GSM based Smart Water Purifier

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Abstract- A big portion of our population has no access to clean and good quality of drinking water. Even though there are many resources of fresh water are available in most parts of the world, many of such resources are contaminated with natural as well as human activities. This paper puts the light on the device which can solve this water contamination problem by purifying the water as well as by monitoring the quality of the purified water. This water purifier has mainly a TDS sensor which senses the TDS level continuously. If at a moment the water we are getting at the output of purifier attains the value below the predefined value of total dissolved solids, the sensor will detect this change and will immediately generate a message about it. This message will be sent to the retailer as well as to the user to alert them about the service of purifier using the GSM technology. The process we are using for the purification of water is reverse osmosis. Along with this module, smart purifier has temperature sensor to monitor the temperature of the water coming out of the purifier and gas sensor which will sense the LPG leakage in the kitchen. The information regarding temperature will be shown on the LCD and the information about the gas leakage will be indicated through the buzzer. The main advantage is that the sensing module can be connected to any kind of purifier.

Keywords – TDS, Sensors, Reverse osmosis, GSM

I. INTRODUCTION

In most parts of the world the fresh water resources are available but many of these resources are getting contaminated with human as well as natural activities. Increasing boom on population, increased migrations, industry expansion and many more factors are responsible for the contamination of water. To increase the production in agriculture various herbicides, pesticides for pest control, fertilizers, fungicides are used. The use of such artificial chemicals is degrading the quality of fresh water resources, ground water adversely. Water purification is the process of removal of undesirable chemicals, biological contaminants, suspended solids and gases from water. If someone used to drink the tap water or impure water without purification, then he/she may suffer from various health problems such as diarrhea, vomiting, nausea, typhoid fever and more. The most common side effect of impurities in water is Diarrhea which harms a digestive system adversely. Furthermore, Arsenicosis disease is caused by arsenic and fluorides in water which can increase diabetes, skin cancer, kidney, bladder, blood vessels, lungs and reproductive problems. Thus we require water purifier for pure this impure water. Water purification can involve various processes in a chain depending on the source water quality such as sediment filter to remove the sand particles in water, pre carbon and post carbon filtration to check the taste colour and odour of the water , RO membrane through which the water is made to pass through so that smaller impurities can be filtered out and the pure water remains on the other side of the membrane. This process is called reverse osmosis. Here pressure is applied on the reverse direction so that the water can go to the other side of membrane to overcome the tendency of water to go to the side with less water and more solute. Thus the pure water will be collected into the collector side of membrane by applying pressure. The RO systems having total dissolved solids (TDS) meter to check the TDS level of water. UV (Ultraviolet) technology also be used along with reverse osmosis. UV kills the bacteria present in water. The purpose of introducing the smart water purifier is to interface the TDS sensor with GSM system. This system consists of Temperature sensor, GSM module and GAS sensor. In which the system automatically measure the TDS water quality if this water quality changes then it sent message to the retailer using GSM Modem that this particular water purifier requires maintenance with the address of the home where water purifier is located. It also consists of temperature sensor which senses the temperature of the water coming out of the purifier. This system also consists of a GAS sensor placed in the kitchen with purifier. Another module we are using this project is gas sensor. If there is LPG gas leakage in kitchen then the gas sensor will sense the leakage and this will be indicated by the buzzer to alert the user so that hazardous accident can be avoided.

II. RELATED WORK

GSM based smart water purifier is basically divided into two sections that are interfaced with each other. These sections are:

1. Purification section
2. Active sensing section

1. *Purification section:*

It involves a series of process water filtration. The main purpose is to eradicate the suspended particles, biological contaminants, gases from the water so that it can be made suitable for drinking. In this project the process namely, reverse osmosis is being used for water filtration. It is the process in which the pressure is applied to the water so that the solute remains on one side of the membrane and the pure water is collected on the other side. Following diagram shows the water filtration process:

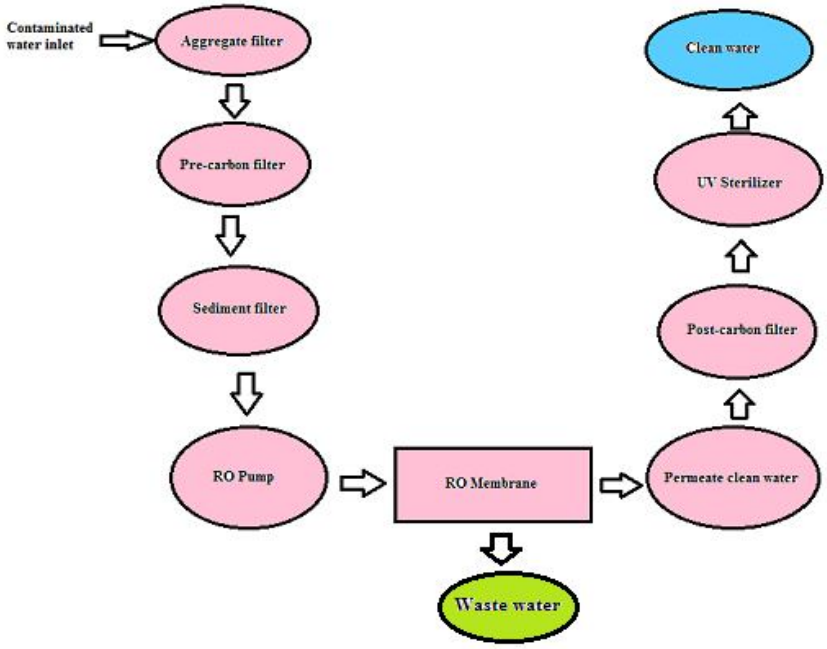

Fig1. Water purification using reverse osmosis

2. *Active sensing:*

In this section three types of sensors are used. These sensors are TDS sensor, Temperature sensor and Gas sensor. TDS sensor consists of TDS meter inbuilt in it. This continuously monitors the quality of the purified water at the output of purifier. It will do nothing if the TDS value of water remains above the predefined value. If the value of total dissolved solids goes below the level the TDS sensor will generate a signal and will send this signal to GSM module. After receiving the active signal the GSM module will generate a message. This message will be sent to the persons whose numbers will be given to the module. Basically it will send a message to retailer as well as to the user. Another sensor is temperature sensor which will continually monitor the temperature of the water. This information will be shown using the LCD. Another sensor is gas sensor which is used to sense LPG leakage. The information about this will be indicated by the buzzer.

III. BLOCK DIAGRAM OF SENSING AND CONTROL UNIT

The brain of GSM based smart water purifier is its sensing and control unit. It consists of different parts which are given as:

1. Microcontroller 8051 (AT89S52)
2. GSM (SIM900)
3. Max232
4. LCD
5. ADC(0808)
6. Temperature Sensor

7. TDS Sensor
8. Gas Sensor
9. Optocoupler
10. Relay
11. Motor
12. Buzzer
13. Power Supply

Now the block diagram of the sensing and control unit with its various parts of components is represented as:

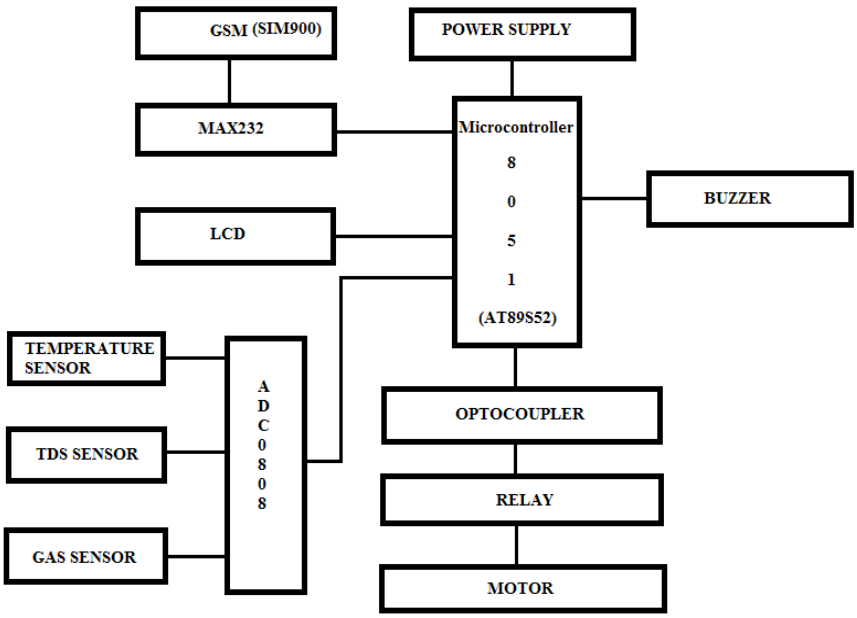

Fig2. Block Diagram of Sensing and Control Unit

1. *Microcontroller:*
The Atmel AT89S52 is an 8051 based Full Static CMOS controller. It has three-Level Program Memory Lock, 32 I/O lines, 8 Interrupts Sources, 3timer/counter, Watchdog Timer. It also has 2 DPTRs, 8K Flash Memory, 256 Bytes On-chip RAM. It transfers the information from the modules connected to it. Basically it controls all the incoming and outgoing signals from different modules connected to it.

2. *GSM (SIM900):*
It is an ultra compact and reliable wireless module. The module number of the GSM module used in this project is SIM900. It is a breakout board which is minimum system of SIM900 Quad-band GSM/GPRS module. It has the capability to communicate with controllers via AT commands (GSM 07.07, 07.05 and SIMCOM enhanced AT Commands). This module support software power on and reset. It requires the power Supply of +5V.This module is fully compatible with Arduino/Raspberry Pi/AVR/PIC/ARM/FPGA. It provides free serial port connection, you can select Hardware/Software Serial port control. It supports Super capacitor power supply for the RTC.
It can use the button for power on, and also can use the digital pin of Arduino to power on and reset the SIM900 module. It operates Quad-Band GSM(2G) GPRS/EDGE 850/900/1800/1900 MHz.

3. *16 on x 2 LCD Modules:*
LCD displays are very popular today because they are cheap and they can display characters. These are very easy to interface with microcontroller. Most of the compilers in present days have inbuilt library routines for them. These LCD modules have 14 pin connection with microcontroller.

TABLE I- PIN DESCRIPTION OF LCD

PIN	SYMBOL	DESCRIPTION
1	VCC	Ground
2	VSS	+5V power supply

3	VEE	Power supply to control contrast
4	RS	RS=0 to select command register, RS=1 to select data register
5	R/W	R/W=0 to write,R/W=1 for read
6	E	Enable
7	DB0	The 8-bit data bus
8	DB1	The 8-bit data bus
9	DB2	The 8-bit data bus
10	DB3	The 8-bit data bus
11	DB4	The 8-bit data bus
12	DB5	The 8-bit data bus
13	DB6	The 8-bit data bus
14	DB7	The 8-bit data bus

4. *MAX232:*

The MAX232 is an IC that converts signals from an RS-232 serial port to the signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver. It typically converts the RX, TX, CTS and RTS signals. The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V supply. This function is performed by charge pumps and external capacitors. The receivers reduce RS-232 inputs, to standard 5 V TTL levels. The MAX232(A) has two receivers that converts from RS-232 to TTL voltage levels, and two drivers that converts from TTL logic to RS-232 voltage levels.

5. *Temperature Sensor:*

The temperature sensor acquires the temperature of the system. In the proposed system we use the temperature sensor LM35. The analog output of temperature sensor which is in analog form is converted into digital form by ADC. This signal is then fed to controller which initializes the LCD to display the temperature of the system. It is a precision IC temperature sensor whose output voltage is directly proportional to the temperature.

6. TDS Sensor:

It indicates the amount of total dissolved particles in water. Dissolved particles can ionized solids such as salts and minerals or colloids. These particles can adversely affect our health if they are present in amount greater than required. This sensor indicates the concentration of dissolved solids on display in ppm(parts per million). When it senses the amount of total dissolved solids in water is not suitable for drinking it generates an analog signal which is fed to microcontroller via ADC (converts the analog signal to digital signal).

7. *Gas Sensor:*

LPG Gas Sensing Module can sense the presence of combustible gases like LPG, iso-butane, and propane in the air. This module uses MQ-6 sensor. This module just senses the presence of gas in the air and generates an analog signal accordingly. The analog output can be hooked up to an ADC of a microcontroller to get a wide range of sensor reading. In this smart purifier the sensor output which is analog in nature is fed to analog to digital converter and then it is hooked up to microcontroller at P0.1. If he signal at this pin comes to be 1, the buzzer will generate a beep to indicate a gas leakage.

8. *Optocoupler:.*

It is an electronic device which is designed to transfer electrical signals by using light waves in order to provide coupling with electrical isolation between its input and output. The main purpose of an optocoupler is to prevent rapidly changing output voltages or high voltages on one side of a circuit from distorting transmissions or damaging components on the other side of the circuit. The input to an optocoupler can be from phototransistor LED. It has a photosensitive device which turns ON and generates nearly same output voltage.

9. *ADC(0808):*

ADC receives analog signal and generates digital signal in binary. It is an 8 input channel analog to digital converter. The analog signal from any of the input channel is received by the ADC. Then the signal from the ADC is processed accordingly and converted to corresponding digital signal. Then this digital signal is fed to microcontroller

10.*Relay:*

A relay is an electrically operated switch. The current flowing through the coil of the relay creates a magnetic field which attracts a lever. This changes the switch contacts. The current in coil can be ON or OFF, so relays

have two switch positions and most of the relays have double throw(changeover) switch contacts. It is simply an electromagnetic switch which is made up to electromagnet and set of contacts. It is an electromagnetic switch operated by relatively small electric current that can turn on or off a much larger electric current. It means it turn on at a very small current and switches the other application using much larger current. In this project relay is used to drive the motor of the system.

11.*Power Supply:*
This unit provides the power supply to the system. Basically the power supply unit converts the AC voltage of high value to low value in dc voltage. In this project we use 5V supply for the controller section and SMPS for the filter section.

12. *Buzzer:*
A buzzer is an audio signaling device which may be mechanical, electromechanical or piezoelectric. It generates noise like an alarm which you can't ignore. It beeps whenever it receives an ON.

IV. CIRCUIT DIAGRAM OF SENSING AND CONTROL UNIT (IMPLEMENTATION METHODOLOGY)

The circuit diagram of the sensing and control unit with the pin connection to different modules is represented in fig 3.
As the circuit diagram shows the sensing and control unit has various modules connected to each other. This diagram shows the pin connections of different modules. The description of interfacing of different modules of sensing and control unit is given further.

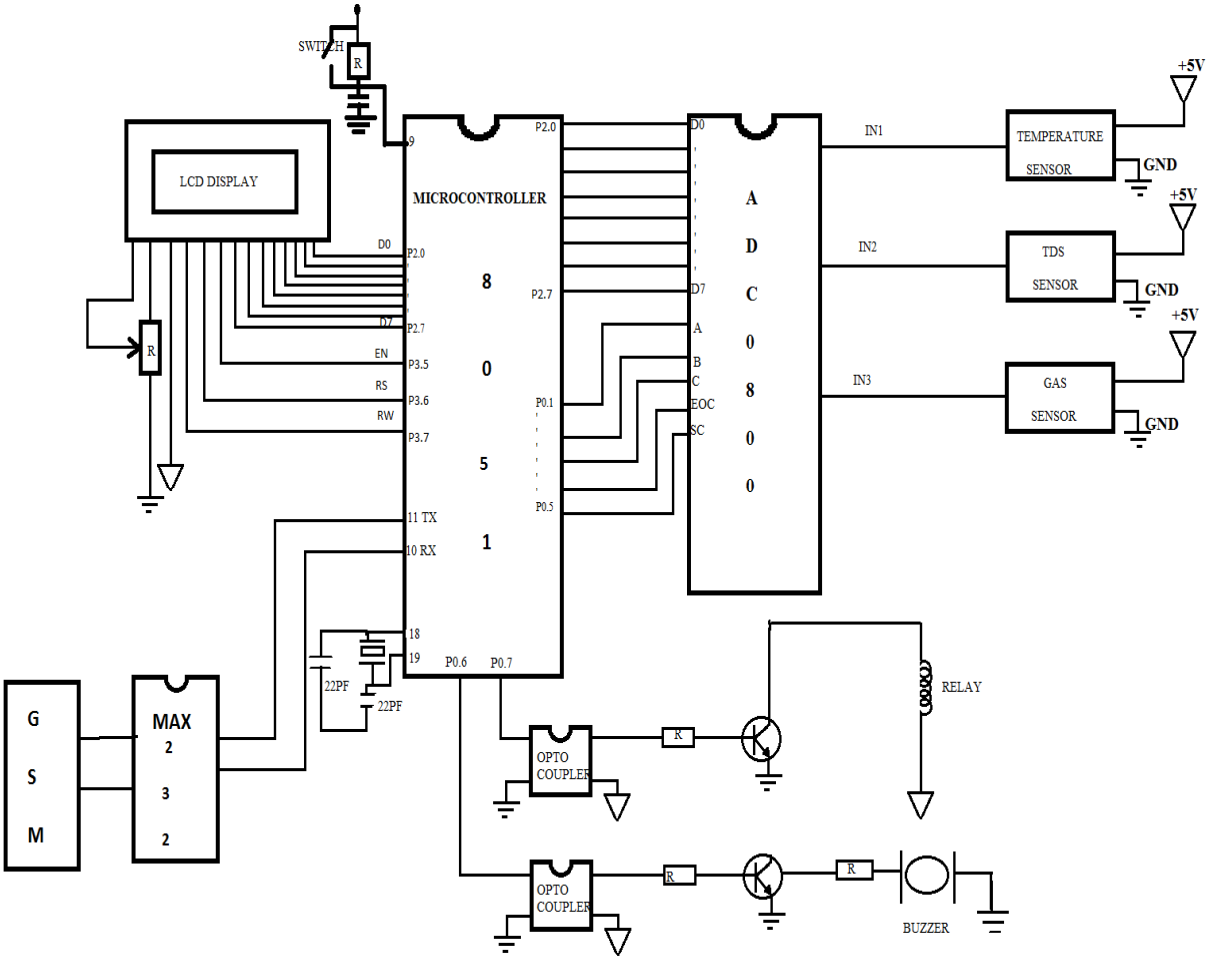

Fig3. Circuit Diagram of Sensing and Control Unit of GSM Based Smart Water Purifier

1. *Interfacing ADC With Temperature, TDS, GAS Sensor:*

Smart water purifier consists of number of sensors like TDS sensor, temperature sensor and gas sensors. These sensors are connected with ADC0808 which convert the analog value into the digital value. We use ADC to convert these analog values into the digital form because these sensors give the output in analog form and we need digital value. Input 1 of the ADC is given to the temperature sensor, Input 2 of the ADC is given to the TDS sensor and Input 3 of the ADC is given to the Gas sensor as shown in fig.3.

2. *Interfacing ADC with 8051:*

Then ADC is connected with 8051 microcontroller. Data out pins (D0 to D7) of the ADC0804 are connected to the port2 from pin P2.0 to P2.7 respectively. We can say port2 of the microcontroller is the input port and port0 is the output port. Control signals for the ADC are INTR, WR, RD and CS that are available at port pins P0.4 to P0.7 respectively.

3. *MAX 232 and GSM Interfacing with 8051:*

The MAX-232 IC is an integrated circuit which consists of 16 pins. It is a resourceful IC mostly used in the voltage level signal problems. Generally, this IC is used in the RS232 communication system for the conversion of voltage levels on TTL devices that are interfaced with the PC serial port and the Microcontroller. The MAX-232 IC is used as a hardware layer converter like to communicate two systems simultaneously. We must put MAX-232 to convert signal from TTL level (uC) to RS232 level (PC) to have serial communication between microcontroller and PC. In this it has transmitter and receiver and transmitter is connected to the port 3 at pin no.10 and receiver is connected to port 3 at pin no.11. Further the output of MAX232 is connected to the input of GSM module. GSM is used to send message to retailer. Thus GSM is connected to microcontroller through MAX232 .

4. *Optocoupler interfaced with microcontroller:*

Pin 6 and 7 of port 0 microcontroller is connected with optocoupler 4n35. Optocoupler 4n35 is a 6 pin IC. The main purpose of an optocoupler is to prevent rapidly changing output voltages or high voltages on one side of a circuit from distorting transmissions or damaging components on the other side of the circuit.

5. *LCD interfacing with a microcontroller:*

Port 1 of the microcontroller is connected with LCD. The VEE pin of the LCD is meant for adjusting the contrast of the LCD display. The contrast can be adjusted by varying the voltage at this pin. This function is done by connecting one end of POT to the VCC (5v), other end to the ground and connecting the center terminal of the POT to the VEE pin. RW pin of the LCD is meant for selecting the read and write modes. LCD module has pins namely RS, R/W and EN. It is a logic state of these pins that make the module to determine whether a given input is a command or data to be displayed. The data pins of liquid crystal display D0-D7 are connected to the port 1 of the microcontroller 8051 from pin 0 to pin 7.The control signals RW is connected at pin no. 5, RS is connected at pin no.6 and EN is connected at pin no. 7.

V.WORKING

Microcontroller 8051 is used in this project which controls all the modules of the project. These modules are: GSM (SIM900), Max232, LCD, ADC(0808), Temperature Sensor, TDS Sensor, Gas Sensor, Optocoupler, Relay, Motor, Buzzer and Power Supply. Smart water purifier consists of number of sensors like TDS sensor, temperature sensor and gas sensors. These sensors are used to measure the TDS level or quality of water, temperature of water level and also sense any gas leakage in kitchen respectively. The analog values of these sensors are interfaced with ADC0808 which converts the analog value into the digital value or binary value because the microcontroller can work only on binary value. This binary signal is given to microcontroller then Microcontroller gives this output to LCD. The LCD automatically converts this binary value in ASCII code and will display the data on LCD screen. The TDS sensor checks the TDS level of water i.e, total dissolved solids in water. It measures the value of TDS level with reference value or threshold values, if it exceeds then buzzer beeps and gives an alarm, then LCD display the message as TDS level is changed and the purifier requires service. This message is also transmitted to the retailer using GSM Modem that this particular water purifier requires maintenance with the address of the home where water purifier is installed. GSM is connected to microcontroller through MAX232. This system also contains the temperature sensor and gas sensor. The temperature sensors check temperature of water and display the value of temperature on LCD.

The GAS sensor is placed in the kitchen with purifier. If there is gas leakage in kitchen then the gas sensor senses the leakage and alarm gives a beep and tells us about the leakage.

VI.CONCLUSION

This paper has analyzed the need the of smart water purification in today's environment where tap water in not fit for drinking in most parts of the world. This device will reduce the botheration to the user about timing for maintenance and service of purifier. As it has TDS sensor interfaced with GSM module, it will alert the retailer as well as user about the service and cleaning of purifier automatically. Thus the people who usually check the quality of the water just by tasting it can leave all this responsibility on smart water purifier. Because it is usually seen in the case of purifiers that even being good in taste, the purified water become unsafe for drinking due to its increased value of TDS. Thus it will eradicate such big problem.

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