical and chemical properties of water. According to WHO, the recommended drinking water temperature is 15 degree Celsius maximum.

III. LITERATURE REVIEW

In the work proposed by Das et al. [1], water parameters pH, temperature, conductivity are monitored using microcontroller and two data transmission modules Zigbee and GSM. The methodology involves sending the parameter values to smart phone /PC via SMS using GSM. Since this is limited to only three parameters, it is suggested to include other sensors for testing parameters like Turbidity, dissolved oxygen, etc.Komiyama et al. [2] developed a turbidity sensor for monitoring of lake water. This turbidity sensor is developed using an optical setup consisting of LED (Light Emitting Dio
de) and photodiode. The principle used here is determining the turbidity by transmittance of scattered LED light by the water sample particles, which is correlated to the photo voltage of photodiode. The experimental results proved this optical turbidity measurement setup to be a helpful tool for sensing the turbidity of water. Tests are done for lake water samples using commercial turbidity sensors, whose results are found to be approximately similar to the results of proposed developed sensor. For future work, it is suggested to develop other water testing sensors such as dissolved oxygen sensor and chlorophyll concentration sensors.

A low cost, light weight, user friendly electronic turbidity sensor is designed and developed by Azman et al. [3], which works on the principle of scattered light intensity with respect to the scattering of light in liquids and solids. To develop this sensor, components used are- LED as transmitter, Light Dependent Resistor as receiver, PIC 16F777 as main processor and RS232 module for sensor communication. The experimental results proved that the results of this self-developed sensor to be comparable with the commercial turbidity sensor values.

Gopavanitha et al. [4] presented a work in which different sensors are used to measure water quality parameters like pH, temperature and conductivity. In this system, Data from sensors is processed using Raspberry Pi controller and then send to cloud database, which is visible on cloud for the users using cloud computing. It is suggested to include biological sensors for better water contaminants detection.

Moparthi et al. [5] proposed Water quality monitoring system using IoT. The main objective of this work is to detect the quality of water in terms of its Ph content. The idea is to implement this project at drinking water reservoirs and municipal water tanks. Using a pH sensor, the pH content of water is measured and this data is processed using Arduino and whenever the pH content is found to be out of range, an alert message is sent to owner using GSM module. LED display is also used to display the pH content values. It is suggested that this framework can be expanded to measure other important parameters of water such as turbidity, temperature, broken down oxygen levels, etc.

Naidu et al. [6] proposed an efficient water quality testing system using WSN, to detect pH, temperature and conductivity of water. Various sensor nodes consisting of sensors, Xbee, Arduino are located at different overhead tanks. Data processed is displayed on a webpage, which is available for users. It is suggested to stretch out this project by including dissolved oxygen sensor and turbidity sensors.

Maqbool et al. [7] came up with Real time wireless monitoring and control of water systems using Zigbee 802.15.4 technology, to examine the water level, pH, temperature and dissolved oxygen. Data from sensor nodes is transmitted to end device via Xbee technology and displayed in PC (Personal Computer) using a C sharp language program. The data is also sent to owners via SMS and at specific levels of data, alarms are generated.

Kumar Jha et al. [8] proposed a smart real time water quality check meter to measure qualitative parameters of water like pH, conductivity and dissolved oxygen; and the results are displayed on a web portal along with bar graphs representing quality status of various water samples with respect to their quality parameters.

Yang et al. [9] has effectively structured and implemented a novel wireless water consumption tracking system in which temperature and water flow sensors are deployed at different household sites, from where the sensed data is collected and send to a computer server. This system has been successfully employed and tested at various households in Greece and Poland.

Dongling et al. [10] presented water quality information management system adopting Geographic Information System (GIS) technique. The test outcomes demonstrated that, this framework can express the state of water quality contamination strikingly and thus improving the working effectiveness of water quality management.

Menon et al. [11] came up with a low cost WSN based water quality monitoring system in natural bodies. Several sensors are used to measure the pH, temperature, conductivity of water and the sensed data is processed using Microcontroller. Solar panels are connected to sensor nodes to provide power to the system. This proposed system senses, processes and transmits the examined data and notifies it to the concerned owners via SMS/ call.

The framework proposed by Nasser, Nidal et al. [12] makes use of pH sensors and Squidbee sensor motes to examine water quality in real time environment. This framework includes an alarm component to send alert mails whenever unusual event takes place. The system also has a sleep mechanism to improve the network lifetime. The experimental results have shown that this proposed system with sleep mechanism provide longer lifetime compared to a traditional conventional WSN based water quality monitoring system.

Myint, Cho Zin et al. [13] proposed a smart reconfigurable water grade checking system in IoT environment. This system includes FPGA (Field Programmable Gate Array) design board, Zigbee module, various sensors and PC. The core component of this system is FPGA which is programmed in very high speed integrated circuit hardware description language (VHDL). The system collects the water
quality parameters data such as pH, dissolved oxygen,

temperature and water level from various sensor nodes in real time. The use of FPGA board provides reusable intellectual property (IP) and increased execution speed to the system; but it is very expensive.

Y. Li, Y. Wang et al. [14] proposed and developed a powerful sensor node using a water proof UAV for real time water quality monitoring and water parameter acquisition. The development of moving node led to increased flexibility and reliability of sensor network; but since the UAV model is not fully waterproof, it can vandalize the components, hence it is not fully reliable.

The system proposed by Vinod Raut and Sushama Shelke [17] is aimed at remotely measuring the pH and turbidity levels of water. This system consists of Peripheral Interface Controller (PIC) microcontroller and two main sections, i.e, Transmitter section that has pH and turbidity sensors for sensing and gathering data from remote places, and Receiver section that makes use of Zigbee technology to collect the transmitted data and this data is utilized to classify water as pure, drinkable and impure water which is displayed on LCD and PC.

Li, Lim Yong et al. [18] proposed an affordable, user friendly WSN based water quality monitoring system. This system makes use of various sensors which after getting activated take the water sample readings and this data is processed using Arduino Uno. Later this processed data is send to ThingSpeak platform via Wi-Fi module. The frame of ThingSpeak displays the water parameter results on the webpage in graphical form.

Kamaludin et al. [19] proposed and developed anIoT based water quality monitoring system by deploying WSN nodes in real time environment at a lake in Malaysia's Sains university campus area for evaluating the performance. This system measured and analyzed the pH level in water using an analog sensor. Atmega 328p microcontroller is used to process the collected data and then TCP/IP communication is established in order to store the data in cloud database. The system provided a mobile application that is developed based on Android OS platform, to enable online monitoring of water pH levels. An algorithm of alerting system is also written to detect the predetermined threshold pH value in order to produce alert sound for the user's mobile.

Xu, Yang et al. [20] proposed the application of wireless sensor network in water quality monitoring to detect the water pH, temperature and other parameters. In this work, study of different wireless transmission protocols that can be used in the water quality monitoring has been done. It is concluded that Zigbee technology to be more suitable for use compared to Bluetooth and Wi-Fi technology.

IV. METHODOLOGY

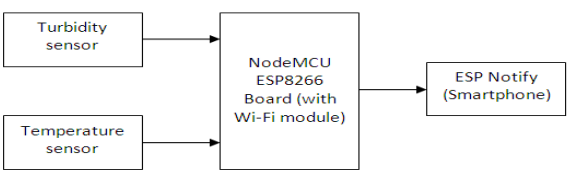


Figure 1: Block diagram of implemented system

i. NodeMCU

NodeMCU board is used for interfacing of sensors. NodeMCU ESP8266 is a Wi-Fi enabled microcontroller board used for IoT. It also has a voltage regulator, a USB interface. It has analog and digital pins for I/O interfacing. It is programmed using Arduino IDE.

ii. Turbidity Sensor

TSD-10 Turbidity sensor is interfaced with the NodeMCU. This sensor has three connections- vcc, gnd and the data pin is connected to A0 pin of NodeMCU. The sensor gives analog readings that are converted to voltage values using equation, voltage = sensor value * (5.0 / 1024.0). It can give values up to 5V. Turbidity is inversely proportional to voltage. As turbidity of water increases, the voltage decreases.

iii. Temperature Sensor

The waterproof DS18B20 Temperature Sensor is interfaced with NodeMCU. This sensor has three connections- vdd, gnd and the data pin is connected to D1 pin of NodeMCU. The data pin gives the Celsius temperature measurements. Power for this sensor can be derived from the data line itself, so there is no need for an external power source.

iv. ESP Notify

ESP Notify is a mobile application that receives alert notifications/messages from ESP8266 module when the turbidity and temperature levels exceed threshold levels.

V. RESULTS AND DISCUSSION

The Experimental setup for water grade inspection system using NodeMCU ESP8266 is shown in Figure 2.

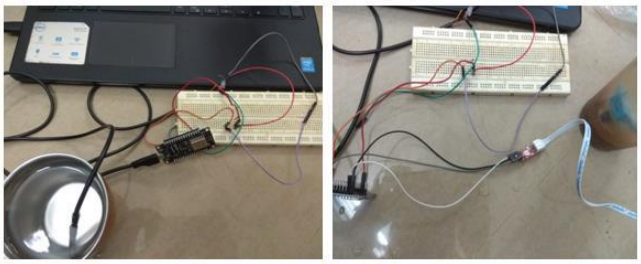
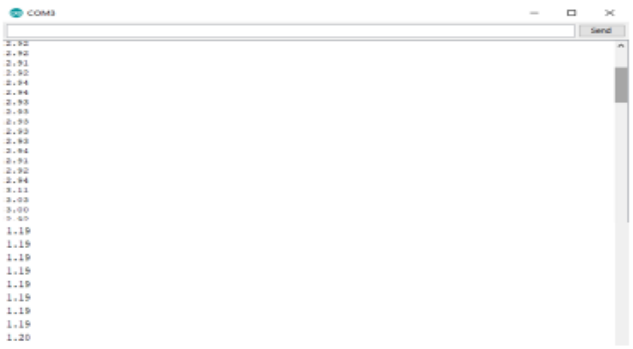


Figure 2: Experimental setup for water grade inspection system

Figure 3 shows the sensor output values displayed on Serial Monitor. The turbidity values are voltage values (higher the turbidity, lower the voltage) and temperature sensor readings are in terms of degree Celsius.



(a)

(b)

Figure 3: Serial monitor display (a) Turbidity values (b) Temperature values

The Figure 4 shows the alert messages received when the turbidity and temperature is detected above threshold levels. When turbidity sensor reading falls below 1.5V and temperature sensor reading exceeds 15 degree Celsius, Alert messages are sent.

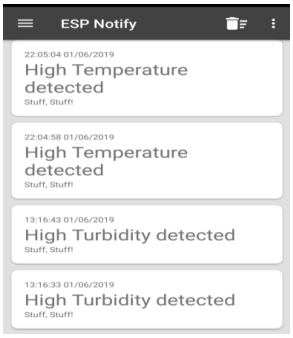


Figure 4: Alert messages to mobile

VI. CONCLUSION AND FUTURE WORK

The water grade inspection system for monitoring the turbidity and temperature is implemented. Alert messages are sent to the users whenever the turbidity and temperature values exceed threshold levels. NodeMCU board is chosen and used over Arduino Uno as it has integrated support for Wi-Fi network and it also has advantage of low cost and less energy consumption. This system can be stretched to include other water quality testing sensors to test pH, conductivity, dissolved oxygen, ammonia, nitrates etc. Similar sensor setups can be deployed at different nodes and the quality of water from different locations can be obtained and analyzed. Other than sending alert messages, the data obtained from different sensor nodes can be stored in a Google spreadsheet and can be made accessible for all users via webpage, so that the users get an idea about the quality of water at any location.

REFERENCES

1. G Das, Brinda, and P. C. Jain. "Real-time water quality monitoring system using Internet of Things." Computer, Communications and Electronics (Comptelix), 2017 International Conference on. IEEE, 2017.
2. Komiyama, Ryohei, et al. "Turbidity monitoring of lake water by transmittance measurement with a simple optical setup." SENSORS, 2015 IEEE. IEEE, 2015.
3. Azman, Ahmad Aftas, et al. "A low cost nephelometric turbidity sensor for continual domestic water quality monitoring system." Automatic Control and Intelligent Systems (I2CACIS), IEEE International Conference on. IEEE, 2016.
4. Gopavanitha, K., and S. Nagaraju. "A low cost system for real time water quality monitoring and controlling using IoT." 2017 International Conference on Energy, Communication, Data Analytics and Soft Computing (ICECDS). IEEE, 2017.
5. Moparthi, Ch. Mukesh, Dr. P. VidyaSagar, "Water Quality Monitoring System Using IoT." 4th International Conference on Advances in Electrical, Electronics, Information, Communication and Bio-Informatics, 2018.
6. Naidu, Ch, et al. "Implementation of wireless sensor network for real time overhead tank water quality monitoring." Advance Computing Conference (IACC), 2017 IEEE 7th International. IEEE, 2017.
7. S. Maqbool and N. Chandra, "Real Time Wireless Monitoring and Control of Water Systems Using Zigbee 802.15.4," 2013 5th International Conference and Computational Intelligence and Communication Networks, Mathura, 2013, pp. 150-155.
8. M. Kumar Jha, R. KumariSah, M. S. Rashmitha, R. Sinha, B. Sujatha and K. V. Suma, "Smart Water Monitoring System for Real-Time Water Quality and Usage Monitoring," 2018 International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, 2018, pp. 617-621.
9. S. Yang, X. Chen, X. Chen, L. Yang, B. Chao and J. Cao, "A case study of internet of things: A wireless household water consumption monitoring system," 2015 IEEE 2nd World Forum on Internet of Things (WF-IoT), Milan, 2015, pp. 681-686.
10. Ma, Dongling, and Jian Cui. "Design and realization of water quality information management system based on GIS." 2011 International Symposium on Water Resource and Environmental Protection. Vol. 1. IEEE, 2011.
11. Menon, Gayathri S., ManeeshaVinodini Ramesh, and P. Divya. "A low cost wireless sensor network for water quality monitoring in natural water bodies." 2017 IEEE Global Humanitarian Technology Conference (GHTC). IEEE, 2017.
12. Nasser, Nidal, et al. "An efficient Wireless Sensor Network-based water quality monitoring system." 2013 ACS international conference on computer systems and applications (AICCSA). IEEE, 2013.
13. Myint, Cho Zin, Lenin Gopal, and Yan Lin Aung. "Reconfigurable smart water quality monitoring system in IoT environment." 2017 IEEE/ACIS 16th International Conference on Computer and Information Science (ICIS). IEEE, 2017.
14. Y. Li, Y. Wang, M. Cong and H. Lang, "Design and development of a water quality monitoring network and system," 2017 IEEE International Conference on Industrial Technology (ICIT), Toronto, ON, 2017, pp. 912-916.
15. Pranata, Alif Akbar, Jae Min Lee, and Dong Seong Kim. "Towards an IoT-based water quality monitoring system with brokerless pub/sub architecture." 2017 IEEE International Symposium on Local and Metropolitan Area Networks (LANMAN). IEEE, 2017.
16. Sukaridhoto, Sritrusta, et al. "Design and development of a portable low-cost COTS-based water quality monitoring system." 2016 International Seminar on Intelligent Technology and Its Applications (ISITIA). IEEE, 2016.
17. Raut, Vinod, and SushamaShelke. "Wireless acquisition system for water quality monitoring." 2016 Conference on Advances in signal Processing (CASP). IEEE, 2016.
18. Li, Lim Yong, HaryatiJaafar, and NurHidayahRamli. "Preliminary Study of Water Quality Monitoring Based on WSN Technology." 2018 International Conference on Computational Approach in Smart Systems Design and Applications (ICASSDA). IEEE, 2018.
19. K. H. Kamaludin and W. Ismail, "Water quality monitoring with internet of things (IoT)," 2017 IEEE Conference on Systems, Process and Control (ICSPC), Malaysia, 2017, pp. 18-23.
20. Xu, Yang, and Fugui Liu. "Application of wireless sensor network in water quality monitoring." 2017 IEEE International Conference on Computational Science and Engineering (CSE) and IEEE International Conference on Embedded and Ubiquitous Computing (EUC). Vol. 2. IEEE, 2017.
21. Pujar, Prasad M., Harish H. Kenchannavar, and U. P. Kulkarni. "Wireless sensor network based water monitoring systems: A survey." 2016 2nd International Conference on Applied and Theoretical Computing and Communication Technology (iCATccT). IEEE, 2016.
22. Chandrappa, S., et al. "Design and Development of IoT Device to Measure Quality of Water." International Journal of Modern Education and Computer Science, 2017.
23. https://itra.medialabasia.in/?p=621

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Krishnananda Shet is currently working as the Associative Professor in the Department of Electronics and Communication Engineering at NMAMIT, Nitte, India. His Research projects include Autonomous Intravenous Infusion, Neural network based predictive controller for ship navigation , Ultra-wide Band Microstrip Patch Antenna for Wireless Communications. He has won Best Paper Presenter award for the research paper titled "A Wideband Probe-fed Conformal Antenna for DSRC Radar Mounted on a Generic Hatchback Car" in the third International Conference on Electrical, Electronics, Communication, Computer Technologies and Optimization Techniques at GSSSIT, Mysuru. He is a member of ISTE.

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