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GSM Based Automatic Water Quality Control Analysis

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ABSTRACT: The common method of water quality testing is to collect samples manually and then send them to laboratory for analysis. However, it has been unable to meet the demands of water quality monitoring today. So a set of automatic measurement and reporting system of water quality has been developed. The system consists of ph sensor, turbidity sensor and conductivity sensors of water quality testing, single-chip microcontroller data acquisition module, information transmission module, monitoring center and other accessories. Various parameters of water quality are automatically detected under the control of single chip microcontroller all day. The single chip gets the data, and then processes and analyses them. After that, the data are instantaneously sent to monitoring centre by GSM network in the form of SMS. If the water quality is unusual, the data will be sent to monitoring centre and management's mobile in the same way at the same time. It is agreeable for management to take corresponding measures timely and be able to detect real-time situation of water quality remotely. The system has , recognize, the automation of water quality monitoring, intelligence of data analysing and networking of information transferring. It is characterized by advantages of shortcut, accuracy and using manpower and material resources sparingly. The system has widespread application value and can be extended and transplanted to other fields of automatic monitoring where needed.

KEYWORDS: Water Quality Monitoring; Measurement and Reporting; Sensors; SMS; Remote

I. INTRODUCTION

With the rapid development of the economy, more and more serious problems of environment arise. Water pollution is one of these problems. Routinely monitored parameters of water quality are pH, turbidity and conductivity. The most common method to detect these parameters is to collect samples manually and then send them to laboratory for detecting and analysing. This method wastes too much manpower and material resource, and has the limitations of the samples collecting .Long-time analysing, the aging of experiment equipment and other issues. Sensor is an ideal detecting device to solve these problems. It can convert non-power information into electrical signals. It can easily transfer process, transform and control signals, and has many special advantages such as good selectivity, high sensitivity, and fast response speed and so on. According to these characteristics and advantages of sensors, automatic Measurement and reporting system of water quality is designed and developed. It bases on SMS (Short Messaging Service) in the GSM (Global System for Mobile Communications) network to instantaneously transfer the collected data. It also can remotely monitor the water quality on line. The system implements automation, intelligence and network of water quality monitoring, and uses manpower, material and financial resources sparingly.

Over the past decade, online water quality monitoring has been widely used in many countries known to have serious issues related to environmental pollution. The water is limited and essential resource for industry, agriculture, and all the creatures existing on the earth including human being. Any imbalance in water quality would severely affect the health of the humans, animals and affect the ecological balance among species [5]. In the 21st century there were lots of inventions, but at that time were pollutions, global warming and so on are also being formed, because of this there is no safe drinking water for the world's population [1]. The drinking water is more precious and valuable for all the human beings so the quality of water should be monitored in real time. Nowadays water quality monitoring in real time faces challenges because of global warming, limited water resources, growing population, etc. Hence, there is a need of developing better methodologies to monitor the water quality parameters in real time.

The WHO (world health organization) estimated, in India among 77 million people are suffering due to not having safe water. WHO also estimates that 21% of diseases are related to unsafe water in India. Also, more than 1600 deaths alone

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cause due to diarrhoea in India daily. Therefore, various water quality parameters such as dissolved oxygen (DO), conductivity, pH, turbidity and temperature should be monitored in real time.

The water quality parameter pH show water is acidic or basic. Pure water has 7 pH value, less than 7 values indicate acidity and more than 7 indicate alkalinity. The normal range of pH is 6 to 8.5. In drinking water if the normal range of pH is not maintained then it causes the irritation to the eyes, skin and mucous membranes. Also, it causes the skin disorders. The dissolved oxygen (DO) indicates the oxygen that is dissolved in water. It makes the drinking water taste better. The conductivity indicates the ability of water to pass an electrical current. In water various dissolved solids such as chloride, nitrate, sulphate, sodium, calcium, etc affect it. Turbidity has indicated the degree at which the water loses its transparency. It is considered as a good measure of the quality of water. The deterioration of water resources becomes a common human problem [3]. The traditional methods of water quality monitor involve the manual collection of water sample from different locations. These water samples tested in the laboratory using the analytical technologies. Such approaches are time consuming and are no longer considered efficient.

Moreover, the current methodologies include analysis of various kinds of parameters of water quality such as physical and chemical. Traditional methods of the water quality detection have the disadvantages like complicated methodology, long waiting time for results, low measurement precision and high cost [4]. Therefore, there is a need for continuous monitoring of water quality parameters in real time.

II. SYSTEM HARDWARE ARCHITECHTURE

A) Overall Design of the System

The system consists of multiple water detection sensors, single-chip microcontroller data acquisition module, information transmission module, monitoring centre and other accessories. Other water quality sensors transform the detected chemical signals into electrical signals, amplified by the signal conditioning circuit. The multiplexers select one road signal and send to A/D converter. Then it is converted into a digital signal. Single-chip reads and processes the digital information. It also controls the GSM module sending the collected data to the monitoring centre in the form of SMS by GSM network instantaneously. Monitoring centre receives the data and then analyses, classifies, saves them and draws corresponding graphs. That can instantaneously monitor and alarm the situation of water quality. If the water quality is abnormal, single-chip will control the GSM module to send data to the monitoring centre in the form of short message. The alarm in the monitoring centre is activated. At the same time, the data are sent to management mobile phone in this way. It is easy for management to take corresponding measures immediately. The system can do all-weather real-time monitor to water's pH, conductivity, turbidity. The design is beneficial for management to know the real-time water quality information, and make man-machine interaction with the system by mobile

. B) Water Detection Sensors

Water detection sensors determine the system's accuracy and cost. Generally, they are very expensive on the market. In order to reduce the cost, we choose DS18B20, make conductivity sensors, turbidity sensors and pH sensors by ourselves, and purchase dissolved oxygen sensor of U.S. Global Water... Conductivity sensors are generally divided into two types: two electrodes or multiple electrodes. Conductivity of two electrodes is commonly used interiorly. Generally, two conductivity electrodes in laboratory can be made by using two platinised platinum to sinter on two parallel glass, or inner wall of the round glass tube. Changing the size of platinum pieces and adjusting the distance between them can make different constant value of two conductivity electrodes. Turbidity is caused by suspended particles in water. Suspended particles block a lot of incident light and scattered light. It also diffuses the incident light. Therefore, photo electricity sensor is used to detect turbidity. PH value is tested by the method of electric potential. Primary cell made by a constant potential reference electrode and measuring electrode is used in the method.

A pH glass probe, which is sensitive to pH, is on measurement electrode. It is made of a special glass that can conduct electricity and permeate hydrogen ion. The potential can be produced when the glass probe touch the hydrogen ion. Different pH in the water generates corresponding potential. It can be converted into 4~20mA output by the transmitter.Conductivity sensors are generally divided into two type's two electrodes or multiple electrodes. Conductivity of two electrodes is commonly used interiorly conductivity measurements are used routinely in many industrial and environmental applications as a fast, expensive and reliable way of measuring the ionic content in a solution.

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As shown in figure 3.1 the diagram the system consists of assorted water quality measuring sensors like pH, turbidity,

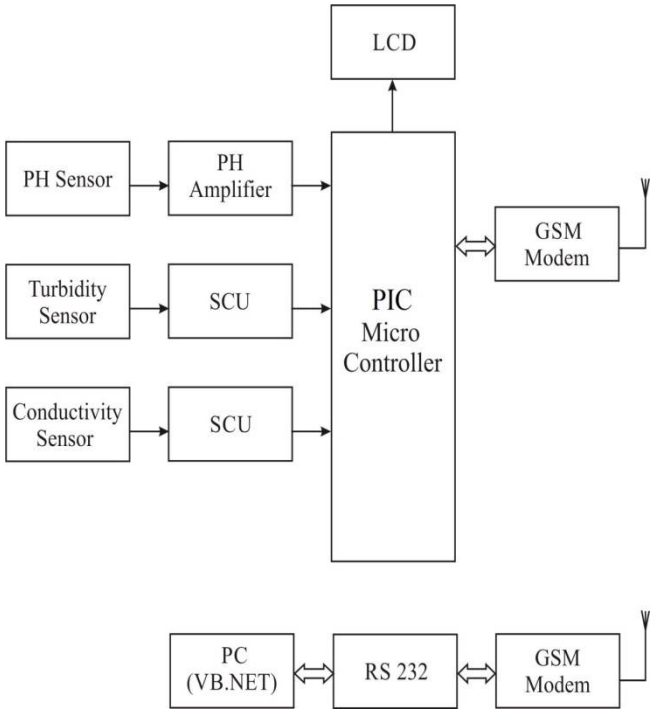

Figure 1. Block diagram of the proposed system

Conductivity, PIC microcontroller, GSM module and LCD. The water quality measuring system uses pH, turbidity, conductivity device to measure the standard of water. This device then measures the corresponding values of the water. Since the outputs of the sensors measured are analog in nature and microcontroller will handle solely digital signals thus there's a necessity of a tool that converts analog signals into digital signals. The system makes use of ADC for this purpose. The outputs of sensors are directly given to ADC, which converts the analog signals into the corresponding digital signals. These digital signals are then given to the PIC microcontroller System uses GSM module for communication. GSM module makes use of interface of the PIC microcontroller for communication. Microcontroller sends the measured values to the watching centre by SMS via the GSM module. Since it is a true time system, thus microcontroller can send the measured values to the watching centre after the particular time as per the program. With the information to the watching centre, the microcontroller conjointly displays the values of the measured quantities on the LCD. It is a true time system thus it does not need any man machine interaction for activity the standard of water.

This model uses sensors, GSM module (SIM900), LCD and a PIC 16F877 microcontroller. The GSM module is connected to PC through RS232 cable. The system model is shown in Figure which says about the connectivity of all mentioned devices. The LCD is attached to PIC 16F877 to simultaneously display the measured values, through which we can experimentally check whether the data that is being sent is correct.

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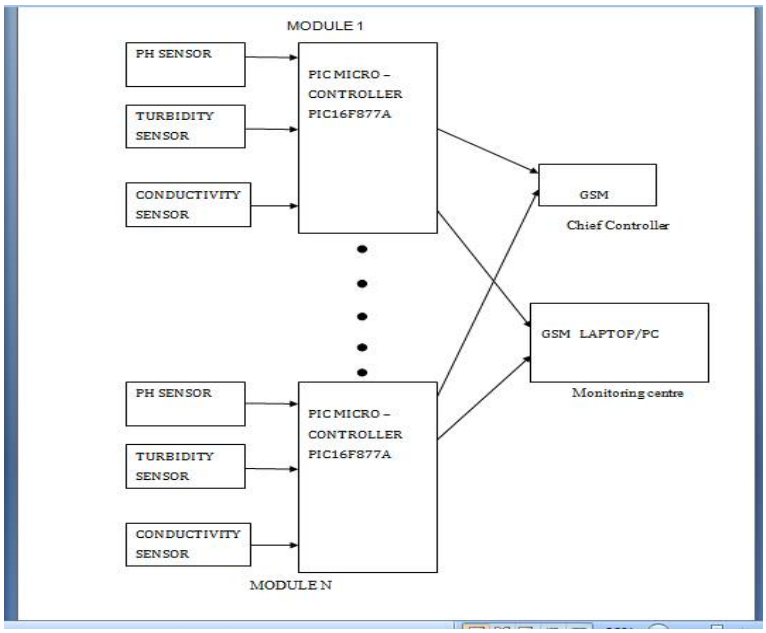
Figure 3.2 shows the schematic diagram of the water quality measuring system using pH sensor, turbidity sensor and conductivity sensor to assess the quality of water. This device then measures the corresponding parameters of the water. Sensors will go on forwarding there values to the microcontroller PIC 16F877A which will be display on PC\laptop. System uses GSM module for communication. Whenever a particular threshold is crossed that will be given on GSM and display on pc\laptop. Many such modules may be used to get better information about the values of different parameters



C) Overview of the device used

1. PIC16F877A microcontroller

The PIC16F877A microcontroller is the main component... The microcontroller that has been used for this project is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory. The microcontroller is mounted on a development board that provides an RS232 serial communication to the GSM modem...

2. Photo resistor

A photoresistor (or light-dependent resistor, LDR, or photocell) is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light-sensitive detector circuits, and light- and dark-activated switching circuits. A photoresistor is made of a high resistance semiconductor. In the dark, a photoresistor can have a resistance as high as several me ohms (MΩ), while in the light, a photoresistor can have a resistance as low as a few hundred ohms. If incident light on a photoresistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band.

3. GSM Modem

The GSM net used by cell phones provides a low cost, long range, wireless communication channel for applications that need connectivity rather than high data rates. Machinery such as industrial refrigerators and freezers, HVAC, vending machines, vehicle service etc. could benefit from being connected to a GSM system. An onboard service application can then notify the garage when the vehicle approaches its service interval. The garage will schedule an appointment and inform the customer.

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This application note describes how to use an AVR to control a GSM modem in a cellular phone. The interface between modem and host is a textual protocol called Hayes AT-Commands. These commands enable phone setup, dialling, text messaging etc. This particular application connects an AVR Butterfly and Siemens® M65 cellular phone using a RS232 based data cable. Most cellular phones could be used, except Nokia® phones using F or M-bus.

III. SOFTWARE MODULE

Transmitter section:

A) The program is written in Embedded C in MPLAB IDE. MPLAB is an Integrated Development Environment (IDE) for the development of embedded applications on PIC microcontrollers and is developed by microchip technology .MPLAB support project management, code editing, debugging and programming of Microchip 8-bit, 16-bit and 32-bit microcontrollers. The build and run tool is WINAVR tool is used to convert C Language to HEX File. The HEX file is dumped into the PIC 16F877 microcontroller using Top Win programmer.

Software program of monitoring centre mainly includes such functions: MT mobile terminated, databank, alarm, data collation, mapping curve, etc. Monitoring centre PC communicates with GSM module by UART. Upper machine reads SMS data received by GSM, and then sorts out and puts them into a database, so it is easy for managements to manage and perform a backup. Meanwhile, the data is plotted to curve and displayed on PC interface. As the SIM card in GSM module can store limited SMS data, it must delete the SMS timely after upper machine has read SMS. When the received data is abnormal, alarm indicator will be displayed on computer screen in the monitoring centre, at the same time, the alarm of monitoring centre will be switched on.

Receiver section:

B) The front end has been designed in visual basic. Visual Basic is a third-generation event-driven programming language and integrated development environment (IDE) from Microsoft for its COM programming model first released in 1991 and declared legacy in 2008. Microsoft intended Visual Basic to be relatively easy to learn and use. Visual Basic was derived from BASIC and enables the rapid application development (RAD) of graphical user interface (GUI) applications, access to databases using Data Access Objects, Remote Data Objects, or ActiveX Data Objects, and creation of ActiveX controls and objects.

A programmer can create an application using the components provided by the Visual Basic program itself. Over time the community of programmers developed third party components. Programs written in Visual Basic can also use the Windows API, which requires external function declarations.

IV.CIRCUIT IMPLEMENTATION

Proteus (***PRO****cessor for* ***TE****xt* ***E****asy to* ***US****e*) is a fully functional, procedural programming language created in 1998 by Simone Zanella. Proteus incorporates many functions derived from several other languages: C, BASIC, Assembly, Clipper/dBase; it is especially versatile in dealing with strings, having hundreds of dedicated functions; this makes it one of the richest languages for text manipulation. Transforming data from one form to another is the main usage of this language

Before implementing the hardware we try simulation of circuit in proteus for simulation we will need Microcontroller PIC 16f877 ,LCD to display values of ph ,turbidity and conductivity , virtual terminal to display GSM commands. Since we don't have electrode sensor and turbidity sensor in proteus hence we will use pots instead of the sensors .To run the simulation we will browse the hex file in Microcontroller then by clicking on the play button we can see the results. The PIC microcontroller is connected to sensors at the port 1 and port 8. sensors helps to detect water quality level.

The number of nodes are connected to each other to form a network. The control unit is present in the monitoring centre of the water quality. Here we use potentiometer in place of the actual sensor to simulate the change in values . So by varying potentiometer we assume that the values of the sensors are changing. The result of proteus are shown below.

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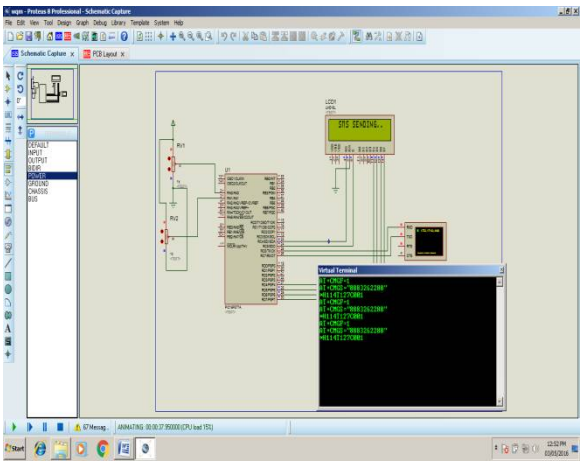
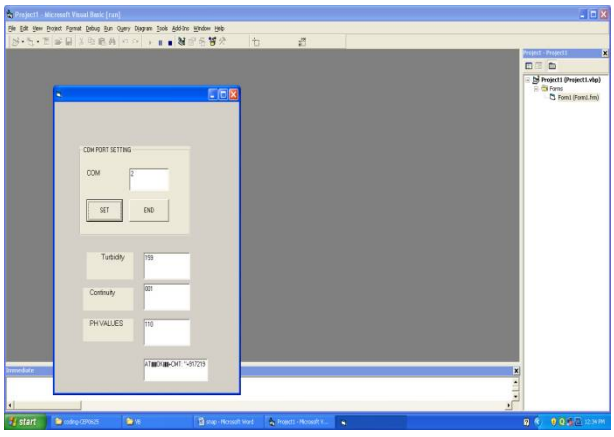


Circuit implementation showing the message being sent to the GSM Module

V. RESULT ANALYSIS AND DISCUSSION

LCD display showing the current usage of ph sensor(ph) turbidity sensor (turbty), conductivity sensor (ctn). It also shows the activities happening regarding GSM modem like Network Connection, message arrival, call is coming etc.

After the data has been proceed by PIC Microcontroller and transmitted over GSM it is fed to data base and the value of the sensors are displayed on front end designed in visual basic. Fig below shows the values of different sensors



frame showing the values of different sensors

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The values shown at the figure is the value which is been provided to us by the sensors which is also been displayed on the LCD. These sensors keep on updating the values regarding the change in environmental conditions.

VI. ADVANTAGES

1. Due to automation it will reduce the time to check the parameters.
2. This is economically affordable for common people.
3. Low maintenance.
4. Prevention of water diseases

VII. CONCLUSION

Automatic measurement and reporting system of water quality based on GSM makes use of water detection sensor with unique advantage and existing GSM network.

This type of system requires less man power for operation The system can monitor water quality automatically, and it is low in cost and does not require people on duty. So the water quality testing is likely to be more economical, convenient and fast. The system has good flexibility. This system is used in commercial and domestic use. This system is used in commercial and domestic use. It can be used in water supply agencies ,for health department to identify the reason of water Diseases so that it can able to measure the water diseases.

Only by replacing the corresponding sensors and changing the relevant software programs, this system can be used to monitor other water quality parameters. The operation is simple. The system can be expanded to monitor hydrologic, air pollution, industrial and agricultural production and so on. It has widespread application and extension value. Real-time water quality data can be seen from a GUI window in PC. The system has advantages such as low carbon emission, low power consumption, more flexible to deploy and so on. In order to monitor water quality in different sites, future work can be focused on establishing a system with more sensor nodes and more base stations.

Future Scope

- Different other sensors as are temperature, dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), ammonia nitrogen, nitrate, nitrite, phosphate, can also be interfaced with the microcontroller to fetch various information about a location.
- The system can be expanded to monitor hydrologic, air pollution, industrial and agricultural production and so on. It has widespread application and extension value.
- To provide information to all the users who are associated with this process.
- Increasing the parameters to be detected and analysed
- Work can be carried on to include the interfacing of relays to control the supply of water

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