IMPLEMENTATION OF WSN FOR THE WATER QUALITY ASSESSMENT IN A REAL TIME APPLICATION

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Abstract-- *The project describes the performance of wireless sensor networks (WSN) for the assessment of the water quality in a real time application. The water quality specifications including turbidity, pH, conductivity, flow and temperature are examined by this system. The PIC microcontroller manages and scans the data taken from different sensors. Risk assessment algorithm is developed for fusing the data collected by the sensors to assess the contamination risk found in the water. The collected data are shown in the notification node and control node. When the risk is analysed, buzzer is activated to trigger alarm and also stops the water flow using pumping motor. The control node creates an application and it gets data through GSM/GPRS module. The wireless sensor data is saved in the database.*

Keywords: GSM/GPRS, PIC, pumping motor, wireless sensors

1) INTRODUCTION

Fresh water and its quality plays a vital role in the society as it is a mandatory resource needed to prolong life. Pure water yielding to the citizens has become a crucial challenge due to the consumption of water resources and the pollution of water bodies. The availability of pure water is reducing in the society day by day. Water from treatment plants even losses the quality once it enters the distribution system. When the consumers gets the water, its quality is very much poor from the plant. So the quality of water must be checked since it has a key role in human life.

Traditionally, quality checking of water includes the accumulation of water samples from different location and time by manual process. Then, it is analysed and processed in laboratory for distinguishing the water quality. Such type of perspectives are not efficient and has several other limitations such as: lack of real time monitoring of related data, less number of locations can be covered, relatively high cost, wastage of time and so on.

Wireless sensor networks(WSN) is a cluster of sensor nodes which transports the sensor information via wireless medium. A WSN typically consists of a large number of low - cost, low - power, and multifunctional sensor nodes that are deployed in a region of interest. These sensor nodes are small in size, but are equipped with sensors, embedded microprocessors, and radio transceivers, and therefore have not only sensing capability, but also data processing and communicating capabilities. They communicate over a short distance via a wireless medium and collaborate to accomplish a common task.

Sensors can be used to detect or monitor a variety of physical parameters or conditions , for example,

- Light
- Sound
- Humility
- Pressure
- Temperature
- Soil composition
- Air or water quality
- Attributes of an object such as size, weight, position, speed, and direction.

2) RELATED WORK

In [3], a WSN-based water environment monitoring system is implemented which senses and monitors video information of major areas and water parameters including temperature, turbidity, pH, dissolved oxygen and conductivity. The data monitoring nodes sends the information and data video base station sends the data to remote monitoring centre using ZigBee and CDMA (code division multiple access) technology.

In [4], a WSN system is implemented for the real time monitoring of fresh water resources such as rivers, lakes or wetlands areas. A smart power system is performed using solar daylight harvesting. The information from the sensor nodes are sent to a sub-base node and monitoring station collects the data from sub-base node using a GSM network.

Advances in online water quality monitoring is discussed in [5] which presents the findings of an international study and detection of contamination in water. The findings are based on the visits to leading water utilities, research organizations and technology providers in Europe, US and Singapore.

3) WATER PARAMETER DETAILS

The regulations for drinking-water quality is given by World Health Organization (WHO) and other organizations like EU, USEPA. So the drinking water quality standards are based on the guidelines provided by such organizations. These organizations tells which parameters should be tested and monitored.

A. TURBIDITY SENSOR

Turbidity is an optical property of the water which is based on the amount of light reflected by particles which are suspended in the water. Turbidity sensor(TSD-10) is used in this project. The sensor operates on the principle that when light is passed through a sample of water, the amount of light transmitted through the sample is dependent on the amount of soil in the water. As the soil level increases, the amount of transmitted light decreases.

B. pH SENSOR

pH is a measure of the basicity or acidity or of an aqueous solution. Solutions which have a pH value less than 7 are said as acidic and solutions which have a pH greater than 7 are basic or alkaline. Clean and pure water has a pH very close to 7. The pH Sensor will produce a voltage of approximately 1.75 volts in a pH 7 buffer. The voltage will increase by about 0.25 volts for every pH number decrease. The voltage will decrease by about 0.25 volts/pH number as the pH increases.

C. TEMPERATURE SENSOR

Temperature sensor is a device which senses variations in temperature across it. LM35 is a precision IC temperature sensor with its output proportional to the temperature (in ^{o}C). With LM35, temperature can be measured more accurately than with a thermistor.

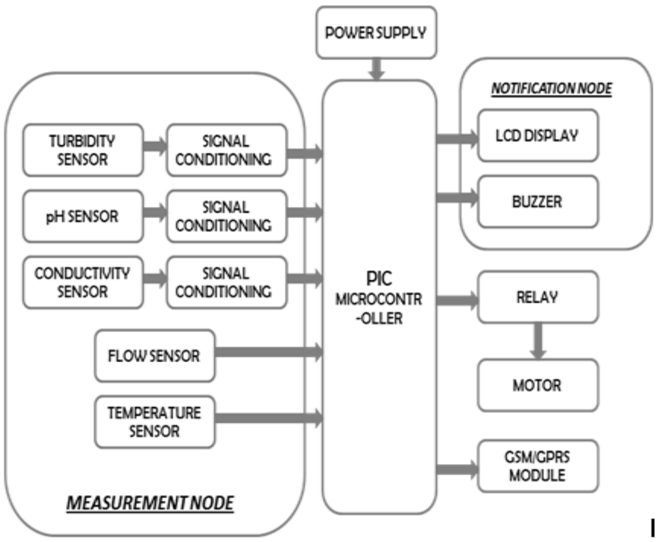

Fig-1: Block diagram of measurement and notification node

D. FLOW SENSOR

The flow of water in a pipe is usually measured by litres per minute(l/min) or litres per hour(l/hour). The turbine flow meter used in this project. A pick-up sensor is mounted above the rotor. When the magnetic blades pass by the pick-up sensor, a signal is generated for each passing blade. This provides a pulsed signal proportional to the speed of rotor and represents pulses per volumetric units and as such the flow rate too.

E. GSM/GPRS MODULE

GSM/GPRS module provides wireless communication between a computer and a GSM-GPRS module. GPRS stands for Global Packet Radio Service which delivers higher data transmission rate. The SIM900 is used in this system which performs in 900/1800MHz for features such as voice, SMS, Data, and Fax in a small form factor and with low power consumption.

F. PIC MICROCONTROLLER

The PIC microcontroller PIC16f877a is one of the most renowned microcontrollers in the industry. This microcontroller is easy to use and for coding and programming too. One of the main advantages is that it can be write-erase as many times as possible because it use FLASH memory technology. It is a 40 pin microcontroller with 33 I/O pins. The PIC16F877A has some peculiarities such as self programming, In-circuit serial programming, 10 bit 8 channel analog to digital converter, two capture/compare/ pwm modules, synchronous serial ports with two modes, usart(universal synchronous asynchronous receive transmit) and so on.

The system architecture consists of measurement node, notification node(Fig.1) and control node(Fig.2). The measurement node includes several sensors for monitoring the water quality parameters such as turbidity, pH, conductivity, flow, and temperature and PIC16F877a. Microcontroller controls the whole system. It takes all the sensor outputs and sends

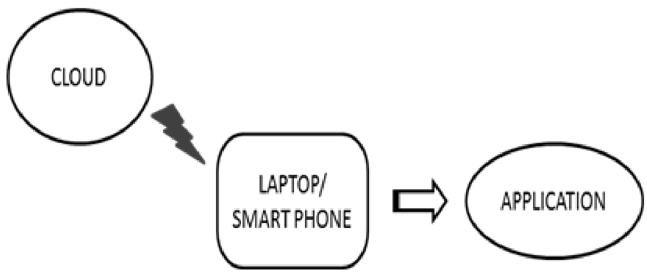

Fig-2: Block diagram of control node

the data to other nodes. The notification node has an LCD display and buzzer to display audio and visual outputs. The sensor data received from the measurement node is displayed on the lcd display and if any contamination risk is found, buzzer is activated to trigger alarm. Pumping motor is used to stop the water flow when water contamination is detected and water is drained out. Relay drives the motor. GSM/GPRS module connected to the pic microcontroller wirelessly transmits the sensor output to the control node. The control node creates an application to store the sensor outputs.

Table- I: Parameters to be monitored.

Sl No.	Parameter	Units	Quality Range
1	Turbidity	NTU	0 – 5
2	Free Residual Chlorine	mg/L	0.2 – 2
3	ORP	Mv	650 – 800
4	Nitrates	mg/L	<10
5	Temperature	^oC	–
6	pH	pH	6.5 – 8.5
7	Electrical Conductivity	$\mu S/cm$	500 – 1000
8	Dissolved Oxygen	mg/L	–

The table I shows the suggested water quality parameters to be monitored that has been determined by the WHO (World Health Organization) guidelines. The measurement units of each parameter and their quality range are given in the table. Within the quality range, the water is disinfected by any contaminants

4) RISK ASSESSMENT ALGORITHM

An algorithm is developed to determine the contamination risk in the water validly. Risk is calculated based on the Euclidian distance(d) between the normalised sensor signal (N) and the normalised control signal (No) of clean water.

$$d = ||N - No||$$

It is calculated for every sensor outputs ie; each sensor output value is compared with the sample values and the output is obtained in a matrix form. To avoid noise or small fluctuations in the sensor output for each parameter Si, $Ni = \frac{Si - \mu i}{\sigma i}$ is calculated where μ is the mean and σ is the standard deviation.If the output value obtained is within the quality range of sensor outputs, then the water is not infected. And if it exceeds the quality range of sensor outputs, then the water is infected.

5) RESULT AND DISCUSSION

Fig-3 shows the experimental setup of the proposed system for monitoring the water quality.

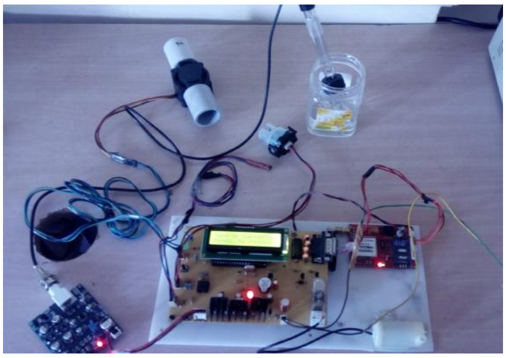

Fig-3 : experimental setup

The various sensors including temperature sensor, turbidity sensor, pH sensor and flow sensor, gsm module and pumping motor form the measurement section. The program is written in MPLAB which is compiled and dumped into the PIC controller board. The information are sent through GSM module.

MATLAB software is used to measure the water parameters accurately. The software platform (fig.4) is developed for the real time measurement of water quality by creating a user interface.

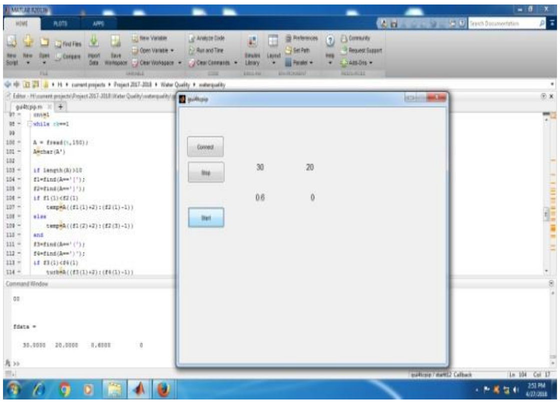

Fig-4: software platform using MATLAB

6) CONCLUSION

The proposed system determines the water quality parameters such as turbidity, pH, conductivity, flow and temperature using wireless sensor networks. The enhanced system is efficient to process, record, and remotely present data. Moreover, a risk assessment algorithm is developed for combining the different sensors to assess the water contamination risk. When anomalies are detected, the notification node is activated to display audio and visual displays. Water flow stops using pumping motor if any risk is found in the water. The PIC microcontroller transmits the measurements wirelessly to the control node via the GSM/GPRS modules. An application software is created to conserve the sensor data for future purpose. Such system is suitable for providing precise data to water consumers, water companies and authorities.

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