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Water Pollution Quality Monitoring System Using Embedded Systems

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ABSTRACT

An embedded system is a small computer with a dedicated function within a larger mechanical or electrical system, associated with real time computing. Networking deals with communication of data and interaction between devices on a computer network. Water pollution is a major threat to all living organisms on the Earth. The quality of drinking water needs to be measured and monitored in real time for the safety of the people. In this paper we present a design and development of a low cost system for real time monitoring of the water quality using embedded systems and networking. The system consists of pH, Turbidity and Temperature sensors to measure the pH level of water, impurities present in water and temperature of water. The measured values are processed by Raspberry Pi controller and sent to the cloud. Finally the results are relayed to the remote user from the cloud as alert messages.

Keywords: pH sensor, Turbidity sensor, Temperature sensor, Internet of Things, Raspberry Pi B+, Ubidots.

1. INTRODUCTION

Drinking water is very precious and essential for all living beings. Nowadays water is progressively getting more polluted and hazardous for drinking. This is mainly due to industrialization, growing population, contamination due to fertilizers etc. Hence there is a need for monitoring the water quality using innovative methods. Traditionally the water quality is monitored by collecting water samples manually from different locations followed by analyzing the ideal characteristics of water in the laboratory. Such methods are time consuming and relatively expensive. Existing methods require skilled labour and they are not suitable for real time monitoring. These methods are no longer considered efficient. The use of prevalent technologies having high cost is associated with installation and calibration of a large distributed array of monitoring sensors. The algorithm proposed on the new technology must be suitable for specific area. A large geographical area is required for setting up a water plant operation. Therefore, there is a need for developing a method that overcomes the drawbacks of the existing methods and provides continuous online monitoring for public health protection. In our design raspberry PI B+ is used as a core controller. The design system applies a specialized IoT module for accessing sensor data from core controller to the cloud. The sensor data can be viewed on the cloud using a special IP address. Additionally the IoT module also provides a Wi-Fi for viewing the data on mobile.

The rest of this paper is organized as follows: Section II shows the overall flow diagram of the proposed method and its corresponding explanation. Section III shows the experiment done and its corresponding result obtained is present. Section IV shows the conclusion of our proposed system.

2. METHODOLOGY

In this section, we present the theory on real time monitoring of water quality in IoT and embedded environment. In section II A, the flow diagram of the proposed method is explained. In section II B, the proposed block diagram is explained in detail.

2.1. Proposed Flow Diagram

The flow diagram of the proposed system is shown in figure 1.

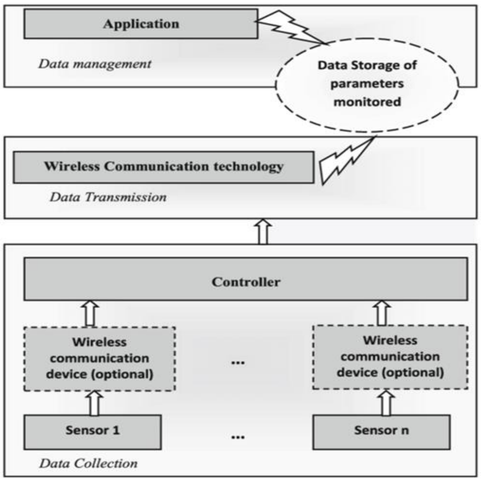

Fig1: Proposed Flow Diagram

The system generally consists of three sections.

Data collection subsystem consists of various sensors and a controller. The controller gathers the sensed data and processes it.

Data transmission subsystem consists of a wireless communication device along with build in security features, which transmits the data from the controller to data storage cloud.

Data management subsystem includes the application which accesses the data storage cloud and displays the same to the end user.

Sensors form the bottom most part of the block diagram. Several sensors are available to monitor water quality parameters. These sensors are placed in the water to be tested.

Sensors convert the physical parameter into equivalent measurable electrical quantity, which is given as input to controller. The main function of the controller is to read the data from the sensor, process it, and send the data to the application by using appropriate communication technology. Application includes the data analysis and alert system based on the monitored parameters.

2.2. Proposed Block Diagram

In our proposed method, Raspberry PI B+ is used as a core controller. The Raspberry Pi is run on LINUX kernel by the use of keyboard and monitors. The LINUX OS is booted on to the Raspberry Pi. The temperature sensor, turbidity sensor and Ph sensor can be read directly from the command line. However, this requires us to input a command every time we want to know the sensors reading. In ordered to access all the terminals of the sensors, Python program is used, which will read the sensors value automatically at set time intervals. The Raspberry Pi comes equipped with a range of drivers for interfacing. However, it’s not feasible to load every driver when the system boots, as it will increase the boot time significantly and use a considerable amount of system resources for redundant processes. These drivers are therefore stored as loadable modules and the command mode probe is employed to boot them into the Linux kernel. Then Raspberry Pi sends the data to the IoT module. The IoT module sends the data to the Internet using Ubidots cloud and also to WiFi for accessing mobile devices.

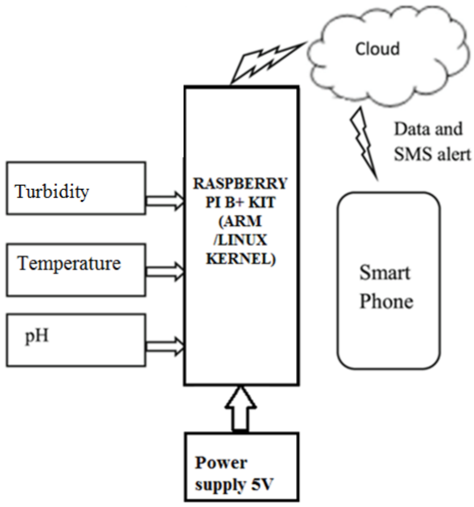

Fig 2: Proposed Block Diagram

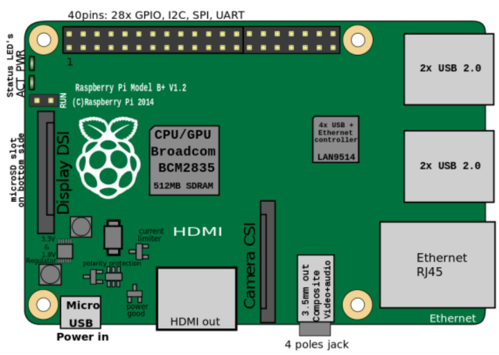

Fig 3: Raspberry Pi B+ kit

The location of connectors and main ICs on Raspberry Pi B+ kit is shown in figure 3. There are now a total of 40 GPIO pins, 26 of which can be used as digital inputs or outputs. 9 of the 14 new GPIO pins are dedicated inputs/outputs

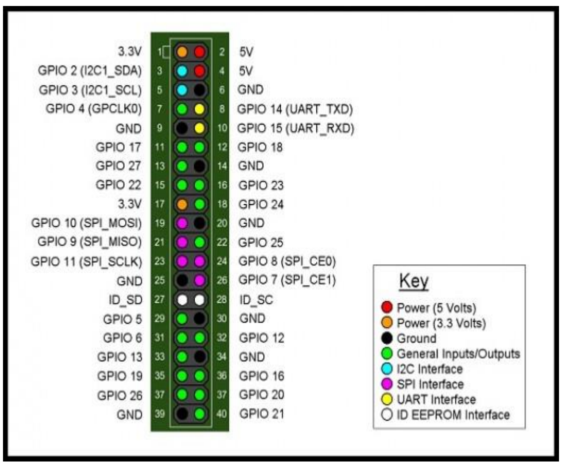

Fig 4: Pin Configuration

3. EXPERIMENTS AND RESULTS

3.1. Proposed Experimental Setup

The key parameters monitored in the proposed system are temperature, turbidity and pH. The block diagram of the proposed system is shown in Fig. 2. A controller forms the central part of the IoT enabled water quality monitoring system. As seen from designs are not cost effective, power efficient and also result in complex circuitry. Sensors are directly interfaced to the controller since the proposed system is to monitor domestic water quality. The sensor parameters such as turbidity, temperature and pH are measured by placing the sensor into different solutions of water. The data from the sensors are sent to the cloud using the controller. Threshold is set in the cloud based on the standards provided by WHO. Message is sent from the Ubidots cloud to the user's mobile if the value exceeds the threshold. pH measures amount of acid or base in the solution. pH sensor consists of two electrodes which is reference electrode and pH electrode also known as measuring electrode. When placed in the solution pH electrode develops a potential that is proportional to pH. The value ranges from 0 to 14.

The acceptable range of pH for drinking water is 6.5 to 8.5. Turbidity is a measure of cloudiness in the water. Water flows between the photo transistor and the photodiode in the sensor. The phototransistor emits light rays that are supposed to reach the photodiode. These light rays come across the water flow and lose their path when they meet any suspended particle in the water. As a result, the light received at the photodiode is less in amplitude when compared to that when it was emitted. This difference in amount of light sent and received is conveyed to the micro controller operating the sensor and turbidity is measured from it. Temperature sensors are used to monitor the temperature of the water sample. The ideal temperature is around 30 to 50 °C.

3.2. Results

Reading from the sensor is constantly updated in the cloud. Data sent from the controller are stored in "Ubidots" cloud. "Ubidots" offers a platform for developers to capture data and turn it into useful information.

Fig 5: Widgets for Parameter Monitoring

Data stored in the cloud can be used for detailed analysis. The measured results are compared with drinking water quality standards defined by WHO.

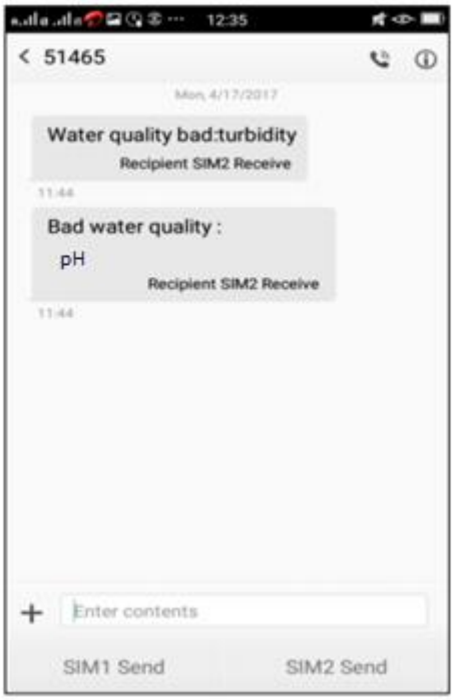

Fig 6: SMS Alert in the Mobile

The events stored can be programmed to automatically send SMS, email and other forms of alerts to the user whenever any parameter exceeds the threshold limit.

4. CONCLUSION AND FUTURE WORK

The paper presents a detailed survey on the tools and techniques employed in existing smart water quality monitoring systems. Also, a low cost, less complex water quality monitoring system is proposed. The experimental setup can be improved by incorporating algorithms for anomaly detections in water quality.

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