Intrusion Detection and Identification in Water Distribution Network

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Abstract - *Drinking Water contamination is a big threat to human living in rural areas. In India, many parts of the states use Water Distribution Network from a common storage system (like pond, river and community water tanks).Water contamination can occur due to various unintentional and intentional behavior of nature and human. Machine-accessible monitoring and ready to test methods does not exist in the current system. In this work, a Wireless Sensor-based technology is used with pH sensor, ultrasonic sensor, and turbidity sensor designed to maintain the ratio of water to the chlorine. The collected information is shared with the main server located in control room for monitoring and maintaining the chlorine level.*

Key Words: **WDN, Chlorine level, Quality of Water, Sensors, Water Supply System, Embedded System, Automation**

1. INTRODUCTION

A typical water distribution network consists of sources, pipes and hydraulic elements connected together to deliver prescribed quantities of water at desired pressure and quality at various demand points[1]. In rural areas the WDN is not very large, there are limited storage tanks and hence the chlorine level fluctuations affect a wide cross section of the area. The chlorine level fluctuations in drinking water can cause various diseases like flu, such as headaches, diarrhea, cramps, nausea or vomiting. It is not possible for the people to get proper medication for these diseases and hence it is very important for the water authority to check the quality of the water.

According to a survey, it is recorded that there have been major fluctuations in the chlorine level of the drinking water. High level of chlorine can cause diseases but low level of chlorine does not kill the germs and hence makes the water unfit for drinking. In the existing system the storage tanks are filled with water regularly and the gasometer adds the chlorine in the pipeline of the flowing water coming from the storage tank, in this system the chlorine value to be given in the pipeline is fixed, therefore when there is a low flow of water, the chlorine level in water increases and vice versa. In this work, we have proposed a system to overcome the problem of chlorine level fluctuations in the drinking water supply system in the Water Distribution Network.

2. SYSTEM ARCHITECTURE

Fig shows the block diagram of the machine accessible monitoring of the chlorine level in the water.

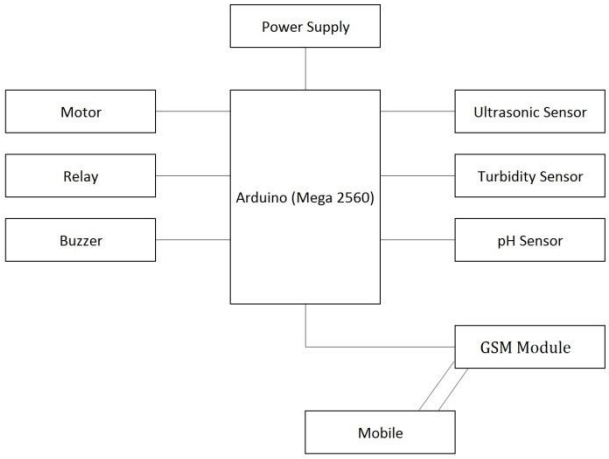

Fig-1 *Block diagram of the Chlorine level controller*

2.1 BLOCK DIAGRAM DESCRIPTION

The above fig.1 shows the Block Diagram of the Chlorine level controller. It consists of Power supply unit, Arduino (mega 2560), ultrasonic sensor, turbidity sensor, pH sensor, Buzzer, Relay, GSM module and DC Motor.

2.1.1 ARDUINO (MEGA 2560)

Arduino (Mega 2560) is based on easy to use hardware and software. In this project, we have used the Arduino IDE. It is an open-source electronics platform which easily helps to interact with the hardware using an Arduino IDE. The Arduino IDE has a concept of sketchbook for writing the programs or storing sketches. The programming of the code for our project is stored in the sketchbook. The programs are saved with an extension ".ino". When we upload a sketch, the Arduino bootloader is executed. i.e. a small program has been loaded on to the microcontroller on your board. Libraries are used to extend the Arduino environment functionalities, As most of the programming

platforms. Libraries provide extra functionality for use in sketches for Arduino IDE.

***Fig -2**: Arduino board*

Table -1: Arduino board specifications

Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Operating Voltage	5V
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
Length	101.52 mm
Width	53.3 mm
Weight	37 g

2.1.2 ULTRASONIC SENSOR

The HC-SR04 ultrasonic sensor is placed on the top of the storage tank, the ultrasonic sensor consists of a transceiver module and a receiver module. The ultrasonic sensor works using trigger and echo method. The transceiver module triggers and sends the signal to the water the water sends back an echo signal which is read by the echo i.e. the receiver module. The ultrasonic sensor calculates the distance of the signal and returns the level of the water. The ultrasound sensor emits an ultrasound of 40000 Hz, which will travel through the air and bounces back when there is an obstacle in the way. The travel time value and the speed value allow the sensor to calculate the level of the water. The figure below is the image of the ultrasonic sensor used in the project.

***Fig -2**: Ultrasonic Sensor*

Table -2: Ultrasonic sensor specifications

Power Supply	+5V DC
Working Current	15mA
Effectual Angle	<15°
Ranging Distance	2cm – 400 cm/1″ – 13ft
Resolution	0.3 cm
Measuring Angle	30 degree
Trigger Input Pulse width	10uS
Dimension	45mm x 20mm x 15mm

2.1.3 TURBIDITY SENSOR

The turbidity sensor measures the amount of transmitted light to determine the turbidity of the drinking water. The turbidity sensor emits light from the photovoltaic diode. The sensor measures the amount of light scattered by the solid substance in the drinking water. During rainy season in India it is widely observed that the drinking water gets mixed with sand and soil particles. The turbidity sensor will check the level of cloudiness in the water and inform the water authorities so that they can take required action of purifying the drinking water. The turbidity sensor can work using analog as well as digital signals. The digital signal gives faster values as compared to the analog signals.

NTU (nephlometric turbimetry units) is the measure for turbidity which measures the suspended solid particles in the water. The solids which are dissolved in water form a homogenous solution. There are two types of solids present in water – suspended solids and dissolved solids. The dissolved solids have an effect on the turbidity but the suspended solids are mostly responsible for it.

***Fig -3**: Turbidity Sensor*

2.1.3 pH SENSOR

The pH sensor is the universal scale to check the quality of a liquid. pH stands for potential of hydrogen. It is a measure the acidity and alkalinity of the water. The pH scale starts from 0 and ends at 14. The 0-7 values show acidic property of the liquid and 7-8 shows the alkaline property of the liquid.0 is the most acidic whereas 14 is the most alkaline. The pure water is neutral i.e. the 7th value of the scale. The drinking water can be of pH value 6.5 to 8.5.

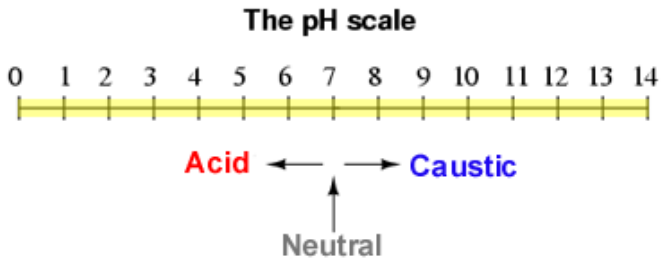

***Fig -4**: pH scale*

In this project, the pH sensor is used to test the pH value of the drinking water present in the storage of the water supply systems. The value from this pH sensor will determine the amount of chlorine to be added in the water. The pH sensor is connected to the Arduino board and it sends analog signals of the pH value achieved.

***Fig -5**: pH Sensor*

2.1.4 GSM MODULE

The GSM module used is SIM900, which is compatible with most of the Arduino boards. The GSM module consists of a GPRS module which helps the system connect with the GSM enabled cell phones.
The words, “Mobile Station” (MS) or “Mobile Equipment” (ME) are used for mobile terminals Supporting GSM services. A call from a GSM mobile station to the PSTN is called a “mobile originated call” (MOC) or “Outgoing call”, and a call from a fixed network to a GSM mobile station is called a “Mobile Terminated call” (MTC) or “incoming call”.AT commands are instructions used to control a modem.AT is the abbreviation of Attention. Every command line starts with "AT" or "at".

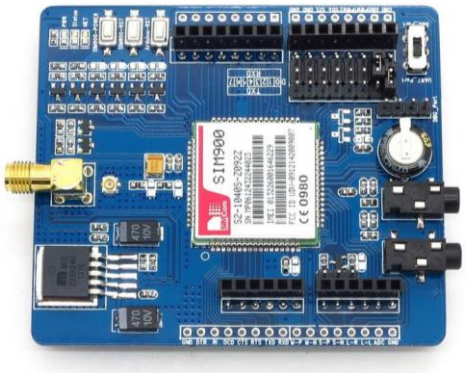

***Fig -6**: GSM Sim 900*

3. WORKING

The Arduino board is connected to the power supply and the voltage and ground of the Arduino board are given to the Breadboard which is given to various sensors. The pH sensor gives an analog value to a pin of the Arduino board whereas the turbidity sensor gives the digital value to the board. The ultrasonic sensor calculates the echo ad trigger which is attached to the 8th and 9th pin of the Arduino board. The DC motor is given the ground and voltage and placed in the storage to add chlorine to the water. The ultrasonic, turbidity and the pH Sensor is placed inside the storage. The pH sensor and Turbidity sensor gives real-time monitoring values to the system.
The chlorine level test value shows that the water of level 50-200 is drinkable water whereas water of level 500-800 is suitable for other uses. The other value of water as shown in the figure below is not suitable for drinking or using purpose.

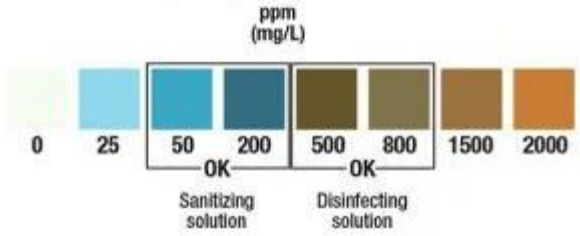

***Fig -7**: chlorine level test*

When there is a change in the pH value and turbidity value i.e. the value drastically increases or decreases then the sensor will send a signal to the system, the system will then check the level of the water in the tank and then it will calculate the amount of water present and amount of chlorine to be added and ten accordingly the chlorine will be added after calculating the amount of chlorine required for the water present in the tank. The GSM module is used to send the message to the water authority when there is a high fluctuation in the chlorine level and increase in the turbidity value of the water. We have also provided a buzzer and a LED light to detect when there is a flow of chlorine in the water

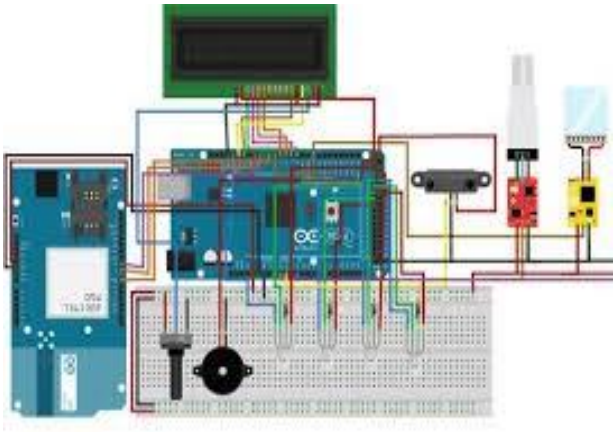

Fig -8*: Chlorine controller system*

4. LIMITATIONS

The limitation of the system is that it cannot purify the water and only monitor the cloudiness in the water and inform the authorities. The system will give real time value of the water quality but it will not be able to clean the solid substances present in the water. Mostly during the rainy season, it is observed that there is a sudden increase in the dirtiness of the drinking water. Therefore it is upon the water authorities to clean the water before supplying the water in the WDN.

5. FUTURE SCOPE

This project has enormous potential and may be used in various other ways, due to its cheap and cost efficient design. For further easy access, the data can also be displayed on android applications. The iteration of this project is for data monitoring and chlorine level control. In future, we can also work on detecting the level of potassium chloride powder quantity in the water. In future, the system can be made on a client-server architecture where the water authority can access the sensor or the system data from anywhere using their personal android devices

5. CONCLUSION

The progress in Computer engineering field paved a way for new inventions and technologies. As we are moving towards miniaturization, handy components are needed which has better accuracy and reliability. Here we are developing a control system which will help the water authorities to provide a good quality of water to the water supply system of the water distribution network in small rural areas.

The sensors present in the system measure various parameters. The sensed data is transmitted to the receiver station via SMS by GSM module. The decisions that are taken by the motor depend on the sensors response i.e. from pH sensor and turbidity sensor as well as the ultrasonic sensor. The Arduino IDE software is used to control the Arduino board accordingly and appropriate sensors like pH and turbidity sensor and the results are analyzed in different water samples

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