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Smart Water Monitoring System Using IOT at Home

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Abstract: *Water is essential to human life and the health of the environment. To fulfill the good quality of water required by the people we developed IoT based water quality monitoring automation system for home, offices, etc. To design a system we measured water pH, water level, flow, temperature etc. water parameters using different sensors. In this paper we proposed a smart sensor interface device that integrates water tank level monitoring, water pollution monitoring and water pipeline leakage monitoring. We used ultrasonic sensor to check the water tank level, flow sensor to detect water leakage in pipelines, pH sensor to check the water quality and temperature sensor to check the temperature of the water. The system automation is represented by using Labview software. This automation system is control by using laptop/mobile phones. By placing this system in a smart building, we will be able to collect and analyze the water usage patterns of the residents and save a lot of water from wastage.*

Keywords: *Microcontroller, pH Sensors, Flow Sensor, Temperature Sensor, Ultrasonic Sensor*

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I. Introduction

Water is an essential need for human survival but due to rapid pace of industrialization and greater emphasis on agricultural growth combined with latest advancements, agricultural fertilizers and non-enforcement of laws have led to water pollution to a large extent. The availability of good quality water is paramount in preventing outbreaks of water-borne diseases as well as improving the quality of life. In order to ensure the safe supply of the drinking water the quality needs to be monitor in real time. The internet of Things (IoT) is a revolutionary concept that has the potential to turn virtually anything to smart. IoT provide interface to monitor and operate remotely from anywhere and anytime.

Water quality refers to the chemical, physical, biological, and radiological characteristics of water. In this work Water quality is calculated by considering waters physical (temperature) and chemical (pH) indicators. Water pollution monitoring system can help to detect the water pollution that means the quantity of pH and the temperature of the water. The pipe leakage detection is also the important thing to avoid the wastage of water. So, to ensure safe supply of drinking water and to avoid wastage of water we are proposing a Smart Water monitoring automation System using the techniques of different sensors (Internet of Things) and Analytics. The existing liquid level control systems are widely used for monitoring of liquid levels, reservoirs, silos, and dams etc. The proposed system is used for home / office.

II. Literature Survey

To Designed a good quality model we studied out different existing system developed by researchers. Different authors have proposed distinguished models to check water quality, water leakage by analyzing the parameters such as temperature, pH and electrical conductivity, pressure and so on. By considering all these points we designed a smart water monitoring system which can perform all these monitoring functions.

Bhad Vidya et al. [1] has proposed a system which monitors the water level periodically. They designed a zigbee network which has lower energy and real time behavior. It helps to wireless sensor network to send the notification message to the mobile application user and digital notification board. A microcontroller, water level sensor and a pair of Raspberry pi and DAS have been used to design the system. The Sensor used to detect the water level, then the data will go to transmit and receive through the Raspberry pi and the whole procedure is then control by this unit.

Mithila Barabde et al. [2] develop a system for continuous monitoring of water quality at remote places using wireless sensor networks with low power consumption, low cost and high detection accuracy. The system architecture consists of data monitoring nodes, a base station and a remote station. All these stations are connected using wireless communication link. For developing this system they have considered the parameters

such as pH, conductivity, turbidity level, etc that are analyzed to improve the water quality. These parameter readings were sent to the remote monitoring station to display in visual format on a server PC with the help of MATLAB and is also compared with standard values. If the obtained value is above the threshold value automated warning SMS alert will be sent to the agent.

Jayti bhatt et al. [3] were proposed IOT based water quality monitoring system to ensure the safe supply of drinking water in real time. Water parameter such as pH, turbidity, conductivity, dissolved oxygen, temperature is considered to check the water quality. The measured values from the sensors are processed by microcontroller and these processed values are transmitted remotely to the core controller that is raspberry pi using Zigbee protocol. Zigbee module is connected to controller which manages data coming from different devices. To transmit the data to IOT, a gateway is created on the raspberry pi using FTP. Separate IP address is provided which make possible to monitor data from anywhere in the world using the internet.

Cho Zin Myint et al. [4] presented a reconfigurable smart sensor interface device for water quality monitoring system in an IoT environment. The smart water Quality monitoring system consists of Field Programmable Gate Array design board, sensors, Zigbee based wireless communication module and personal computer (PC). System collects the five parameters of water data such as water pH, water level, turbidity, carbon dioxide (CO2) on the surface of water and water temperature in parallel and in real time basis with high speed from multiple different sensor nodes. Author provided smart water quality monitoring system of single chip solution to interface transducers to sensor network using Field Programmable Gate Array development tool presented with wireless method by using a wireless XBee module.

Anthony Faustine et al. [5] implemented a model by evaluating prevailing environment including availability of cellular network coverage at the site of operation. The system consists of an Arduino microcontroller, water quality sensors, and a wireless network connection module. It detects water temperature, dissolved oxygen, pH, and electrical conductivity in real-time and disseminates the information in graphical and tabular formats to relevant stakeholders through a web-based portal and mobile phone platforms.

Ali M. Sadeghioon et al. [6] designed a smart wireless sensor network for leak detection in water pipelines, based on the measurement of relative indirect pressure changes in plastic pipes. The sensor nodes were deployed in the field trials and they collected temperature and relative pressure data. Leak tests and daily pressure variations were clearly registered by the nodes showing a response in both the relative pressure sensor (FSR) as well as the temperature sensors. It is postulated that the temperature sensors have the potential to be combined with the FSR data to identify leaks as opposed to 'normal' pressure drops.

A. Ejah Umraeni Salam et al. [7] proposed a model to detect the leakage of pipeline by computerized on-line system using pressure analysis, as a determinant of the leakage in a pipe. Pressure at each node is taken as input data .The pressure data is obtained from the simulation results using the EPANET 2.0 software. To train the data A detection system of magnitude and location of leakage with pressure analysis obtained from the EPANET using the method of Radial Basis Function Neural Network produces the accuracy of the 98% of the entire existing pipeline on the water distribution network

J.Navarajan et al. [8] introduces wireless sensor networking using several sensors to measure water quality, microcontroller and Zigbee module. This system based on wireless sensor network that consists of Wireless Water Quality Monitoring Network and Remote Data Center.

S. Geetha et al. [9] provided a power efficient, simpler solution for in-pipe water quality monitoring based on Internet of Things technology is presented. The model developed is used for testing water samples and the data uploaded over the Internet are analyzed. The system also provides an alert to a remote user, when there is a deviation of water quality parameters from the pre-defined set of standard values.

III. Components of System

In the proposed smart water quality monitoring automation system, water quality monitoring, pipe leakage detection and water level monitoring is designed. The hardware of wireless smart water quality monitoring automation system comprises the following components:

3.1 Ultrasonic Sensor

Ultrasonic sensors emit short, high-frequency sound pulses at regular intervals. These propagate in the air at the velocity of sound. If they strike an object, then they are reflected back as echo signals to the sensor, which itself computes the distance to the target based on the time-span between emitting the signal and receiving the echo. The ultrasonic sensor is used to measure the level of our water tank to avoid the overflow of water.

3.2 Temperature Sensor

The temperature sensor is used to measure the temperature of water. In our system to check the quality of water, temperature is also considered as one parameter.

3.3 PH Sensor

The pH sensor is used to measure the quantity of hydrogen in water. pH is only one of a variety of factors affecting corrosion (3–8).The pH of a solution is the negative common logarithm of the hydrogen ion activity: The pH of water is a measure of the acid–base equilibrium and, in most natural waters, is controlled by the carbon dioxide bicarbonate, carbonate equilibrium system. An increased carbon dioxide concentration will therefore lower pH, whereas a decrease will cause it to rise.

3.4 Flow Sensor

Flow sensor is used for flow measurements to find the leakage in a pipe. Accurate flow measurement is an essential step both in the terms of qualitative and economic points of view. This sensor sits in line with the water line and contains a pinwheel sensor to measure how much water has moved through it. There is an integrated magnetic Hall-Effect sensor that outputs an electrical pulse with every revolution.

3.5 GSM

A GSM modem could also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port or USB port on computer. Any phone that supports the "extended AT command set" for sending/receiving SMS messages is used.

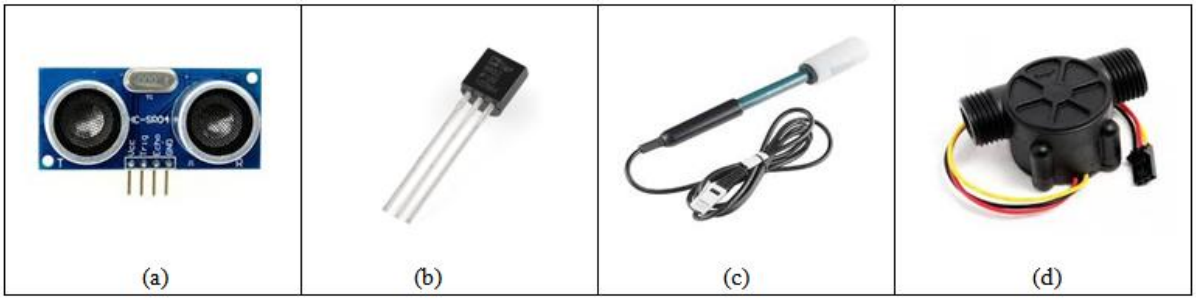

Fig1. (a) Ultrasonic Sensor (b) pH sensor (c) Temperature sensor (d) Flow Sensor

IV. Methodology

In our proposed system we carried out experiments for identifying water tank level, to check water quality and to detect water leakage in a pipe.

4.1 Water tank level monitoring

In water tank level monitoring system for monitoring the level of tank we use the ultrasonic sensor. An ultrasonic sensor is a device that can measure the distance by using sound waves. In water level monitoring the transmitter send the sound waves and receiver receive the signal. By using following formula we calculate the distance.

*Distance =(speed of sound*time taken)/2*

In our system we consider that the height of our tank is 30cm. To avoid the wastage of water we use the automation for the motor. If the water level is less than 20 % then microcontroller send the +ve signal to the relay and relay automatically gets ON and motor will be get started. If the level of water tank is greater than or equal to 80% then microcontroller send the –ve signal to the relay and relay will be automatically gets OFF then motor also gets OFF. In this both the situations the GSM send the message to the user. If the level is less than 20% then it will send the message Alert: level is 20. If the level is greater than or equal to 80% then it will send the message like Alert: level is 80.

4.2 Water quality monitoring

Water quality monitoring system is very important for measure the quality of the water. To measure the quality of water we use the pH and the temperature sensor. The pH stands for "Potential of Hydrogen," referring to the amount of hydrogen found in water. pH is measured on a scale that runs from 0 to 14. 7 is neutral, meaning there is a balance between acid and alkalinity. A measurement below 7 means acid is present and a measurement above 7 is basic (or alkaline).

The second parameter is a temperature. Temperature will also affect the equilibrium and the pH. In pure water, a decrease in pH of about 0.45 occurs as the temperature is raised by 25 °C. We kept the pH probes

and temperature sensor in the water for two minute and recorded the pH value and temperature value that was displayed on the meter screen on Labview.

In this water quality monitoring system if the value of pH sensor is greater than 7 then it will be send the message to the user and if the temperature is greater than 50 then also the GSM send the message to the user.

4.3 Water pipe leakage detection

In the water pipe leakage detection system for detecting the leakage we use the flow sensor to measure the flow of the water. In our system we use the two flow sensors for measure the flow of water. If the flow measured from first flow sensor and flow measured from second flow sensor is not equal that means the leakage is present in our system.

If the leakage is occurred in our system then the GSM send the message to the user that is Alert: Leakage is detected. The block diagram of our system is shown in Fig 2.

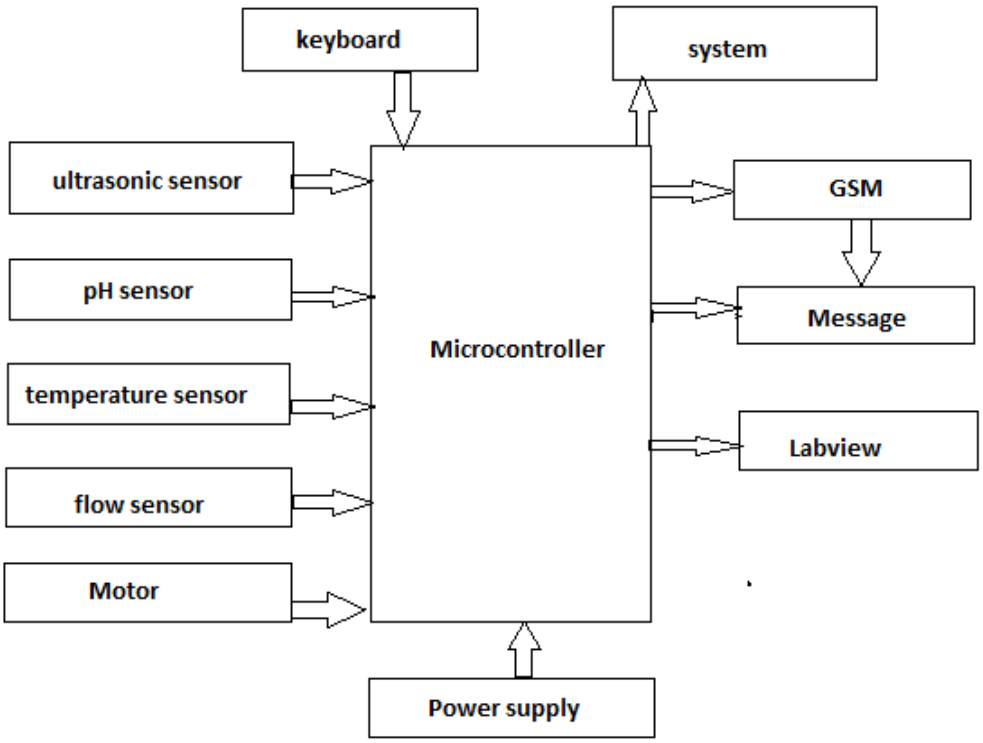

Fig 2: Block diagram of system

In our system the microcontroller is the core component which controls all the devices those are connected to the microcontroller. Ultrasonic, pH, temperature, flow sensor, motor, 22 GSM is connected to the microcontroller. Microcontroller sends the data to the computer through the USB connector. Motor is used to fill the empty tank. If the tank level is below 10% then motor automatically gets ON and if tank level is greater than 80% then it will be gets OFF. The relay is used to control the functioning of motor. Relays are switches that open and close circuits electromechanically. Relay controls one electrical circuit by opening and closing contacts in another circuit.

In our model the coding of required component is written in Arduino IDE. In this we can show the output on serial monitor. We connected microcontroller to the computer through USB cable and then measured the data measured by sensor.

Following figure 3 displays the results of experimental work done. The first graph represents the pH value of the water which is the 5 and second graph represent the value of the temperature which is 25 degree Celsius. Leakage is represented by third graph. And last graph represent the water tank level. Dashboard is created by using Labview.

System runs on battery power and comprises of four sub circuits working synchronously; sensor circuit, controller circuit, SMS circuit and relay driver circuit. Sensor senses the level of the water in tank which is continuously fed to controller system. As the system encounters the empty level condition, status of load shedding is checked. Relay coil is energized and the pump operates when there is no load shedding.

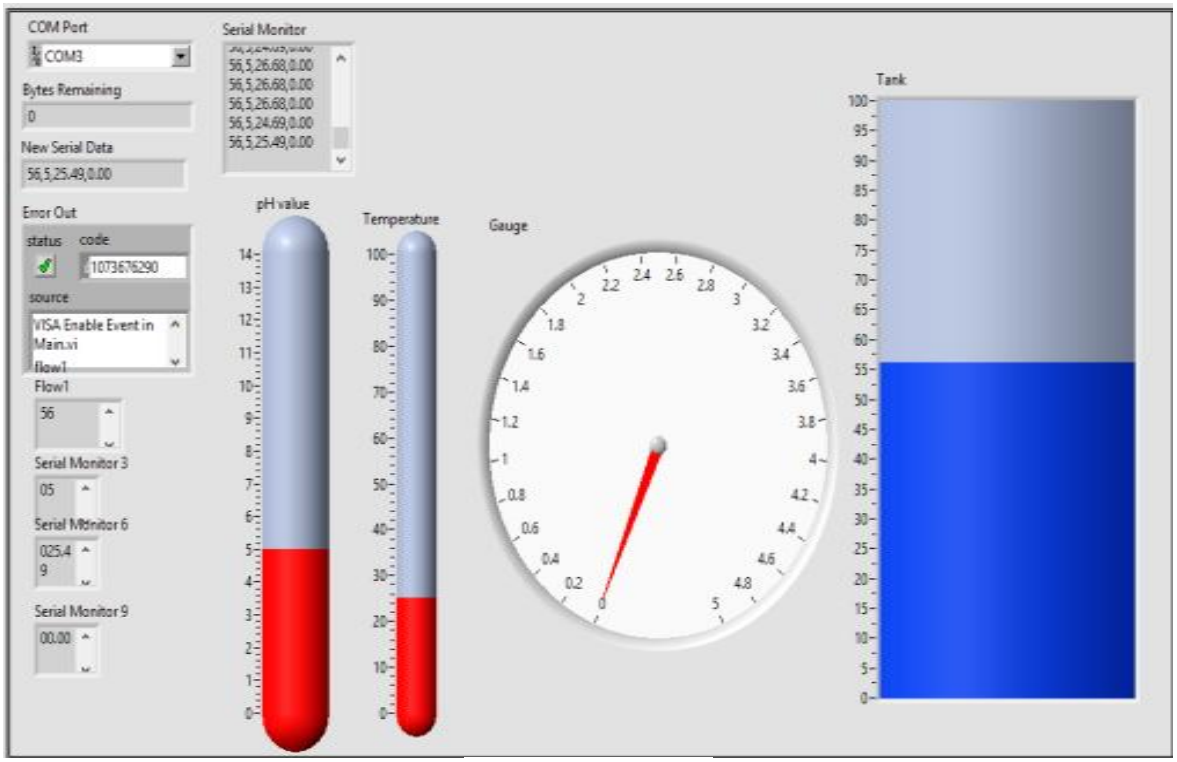

Fig 3. Result of system

Figure 4 illustrates screen view of alert messages send to the user. In the proposed system we send the alert messages to the user in following situation: If

1. The pH value of water is greater than 7.
2. Leakage is detected in a pipe.
3. Temperature of the water is above 7degree Celsius
4. Tank level is greater than 80% and below 20%.
5.

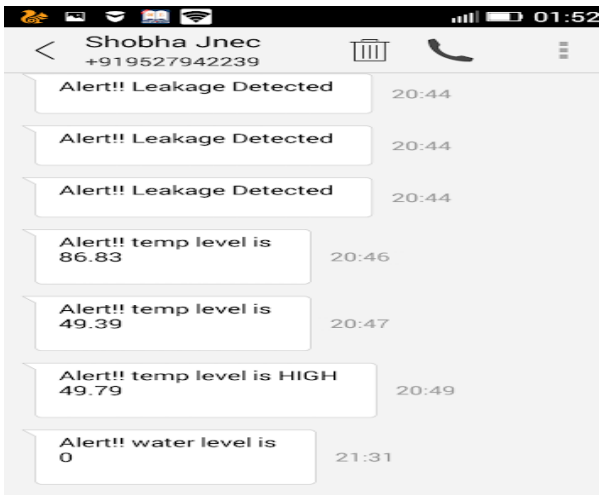

Fig 4. Result Of message

V. Conclusion

The system can monitor water quality automatically, and it is low in cost and does not require people on duty. This system is used to avoid the huge amount of water is being wasted by uncontrolled use of home/offices etc. So the water quality testing is likely to be more economical, convenient and fast. This designed smart water system can be easily applied to home, offices, and schools and at any places where water tanks are used. By placing this system in a smart building, we will be able to collect and analyze the water usage patterns of the residents and save a lot of water from wastage. This is the small contribution from our side to save and supply good quality of water.

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