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SMART WATER QUALITY MONTIORING SYSTEM USING IoT

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Abstract: Pollution of water is one of the main threats in recent times as drinking water is getting contaminated and polluted. The polluted water can cause various diseases to humans and animals, which in turn affects the life cycle of the ecosystem. If water pollution is detected in an early stage, suitable measures can be taken and critical situations can be avoided. To make certain the supply of pure water, the quality of the water should be examined in real-time. Smart solutions for monitoring of water pollution are getting more and more significant these days with innovation in sensors, communication, and Internet of Things (IoT) technology. In this paper, a detailed review of the latest works that were implemented in the arena of smart water pollution monitoring systems is presented. The paper proposes a cost effective and efficient IoT based smart water quality monitoring system which monitors the quality parameters uninterruptedly. The developed model is tested with three water samples and the parameters are transmitted to the cloud server for further action.

Keywords: Water Quality Monitoring System, Ph sensor, Temperature Sensor

I. INTRODUCTION

With the rising awareness of the importance of energy saving and carbon emission reduction worldwide, application 22 of renewable energy is bound to increase rapidly for the 23 foreseeable future. However, due to renewable energy power 24 generation being intermittent and subject to weather conditions, as its proportion gradually increase in grid, it will 26 seriously affect stability and power quality of power system. As the manufacturing technology of electronic vehicles 59 (EVs) become mature in recent year, in response to policies 60 of energy saving and carbon emission reduction worldwide, 61 governments around the world takes relevant policies to advocate EVs as the main transportation in the future to replace 63 petroleum-fueled engine vehicles the utilization of 64 EV will increase greatly in the next few years. With the declining oil reserves and the increasing air pollution, Electric Vehicles(EVs) usher in a golden development period. In 2019, global Electric Vehicle(EV) sales were approximately 2.2 million units, a yearon- year increase of 10%. GlobalData predicts that the number EVs on the road will climb to 300 million by 2040. EVs are powered by onboard power supplies and use motors to drive wheels. EVs have the characteristics of being clean and pollution-free, low driving noise, high energy efficiency, low use cost, and small maintenance work. European countries have introduced national incentives and benefits for EVs, and France provides benefits of up to 12,000 euros for EV users. The U.S. government has established 25 billion US dollars of funds to support manufacturers in the field of new energy vehicle research and production. China has included charging piles(CPs) for EVs in new infrastructure development, and 10 billion RMB will be invested in EV charging infrastructure.

II. LITERATURE SURVEY

In this paper [1], this work proposes a system that overcomes these problems. With the use of an industrial multi-parameter sensor node, EXO Sonde the desired sensor values can be extracted from the physical world. The sensed data is processed and communicated forward to the server forward through a layered architecture to a server. The sensor node utilizes a file system to save the sensor data in case of network loss. The communication technology between nodes and sensors is GSM. In the server, the data gets stored and gets visualized in a web UI. EXO Sonde is a stand-alone module that allows the user to collect multiple water quality-related parameters. Since this module is used for water-related issues it has corrosion-resistant connectors. All the modules are isolated to avoid short circuit issues. The smart sensor options in the EXO are conductivity, dissolved oxygen content, pH, rhodamine, total algae, and turbidity. The other parameters available are absolute pressure, ammonia, depth, salinity, suspended solids, and density of water. The module is tested in various rigorous conditions to confirm accuracy. It has 7 universal ports and a central wiper feature. The paper presents the details of the tools and techniques used in the smart water monitoring system. The work uses a layered architecture. Here the layers are data acquisition layer, data transmission, and processing.

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The project achieved the desired output of water monitoring, using the EXO Sonde, GSM, and the flask server. The features of EXO Sonde have added better performance and improved the monitoring process. The sensor data are received and visualized on the server.

In this paper [2], it proposes a modern system that could be used to determine the quality of water. After all the analysis, it can be suggested that the proposed solution might perhaps be far more comprehensive and suitable for the monitoring of the water quality in real-time as compared to the conventional monitoring ways. Here, the data from the sensors can be viewed via cloud computing on the internet browser request by using the Zigbee protocol. Each sensor used here has a specific job which is to measure various parameters. The temperature sensor is employed to measure the temperature, the turbidity measures the cloudiness or haziness caused by large amounts of individual particles usually invisible to the naked eye, similar to smoke, whereas the pH sensor checks the water's pH level, the dissolved oxygen sensor detects the amount of oxygen dissolved and the conductivity sensor monitors the control system which examines the particles dissolved in water and detects any leakages.

In this paper [3], the proposed system monitors the quality of water relentlessly with the help of IoT devices, such as NodeMCU. The in-built Wi-Fi module is attached in NodeMCU which enables internet connectivity and transfers the measured data from sensors to the Cloud. The prototype is designed in such a way that it can monitor the number of pollutants in the water. Multiple sensors are used to measure various parameters to assess the quality of water from water bodies. The results are stored in the Cloud, deep learning techniques are used to predict whether the water is suitable or not. The performance of the sensor node is stored in the real-time database and live feed is monitored using a smart water quality assessment and decision system. The water quality is analyzed using the live feed of data and the system indicates the status as normal, warning and abnormal based on the sensor value correlated against the threshold. The Sensed values like Temperature, Humidity, Co2, pH, Dissolved oxygen and Soil moisture from different sensors are measured and transmitted to firebase cloud with the help of the ESP8266 with in-built Wi-Fi protocol. The dissolved oxygen, temperature, water moisture, and pH sensors built on the floating buoy were reliable and easier for expansion throughout the water resource. Moreover, the sensor supports continuous monitoring and maintains network life for about 90-120 days based on the sleep-wake mechanism cycles. The cluster head protocol suited well for data transmission and single end traffic improves network stability. The buoy is self-balanced over the water surface ensuring the sensor portion completely sinks and antenna heads are available for communication. Moreover, the buoy eli

In this paper [4], this project proposes an IoT based water quality monitoring system and alerts the concerned authorities if the consumed groundwater is polluted. The proposed system uses various sensors, Node MCU and is integrated with cloud infrastructure for database storage and for real-time dashboard maintenance of the measured parameters. The proposed system includes sensors like pH, turbidity, temperature, Node MCU, Thingspeak IoT for cloud access. Initially, the sensors have to be calibrated with distilled water or deionized water. Further place the pH sensor, turbidity and temperature sensors in a tank of water. The system monitors the sensor readings, and the values are managed by the Node MCU to carry out the required actions. The data is continuously transmitted to the cloud; the devices and the sensors are identified by a unique ID called a token ID. A specific delay can vary the data transmission speed from the Node MCU to the cloud. The transmitted data can also be viewed in the serial monitor. The cloud has different fields which include pH, turbidity and temperature levels. If there is a deviation in the value, then the cloud will alert the user. The sensors will check the parameters continuously, and the data will be uploaded to the cloud. A real-time water quality monitoring and the alert system was designed using Node MCU and various sensors. The designed system is cheaper and cost-effective and provides fast and reliable data in real-time as it is integrated with sensors and cloud. The waste contamination from landfill to the groundwater will turn the water unsafe for drinking purposes. The proposed system monitors and alerts the respective authorities to prevent the illness due to the consumption of polluted water. This system can be improved by involving more parameters such as dissolved oxygen and carbon dioxide, dissolved salts, monitoring dead organisms in the water etc. and it can be implemented on a large scale in villages to provide awareness among the people. It can be used to trigger specific actions for water treatment based on the sensed data.

In this paper [5], discusses the proposed Smart Water Quality Monitoring System (SWQMS) design, and the evaluation of factors influencing pH value and temperature of swimming pools using DOE and ANOVA statistical tools. The experimental findings reveal that time of day, pool volume and their interaction factors do not influence the pH value however time of day does have an effect on the water temperature of the swimming pool. In the system implementation, the staff will be able to monitor the pH value in real-time using their mobile phone or personal computer. Hence, prompt action can be taken in order to ensure the swimming pool is safe to be used all the time. To regulate the pH level of the water pool, water pump 1 and pump 2 are embedded into the system for pumping acidic and alkaline solution respectively Furthermore, the proposed system enables the operation management to trace the data and do analysis for all the problem occurred so that the same problems will not occur in the future. The system is capable of automatically updating the

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current status of water quality of the pool via IoT platform and make an adjustment to the pH level. This SWQMS system is also capable of providing real-time monitoring and requires less operational maintenance. Based on the statistical analysis that was conducted, the time of day, pool volume and the interaction factors do not influence the reading of pH value. While for the temperature, the time of day factor does influence the temperature condition.

III. COMPONENTS REQUIRED

ESP32 DevKit Module

The ESP32 DevKit Module is a development board based on the ESP32 microcontroller. It is designed for the rapid prototyping of IoT (Internet of Things) applications and projects. The board includes the ESP32-WROOM-32 module, which contains a dual-core processor, Wi-Fi and Bluetooth connectivity, and various peripheral interfaces.

The main features of the ESP32 DevKit Module include:

- Dual-core processor: The ESP32 microcontroller has two Tensilica LX6 CPU cores, each running at up to 240 MHz. This provides plenty of processing power for IoT applications.
- Wi-Fi and Bluetooth connectivity: The ESP32 supports both Wi-Fi and Bluetooth connectivity, making it easy to connect to the internet and other devices.
- Peripheral interfaces: The board includes various peripheral interfaces such as UART, SPI, I2C, ADC, DAC, PWM, and GPIO. This allows the board to interface with a wide range of sensors and devices.
- Development tools: The ESP32 DevKit Module can be programmed using the Arduino IDE or other development environments such as Espressif's ESP-IDF.
- Low power consumption: The ESP32 microcontroller is designed for low power consumption, making it suitable for battery-powered IoT applications.
- Compact size: The ESP32 DevKit Module is small in size, making it easy to integrate into IoT projects and prototypes.

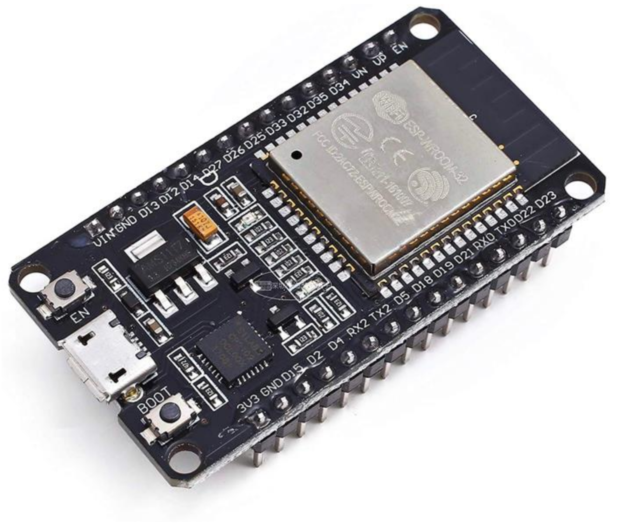

Fig. 1: ESP32 DevKit Module

With the above specifications in front of you, it is very easy to decipher the reasons for ESP32's popularity. Consider the requirements an IoT device would have from its microcontroller (μC). If you've gone through the previous chapter, you'd have realized that the major operational blocks of any IoT device are sensing, processing, storage, and transmitting. Therefore, to begin with, the μC should be able to interface with a variety of sensors.

It should support all the common communication protocols required for sensor interface: UART, I2C, SPI. It should have ADC and pulse-counting capabilities. ESP32 fulfills all of these requirements. On top of that, it also can interface with capacitive touch sensors. Therefore, most common sensors can interface seamlessly with ESP32.

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TDS Sensor

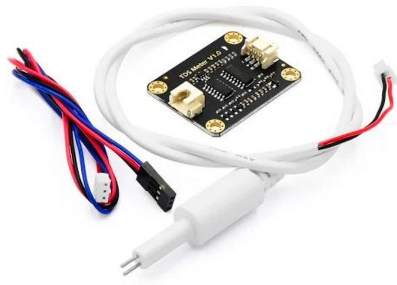

Fig. 2 TDS Sensor

A TDS (Total Dissolved Solids) sensor is an electronic device that is used to measure the concentration of dissolved solids in water. The TDS value is a measure of the total amount of inorganic and organic substances in a solution, including minerals, salts, metals, and other substances.

TDS sensors typically use conductivity to measure the concentration of dissolved solids. The sensor contains two electrodes that are placed in the water sample. An electrical current is passed between the electrodes, and the conductivity of the water is measured. The TDS value is then calculated based on the conductivity measurement.

TDS sensors are commonly used in a variety of applications, including:

- Water quality monitoring: TDS sensors are often used in water treatment plants and distribution networks to monitor the quality of the water.
- Aquaculture: TDS sensors are used to monitor the water quality in aquaculture systems, such as fish tanks and ponds.
- Hydroponics: TDS sensors are used to monitor the nutrient levels in hydroponic systems, where plants are grown in water without soil.
- Beverage production: TDS sensors are used in the production of beverages such as beer and soft drinks to ensure that the water has the correct mineral content.

pH Sensor

Fig 3: pH Sensor

A pH sensor is an electronic device that is used to measure the acidity or alkalinity of a liquid solution. The pH value is a measure of the concentration of hydrogen ions (H+) in the solution. A pH sensor typically consists of a sensing electrode and a reference electrode, which are immersed in the solution being measured.

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The sensing electrode of a pH sensor is typically made of glass, and it contains a special membrane that is sensitive to changes in the concentration of H+ ions. When the electrode is immersed in a solution, H+ ions in the solution interact with the membrane, creating an electrical potential difference between the sensing electrode and the reference electrode.

DS18B20 Water Proof Temperature Sensor

Fig. 4 DS18B20 Water Proof Temperature Sensor

The DS18B20 Water Proof Temperature Sensor is a digital temperature sensor that is designed to measure temperature in harsh environments, such as in water or other liquids. The sensor consists of a small probe with a stainless steel enclosure that is waterproof and resistant to corrosion.

The DS18B20 sensor is based on the 1-Wire interface, which means that it requires only one data line and a ground connection to communicate with a microcontroller. The sensor provides 12-bit temperature readings with an accuracy of ±0.5°C from -10°C to +85°C.

IV. CONCLUSION

In this study, implementing a water quality prediction system using IoT devices (ESP32) and analyzing the data in ThingSpeak can provide valuable insights and monitoring capabilities. By combining sensors such as pH, TDS, and temperature, along with machine learning models, it becomes possible to predict water quality and identify potential issues in real-time.

- IoT-enabled Water Quality Monitoring: The use of IoT devices allows for remote and continuous monitoring of water quality parameters. The ESP32 board, along with the connected sensors, can collect data accurately and efficiently.
- Data Transmission and Analysis: ThingSpeak provides a platform for transmitting and storing the collected sensor data. The data can be accessed using ThingSpeak's API, enabling seamless integration with data analysis tools such as MATLAB. This allows for real-time analysis and prediction of water quality based on the collected data.
- Machine Learning for Prediction: By utilizing machine learning models, such as those from the provided list (e.g., Logistic Regression, Decision Tree, Random Forest), it becomes possible to train models to predict water quality based on the sensor data. These models can learn patterns and relationships within the data, enabling accurate predictions and proactive monitoring.
- Real-Time Visualization and Monitoring: ThingSpeak offers visualization tools and dashboards to display the analyzed data and prediction results. This allows stakeholders to monitor water quality parameters in real-time and detect any anomalies or changes that may require attention.
- Early Detection of Water Quality Issues: With a water quality prediction system in place, it becomes possible to detect potential issues or deviations from acceptable quality standards at an early stage. This early detection can help prevent adverse effects on ecosystems, human health, and industrial processes that rely on clean water.

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