WPAN and PSO based Water Quality Monitoring with LabVIEW as data logger

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Abstract— Earth is only resource for drinking water, with a huge amount of unexploited elements which lies under the earth. This water purifies by using different purifying techniques at the government end also at consumers end. But the most of the purifiers which are used by the middle class families of India, does not provides any mean of monitoring the quality of water. As a result most of the people use the same purifier for years without service, which ultimately results in more contaminated water. This paper proposes a WPAN based system for monitoring the water quality of the water purifier, and real time data acquisition on LabVIEW. An automated procedure is proposed to determine the total dissolved in the water and the data collected from the system is displayed on LCD as well as the same data acquired by the handheld device. Then whole data is analysed using LabVIEW. This system indicates the danger level on the bases of input range of the sensor. The system has advantages such as early warning of the contaminated water and the same time purifier services person can collect the data and on time service of the water purifier can be maintained.

Keywords: Data logger, Hand held device, TDS meter, LabVIEW

I. INTRODUCTION

The quality of the drinking water degrading day by day due to various dissolved solids in drinking water which comes from the organic sources such as the Leaves, slit, sewage, plankton and industrial waste[1]. These Dissolved Solids form contaminated water which causes the diarrheal diseases, due to which thousands of people suffers every year [2]. The water purifiers used in middle families does not provide mean of water quality measurement, so to determine the water quality there is need to develop a supervising device with capability of displaying water quality [3] and that will reduce the risk of water contamination which causes public health issue. paper proposes WSN based purifier's water quality monitoring [4] and implement this system for the various house hold within a particular area, which is being under the surveillance of the Local distributor [5]. The data is received at a hand held device, with capability of storing the data of each purifier machine with a UIND. The TDS parameter is measured to determine the quality of the water and also provides early indication to the customer [6]. The TDS concentration is calculated by the sum of the anions (negatively charged) and cations (positively charged) ions in the water. Electrical conductivity (EC) of water is essential parameter on which TDS meter is based. Pure water has virtually zero conductivity. Conductivity is usually about 100 times the total cations or anions expressed as equivalents. Electrical Conductivity is converted by a factor of 0.5 to 1.0 times which gives the equivalent value of TDS. Higher conversion factor to be determined typically with the higher level of EC. According to the EPA Secondary Regulation advice a maximum contamination level (MCL) of 500mg/liter (500 parts per million (ppm)) for TDS [8]. But for numerous water supplies TDS value exceed this level. It is generally consider unfit for human consumption, if the TDS level exceeds the 1000mg/l. The high value of the TDS is caused not due to the presence of the potassium, chlorides and sodium. These ions have little or no short term effects, but toxic ions lead arsenic, cadmium, nitrate and others causes health issues [7]. Even best water purification in the market requires monitoring for the TDS to ensure the effective working of filters. So the basic parameter to be measured includes dissolved solids [9].

II. PROPOSED SYSTEM

The Fig.1 shows the key features of the system in the form of block diagram. A WPAN based TDS monitoring is proposed. TDS meter is attached with the water purifier machine which, continuously monitors the quality of the water and sends this information wirelessly within a coverage area. TDS value is also displayed on the water purifier with a small LCD. The each water purifier with TDS meter is provided with a (unique ID)UNID, which includes the data bits regarding the water purifier machine and the complete details of the customer address. A handheld device is proposed which is to be carried by water purify agency. It is to gather the information from a locality and the TDS status can be monitored. By using the Hand held device without visiting the customer house data can be received. After collecting the data of a particular area a database can be maintained containing all the information about TDS level with customer ID. By observing this sheet agency can contact to the customers for maintenance or customer can also contact to agency by own as meter is continuously providing the TDS value on the LCD placed on the machine. Also the system can be developed for ‘N’ societies and ‘N’ hand held devices with a centralized server with one agency. Now problem is to reach at serve with low coverage range of RF modem. It is solved by applying PSO algorithm as shortest path finding algorithm. It is achieved by the hopping of data with existing nodes and then reach at server.

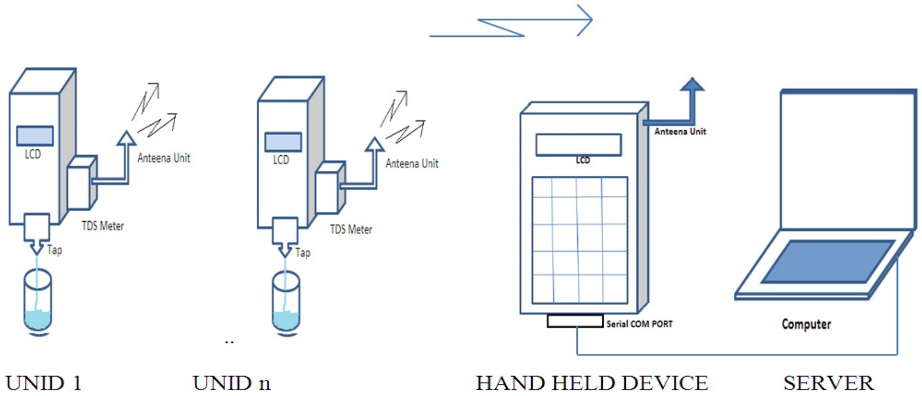


Fig. 1 Block Diagram of the proposed system

The Hand held Device having the storage capability that can store the data of ‘n’ water purifier machines with a unique identification. In the transmitter section the data from TDS meter continuously displayed on the water purifier machine with the LCD and at the same time it is transmitted to hand held device.

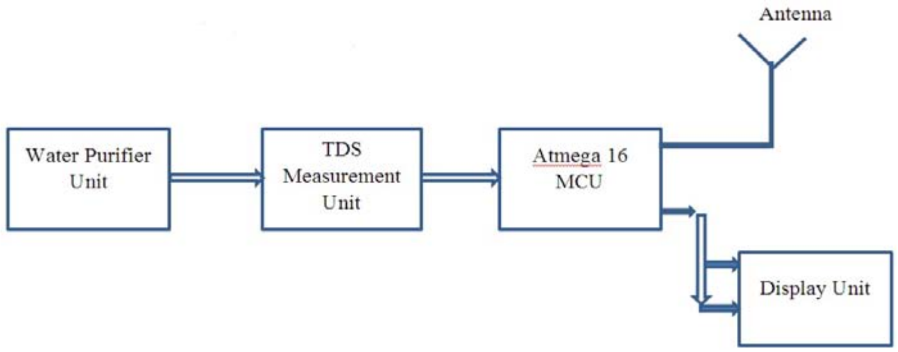


Fig.2 Block diagram of transmitter unit

In the receiver unit the hand held device is to receive the data from the ‘n’ water purifiers with a UNID. Now this information can be put to the server unit through the serial port with the hand held device and this record can be maintain on the excel sheet at the server end. For server LabVIEW is used as front end to display the TDS values with UNID.

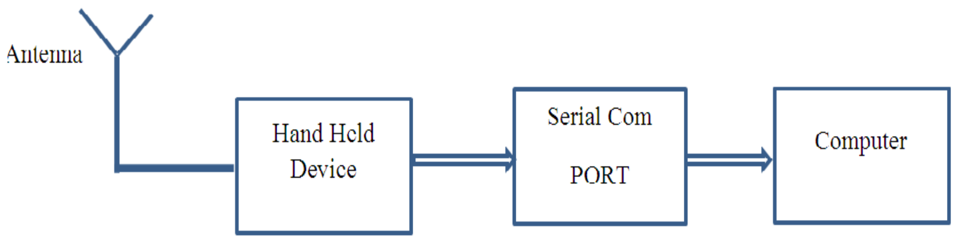


Fig.3 Block diagram of the receiver unit

III. PROTOTYPE DEVELOPMENT

Atmega16 is used as the control unit for transmitter and receiver. At transmitter it processes the detected TDS value and sends it to receiver through the wireless module.

The main modules that are used in the circuit are as follow:

A. **TDS meter-** TDS meter is basically a sensor unit which detects the TDS parameter of water. The TDS meter generates a particular voltage signal corresponds to the TDS value of the water. This voltage signal is then passed through the signal conditioning to produce the actual value of the parameter to be measured.

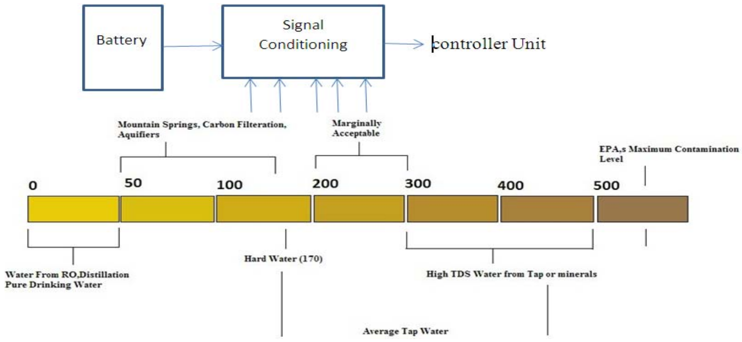


Fig.4 TDS meter range

B. **RF Modem-** RF Modem used is Zigbee, which is using the CC2500 transceiver IC, having a power transmission of the 100mW. The zigbee module requires a power supply of 5VDC and is operating at a frequency of 2.4GHz.
C. **Control Unit -** Control Unit module consist of the Microcontroller ATmega16 which is 8 bit microcontroller and operates on 16 MHz with advanced RISC Architecture.
D. **LCD -** The 16x2 LCD is used to display the TDS values. The LCD is having 16 pins among which 8 are data pins (D_0-D_7), three control pins RS, R/W and E. Each character is displayed across 5x7 matrixes. The LCD consists of two type of registers, that are Command Register and Data Register. Command Register is used to send commands and data register is used to store the data and display it on the screen.
E. **LED Indicator-** LED Indicator connected to the controller pin through a resistance of 330 ohm to indicate the critical values of TDS.

Circuit Diagram - The hardware consist of two sections one is transmitter end and another for handheld device as receiver unit. The two modules are as follows:-

Transmitter unit-

Fig.5 shows the circuit diagram of the transmitter unit, which comprises TDS meter , controller and RF Modem module. The TDS meter meter is connected with the PORTC PC5 of the Atmega16 microcontroller and RF modem. The RF Modem is having the four pins Rx, Tx, Vcc and Ground, which are connected to correspond pin of the Microcontroller.

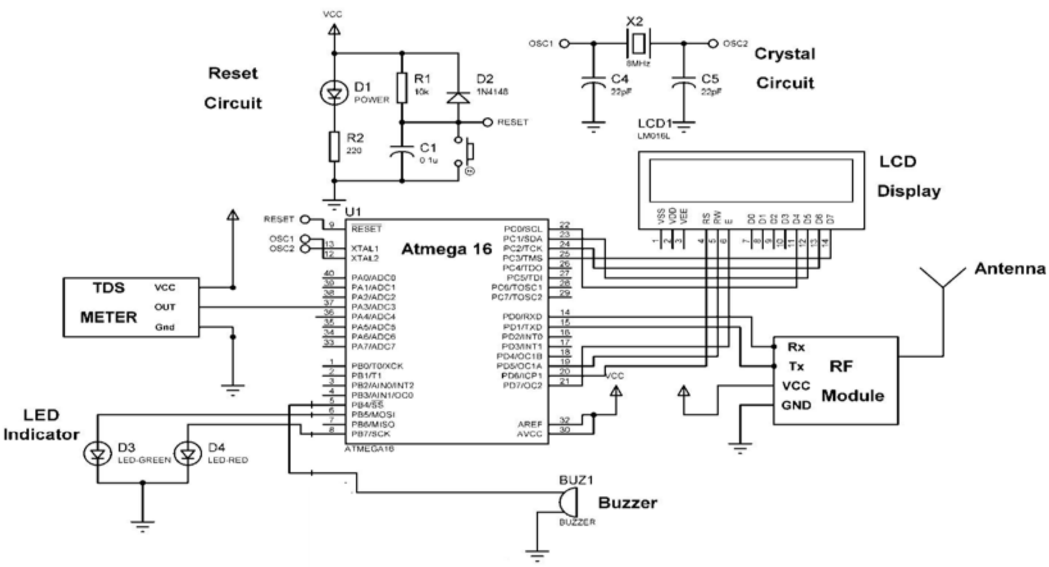


Fig. 5 Circuit diagram of transmitter unit

The crystal oscillator of 11.0592 MHz has been used to generate a baud rate of 9600. The two Indication RED and GREEN LED are connected with the PORTB and a Buzzer connected with PORTB. The 16x2 LCD connected with the circuit in which the RS, R/W and E pins connected to PD5, PD6 and PD7 pins of the microcontroller. The upper data pins D4, D5, D6, and D7 of the LCD are connected with PC0, PC1, PC2 and PC3 pins of the microcontroller.

Receiver Unit-

As shown in the fig.-6 the receiver unit consists of Atmega16 microcontroller with RF module, which is operating at a frequency of 2.4GHz. Receiver unit is a handheld device with capability to store the data in EEPROM. This data then communicated to the computer/Server. DB9 connector for serial communication is used which is connected with IC MAX 232. LCD pin RS, R/W and E are connected to the PD5, PD6 and PD7 pin of the microcontroller and upper data pins are connected to the PC2, PC3, PC4 and PC5 pin of the microcontroller.

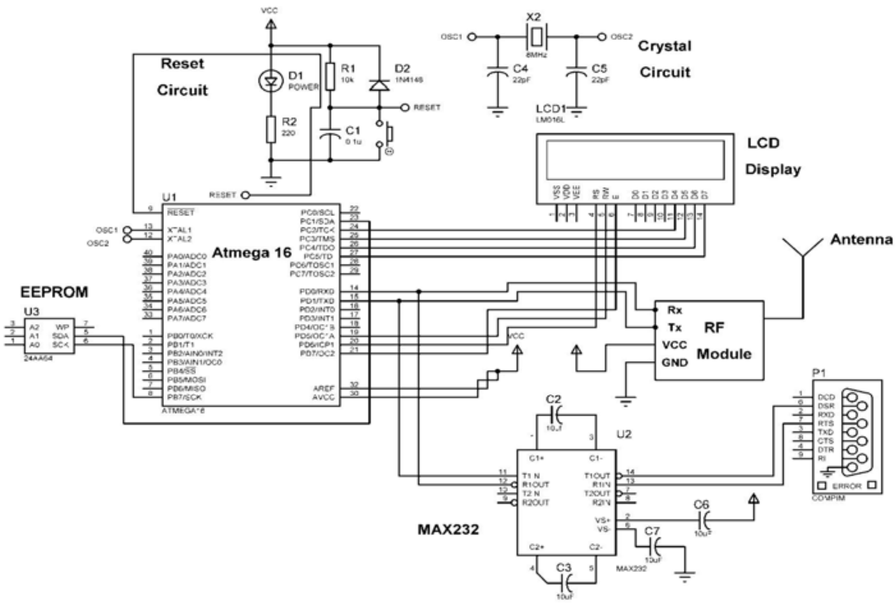


Fig. 6 Circuit diagram of receiver section

Hardware Description: - In transmitter unit the TDS meter continuously monitors the quality of drinking water which has the 7 level of the monitoring. This TDS value displayed on the LCD placed in the purifier system. The wireless modem transmits this value continuously and green LED remained ON. When TDS value of the water increases over the particular limit, the red LED blink continuously and buzzer gets ON after each 1 hour. This indication provides the early warning to the customer regarding the quality of water. So they can contact to the service person of the particular purifier agency. The meter output is distinguished to 7 different levels. TDS level from 0 to 50 to be considered be best water for drinking. If the TDS level is <=50 the output on the LCD gives TDS level and when TDS level increased above 50 then the TDS value displayed and at the same time the RED LED starts blinking which gives the indication of dissolved water. Now if the TDS level increased more than the 200 the buzzer connected to the panel starts beep after each one hour and if the TDS level increased above 200 than corresponds value along with RED LED and buzzer starts to beep for every 15 minutes.

At the same time this TDS value transmits to handheld device with agency man. In the receiver section the handheld device receives the particular UNID which identifies the detail of the customer and handheld device stores the corresponding data. Now this data provides the TDS value of the particular machine and identifies whether the system needs services or not and this detail data to be stored in a server through the serial communication port provided with the handheld device.

The Fig.-7 shows the algorithm for the step by working of whole system.

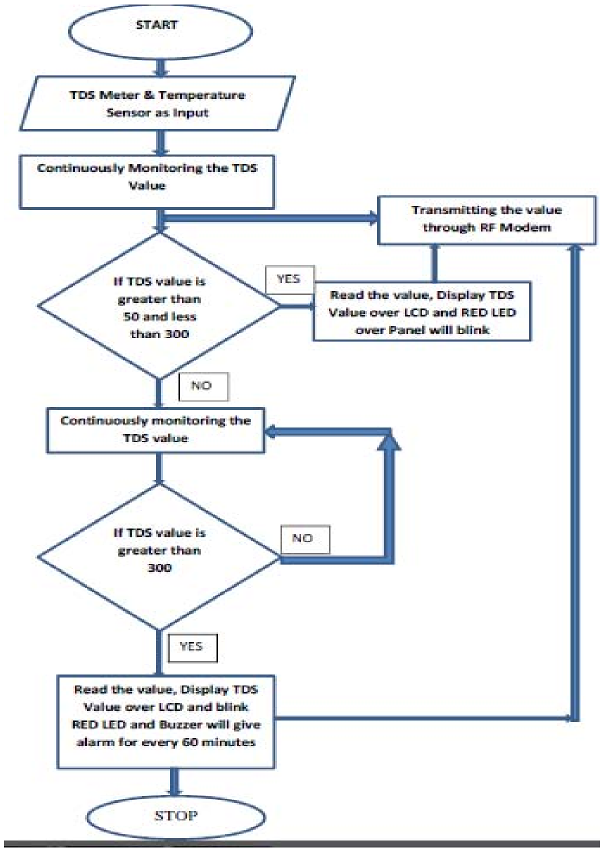
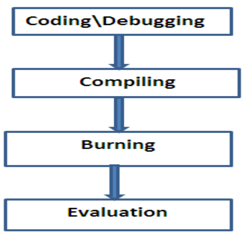


Fig.-7 Flow Chart for the working of the proposed system

IV. SOFTWARE DEVELOPMENT

The software for the both transmitter and receiver is developed by using WinAVR compiler, AVR Studio, Proteus simulator, Lab view and Virtual Serial Port. The C programming is used to develop the program and same is compiled using open source compiler avr-gcc. The basic steps for coding are as



Fig,-8 Coding steps

PSO as routing algorithm- For parameter initialization, every particle is given a random position and velocity.
1. Input all the desired constraints (number of nodes)
2. Initialize the particle positions and velocities
3. Evaluate the fitness value of system
4. Compare the individual fitness value of each particle to its previous value, and if it is better than previous one, replace with new value, i.e., local best position
Otherwise do not change
5. The position of particle having best value is global best value
6. Update position and velocity of particles
7. Go back to step (3) and repeat all steps until system constraints are met
n = 40; % Size of the swarm “no of birds”
bird_setp = 40;
dimension = 2;
c2 = 1.3;
c1 = 0.14;

w = 0.9;
fitness = 0 * ones(n, bird_setp);
velocity = w*velocity + c1*(R1.*(L_b_position-c_position)) +c2*(R2.* (g_b_position-c_position)); and c_position = c_position + velocity [10].

Proteus Simulation-

Proteus Simulator is used as hardware simulation platform. Which provides a powerful design environment with the ability to define most aspects of drawing appearances. The feasibility is checked on Proteus before actual hardware implementation.

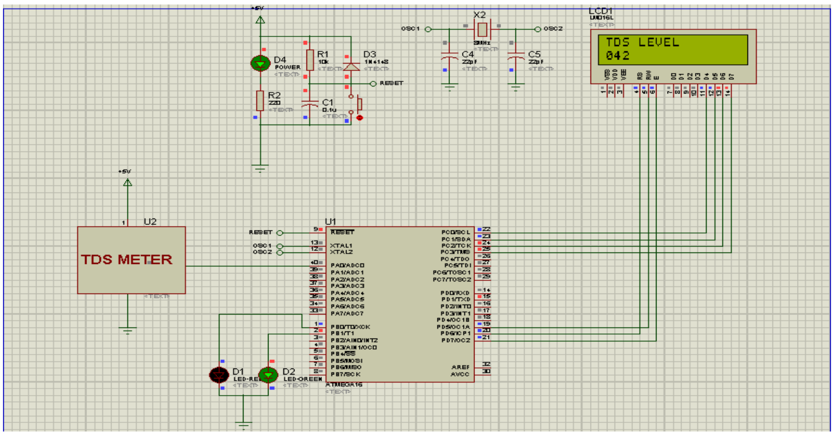


Fig. 9 Simulation of Model using Proteus

LabVIEW as data logger-

The LAB View environment consists of the two panels-Front Panel and back panel.

Fig.-10 and 11 shows front panel and back panel developed for the system. The Programming has the VISA resource and VISA Read unit with predefined baud rate, data bits, parity, stop bits, flow control. The data reads by the VISA resource is in the predefined string format which match with the pattern and gives the TDS output level. At the same time this decimal string converted into the Number which multiplied by a factor of 0.3544 gives correspond Sensor output in mV. This output of the Sensor in mV is multiplied by the 1 bit resolution (0.005V) gives the sensor output in Volts. The communication between the real time hardware and the LabVIEW model is through serial virtual port.

Fig. 10 LabVIEW Front Panel showing TDS values

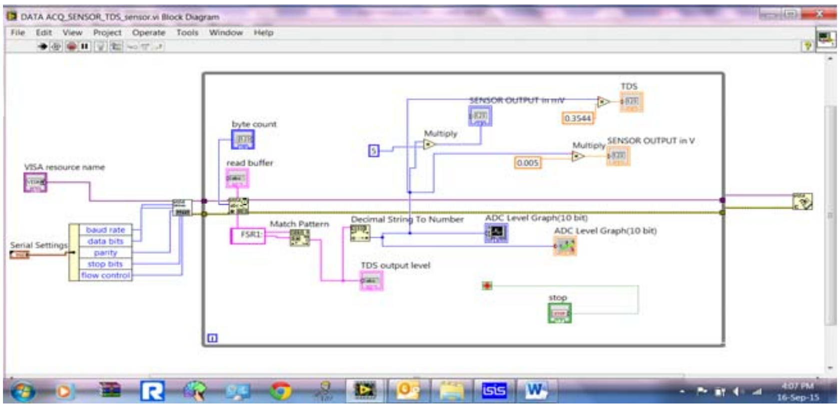


Fig.11 LabVIEW back panel

Virtual Serial Port is used to debug/create /test various applications that utilizes the serial port for communication. By using Virtual Serial Port one can expose serial port to local network (via TCP protocol) and can create virtual serial port device pairs. Virtual Serial PORT perform their work by creating serial virtual

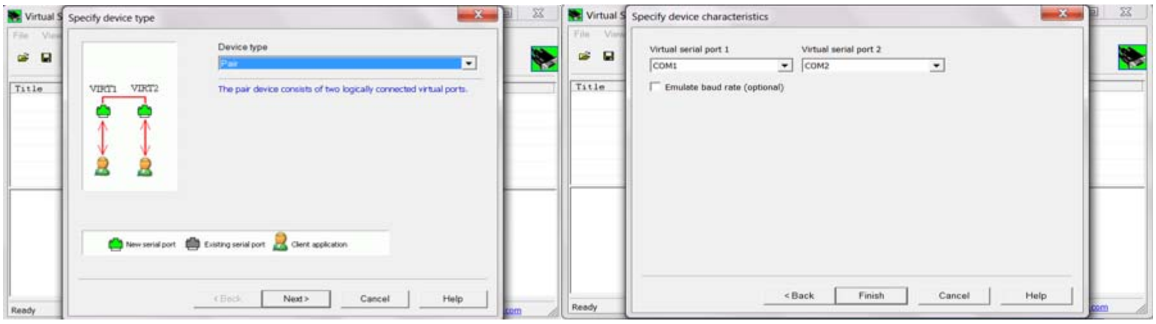


Fig.12 Virtual Serial Port Configuration

V. RESULT AND DISCUSSION

The proposed system is mainly focused on the analysis of the water quality in the water purifier used in domestic purpose and provide early indication of the contaminated water with WSN to ensure on time service of the purifier water. The code for the system has been designed based on the output of TDS meter.

Fig.13 Real hardware prototype for the system

Table- 1 Water source with TDS values

Water Source	TDS value
Fro RO, Distillation pure drinking water	0-50
Mountain Springs, carbon filtration, aquifiers	50-170
Hard Water	170-300
High TDS water from Tap or Minerals	300-500
EPA, Maximum contamination level	500 or above

The standard ranges of the TDS of different water have been tabulated and the various results are analyzed through the LabVIEW as data logger. The excel sheet can also be generated for records.

VI. CONCLUSION

The assurance of good quality water from the water purifier is one of the major challenges facing the various water operators. The water purifier with low cost and most probably utilized by the middle family in all location does not provide quality assurance of the drinking water. By this system it is possible to monitor the quality of the purifier water and can attain the early warning regarding the contaminated water. Monitoring the water quality and within a distributed area to a particular purifier service person with an ability of receiving the data from each water purifier machine and then storing the data to a central control station provide significant advantages to both the customer and purifier service person regarding the notification of the changes in the water condition and rapid response to the particular machine. This type of early warning of contaminated and quick response by the service provider will strengthen the health of public by consuming pure water.

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