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Potable Water Quality Monitoring and Automatic Billing System

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ABSTRACT: Water is essential to sustain life, and a satisfactory (adequate, safe and accessible) supply must be available to all. Improving access to pure drinking-water can result in tangible benefits to health. Every effort should be made to achieve a drinking-water quality as safe as practicable. The aim of the project is to design a real time system for monitoring drinking water quality and quantity at customer sites. Also automatic billing system is done using GSM Modem. This system consists of several sensors that can reliably monitor the water quality based on parameters like water pH, Total Suspended Solid(TSS), Total Dissolved Solid(TDS),colour of water, Dissolved oxygen. The customer usage water is measured using flow sensor. The parameters values are displayed in customer sites using LCD. If it exceeds the threshold value, alarm will be indicated. Then monthly water usage can be sent to municipal corporation officei.e base station within fraction of seconds in the form of text message using GSM Modem. The calculated bill is based on the amount of water consumed by the customer and then the billing amount will be sent to the customer site through SMS. This text message consists of bill amount with due date. If the customer payment process is completed on or before the due date, then water supply will be connected otherwise water supply connection will be disconnected.

KEYWORDS*:* Water quality monitoring, Sensor network, GSM, Automatic billing system.

I.INTRODUCTION

Safe water is a precondition for health and development and a basic human right, yet it is still denied to hundreds of millions of people throughout the developing world. Water related diseases caused by insufficient safe water supplies coupled with poor sanitation and hygiene cause 3.4 million deaths a year, mostly among children. Despite continuing efforts by governments, civil society and the international community, over a billion people still do not have access to improved water sources. The scale of the problem of water quality is even larger. It is increasingly clear that many of the existing improved sources in developing countries do not provide water of adequate quality for domestic purposes. As serious as this and other cases of chemical contamination are, the principal cause of concern is microbiological contamination, especially from faeces. While groundwater is generally of much higher microbiological quality than surface water, an increasing number of sources and systems used by people for drinking and cooking water are not adequately protected from faecal contamination. This is due to a variety of factors, including population pressure, urbanization and the inadequate construction, operation and maintenance of water systems. Even fully protected sources and well-managed systems do not guarantee that safe water is delivered to households. Safe sources are important, but it is only with improved hygiene, better water storage and handling, improved sanitation and in some cases, household water treatment, that the quality of water consumed by people can be assured.

Municipality and household water treatment

Drinking water is sourced from a variety of places by utilities. It can be sourced from groundwater, rivers, lakes, canals, reservoirs, and even from seawater. After transporting water from the source, the utility needs to treat this water to ensure that it is suitable to drink by improving the physical, chemical, and biological characteristics of the water. Water purification can involve a series of processes depending on the source water quality. Water utilities often perform screening for large debris, pre-conditioning to treat hardness and normalize pH, then flocculation to clarify the water by binding particles, settling the particles, and filtration to remove additional suspended particles and microbiological

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contaminants. A final phase is disinfection, which typically at a municipal scale uses chlorine or chlorine-based disinfectants which leave a residual to the tap, or ozone. The last decade has seen an increasing focus on the importance of drinking water treatment at the household level. While, ideally, every person should have access to safe drinking water from a household tap, it has become clear that strategies to improve the quality of drinking water through household water treatment and appropriate storage could have a significant impact.

II. RELATED WORKS

In this paper present an improved hardware platform, to develop a new advanced system for both water quality monitoring and automatic billing system. A number of multi-parametric sensor arrays have been developed and presented in the literature based on various sensor technologies. In limited number of on-line, reagent-free water monitoring systems are commercially available[7] but these systems are bulky and remain cost prohibitive for large scale deployments Such systems can take frequent samples of the water quality at a very limited number of locations. However, substantial proportion of contamination problems is attributable to problems within distribution systems and due to the limited spatio-temporal sampling, it is impossible for the water companies and consumers to know the quality of potable water delivered to consumer households. In these paper given the absence of reliable, in-line, continuous and inexpensive sensors for monitoring all possible biological and chemical contaminants, our approach is to measure physicochemical water parameters quality standards [4],[8] that can be reliably monitored and billing system with low cost sensors and develop low cost networked embedded systems.

III. EXISTING SYSTEM IN WATER QUALITY AND BILLING SYSTEM

In existing system methods of water quality control involve the manual collection of water samples at various locations and at different times, followed by laboratory analytical techniques in order to characterize the water quality. Such approaches are no longer considered efficient Although, the current methodology allows a thorough analysis including chemical and biological agents, it has several drawbacks. The lack of real-time water quality information to enable critical decisions for public health protection (long time gaps between sampling and detection of contamination), Poor spatio temporal coverage (small number locations are sampled),It is labor intensive and has relatively high costs (labor, operation and equipment).

Previously some traditional methods were used such as mechanical meters in which water flow drives mechanical gears which drives moving arrow pointer on the water meter scale, such meter need to be read in customer premises which is time consuming process. Such mechanical meters overtaken by electronics meters which works on RF frequencies. RF transmitter is mounted on meter which will transmit water usage on monthly basis within a limited range which then collected by RF receiver based hand held device. Then by using computer interfacing billing can be done. Such system needs manpower and it takes some time in collecting and distributing bills.

Aim of the project is to design a real time system for monitoring drinking water quality and quantity at customer sites and also automatic billing system are done based on GSM technology. First, it proposes the need for a shift in the present monitoring paradigm and propose the idea of monitoring the quality of water delivered to consumers, using low cost, low performance and tiny sensors. We argue that this approach can achieve more reliable quality monitoring due to the large spatially distributed deployment and the possibility of correlating the quality measurements from various consumers. Second, it presents the first step towards this goal which is the design and development of a low cost system that can be used at the premises of every consumer. The embedded systems developed can also be used in a consumer-oriented manner to continuously monitor qualitative water parameters and fuse multi-parametric sensor response in order to assess the water consumption risk at consumer level, locally and independently from other consumer measurements. The calculated bill based on water used by the customer then billing amount will be sent to customer site through SMS.

IV. PROPOSED SYSTEM OPERATION

The proposed system block diagram is consists of two modules. One is transmitter module another one is receiver module.

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Block Diagram of Transmitter

The transmitter module presents three subsystem. One is sensor nodes are used to collect the water quality from the selected parameter. Second one is PIC16F877A microcontroller assess the data and transmit to another system. Finally sent and receive the data through GSM modem

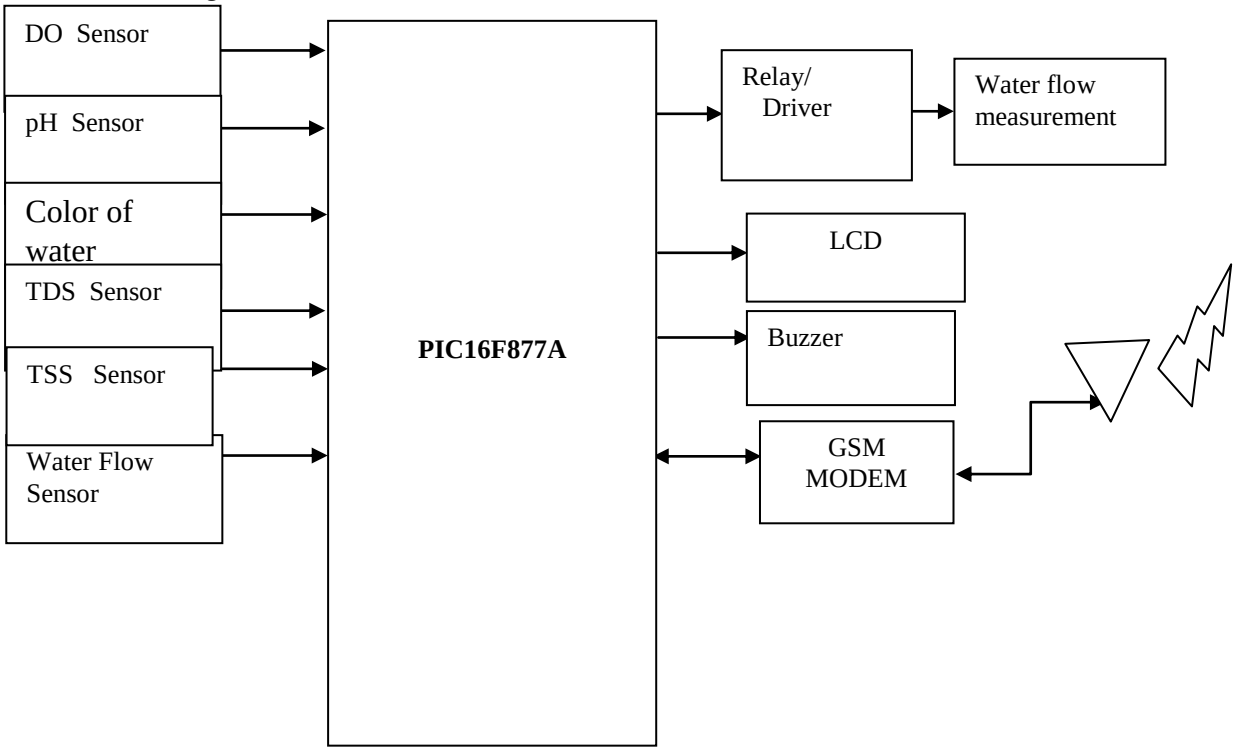

Fig. 1 Block diagram of transmitter

In fig. 1 shows transmitter system function. It contains number of sensor are measure the parameter value of water quality and its analog value are interfaced with microcontroller. This controller have inbuilt 10 bit ADC it convert the analog value measure the water quality and values are displayed in LCD. It process the values with reference value or threshold values if its exceeds buzzer alarmed and LCD display the message as its not a pure drinking water and this message also transmitted to the municipal corporation office.This system also design automatic billing system for monthly water usage by customer amount of water usage is measured by using flow sensor pulse value calculated monthly bill amount also displayed with due date through the text message format using GSM technologies.

Block Diagram of Receiver

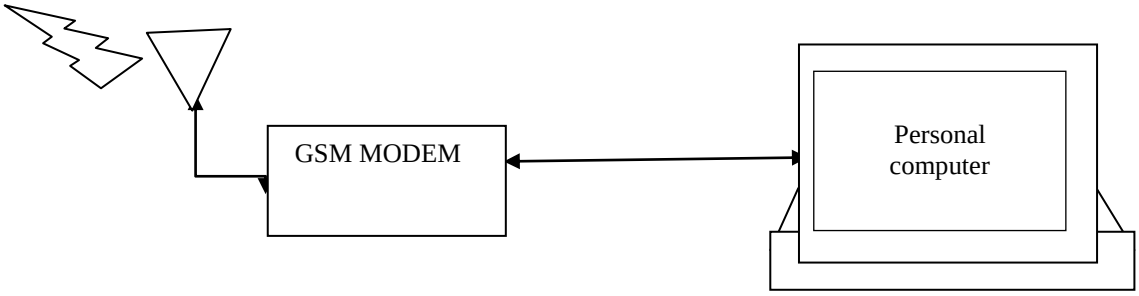

Fig. 2 Block diagram of receiver

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In fig. 2 shows the receiver end at present in municipal corporation office receives the unit of water consumed by customer through the GSM modem and the monthly bill amount with due date is transmitted. The receiver end controls the connections control valve also. (i.e) if amount is paid within due date supply water valve is opened otherwise closed.

A)Sensor

1.Total dissolved solid(TDS) sensor

Total dissolved solids (TDS) combine the sum of all ion particles that are smaller than 2 microns (0.0002 cm). This includes all of the disassociated electrolytes that make up salinity concentrations, as well as other compounds such as dissolved organic matter. In "clean" water, TDS is approximately equal to salinity. In wastewater or polluted areas, TDS can include organic solutes (such as hydrocarbons and urea) in addition to the salt ions. While TDS measurements are derived from conductivity, some states, regions and agencies often set a TDS maximum instead of a conductivity limit for water quality. At most, freshwater can have 2000 mg/L of total dissolved solids

2.pH Sensor

The pH unit measures the degree of acidity or basicity of a solution. To be more exact, pH is the measurement of the hydrogen ion concentration, [H+]. Every aqueous solution can be measured to determine its pH value. This value ranges from 0 to 14 pH. Values below 7 pH exhibit acidic properties. Values above 7 pH exhibit basic (also known as caustic or alkaline) properties. Since 7 pH is the center of the measurement scale, it is neither acidic nor basic and is, therefore, called "neutral." pH is defined as the negative logarithm of the hydrogen ion concentration. The measurement of pH in an aqueous solution can be made in a variety of ways. The most common way involves the use of a pH sensitive glass electrode, a reference electrode and a pH meter.

3.Total suspended solid(TSS)

Total suspended solids is a water quality measurement usually abbreviated **TSS**. It appears to be a straightforward measure of particulate weight obtained by separating particles from a water sample using a filter, it suffers as a defined quantity from the fact that particles occur in nature in essentially a continuum of sizes. At the lower end, TSS relies on a cut-off established by properties of the filter being used. At the upper end, the cut-off should be the exclusion of all particulates too large to be "suspended" in water.

4.Color of water

Often it is the color of freshwater or how clear or hazy the water is that is the most obvious visual characteristic. Unfortunately neither color nor turbidity are strong indicators of the overall chemical composition of water. However both color and turbidity reduce the amount of light penetrating the water and can have significant impact on algae and macrophytes. Some algae in particular are highly dependent on water with low color and turbidity.

5.Water flow sensor

Water flow sensor consists of a plastic valve body, a water rotor, and a hall-effect sensor. When water flows through the rotor, rotor rolls. Its speed changes with different rate of flow. The hall-effect sensor outputs the corresponding pulse signal. This one is suitable to detect flow in water dispenser or coffee machine. This system uses a JT121 flow sensor used for measure the water level.

B)GSM Billing operation

GSM service providers are doing billing based on the services they are providing to their customers. All the parameters are simple enough to charge a customer for the provided services.

SMS service

In most of the service providers are charging their customer's SMS services based on number of text messages sent from their mobile phone. There are other prime SMS services available where service providers are charging more than normal SMS charge. These services are being used in collaboration of Television Networks or Radio Networks to demand SMS from the audience.

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AT Commands for sending SMS
1.Define message format by typing "AT+CMGF=1" (Text mode).
2.Set message center number by typing " AT+CSCA=XXXXX"(Center number of service provider)
3.Enter recipient number by "AT+CMGS=YYYYYY".
4.Write message and press Ctrl-z.

AT Commands for receiving SMS
1.Define message format by typing "AT+CMGF=1"(Text mode).
2.Type "AT+CNMI=1,,2,0,0,0" In order to see all received messages.

V.METHODS

Drinking water quality standards are determined according to World Health Organization (WHO) guidelines for drinking-water quality as well as other pertinent organizations (i.e. EU , USEPA). These organizations set the standards for drinking water quality parameters and indicate which Microbiological, chemical and indicator parameters must be monitored and tested regularly in order to protect the health of the consumers and to make sure the water is wholesome and clean. For the developed system, the selection of the physicochemical parameters to be monitored was based on extensive scientific literature review on the relation between certain physicochemical parameters and chemical or biological contaminations that present in water.

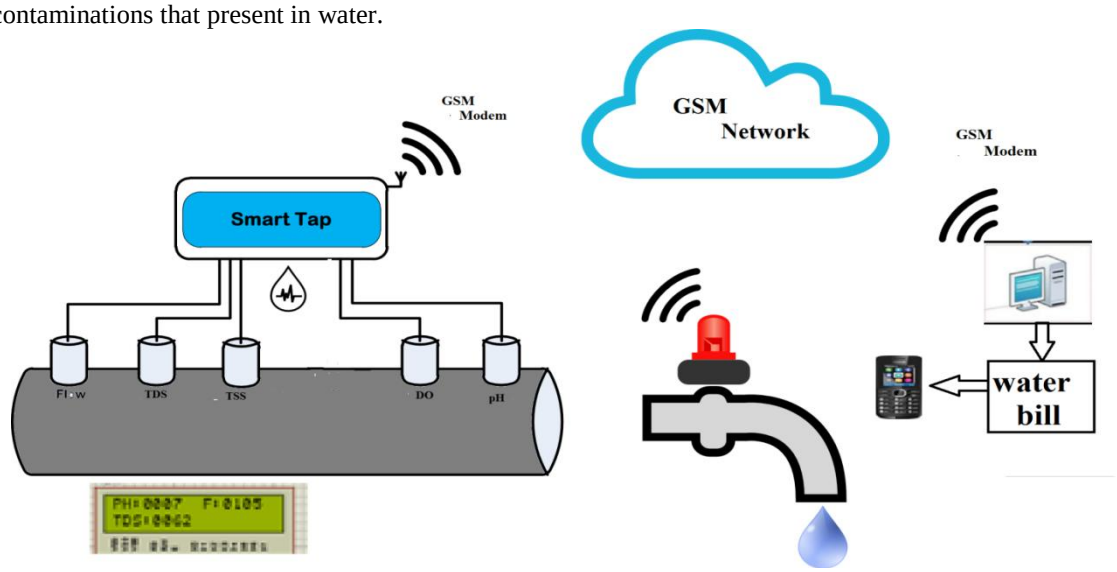

Fig.3 System Architecture

In fig. 3 shows the overall system architecture for monitoring the water quality parameter and automatic billing system using GSM networks.

S.No	Parameter	Units	Quality range
1.	pH	pH	6.5-7.5
2.	TDS	mg/L	2000
3.	DO	mg/L	0-20
4.	Color of water	-	Colorless

.TABLE. 1 suggested parameter to be monitored.

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Table I enumerates the suggested parameters to be Monitored are following 1)pH 2)TDS 3)DO 4)TSS and 5)color of water. Its noted that pH , TDS and color of water only measured then another parameter TSS and DO are not selected due to several compensations and frequent membrane replacements needed.

Then In which quantity of water usage is measured with the help of flow sensor, which will give square waves output proportional to quantity of the water flow. Sensors output is given to GSM modem at user end through micro controller. GSM modem transmits data regarding quantity of water used in the form of SMS to GSM modem at office end. Modem at office end receives SMS and gives to billing software for calculating bill. We can take its print or can send it via SMS.

VI.RESULT AND DISCUSSION

All the planned modules can be implemented by using Embedded C. Automated supply can be well executed by embedding all the details such as time and quantity to the microcontroller. PIC family microcontroller is used in the proposed system. Flow measurement on each channel can be easily measured by employing flow sensors. Voltage is produced when water flow through the sensor and by modulating the calculated value, flow can be easily found. All home units will not be consuming water evenly. Some may consume water quantity beyond the desired level which leads to scarcity among other home units. To check the quality of water pH, TDS sensors are used. Communication support is provided by GSM. Finally the overall water distribution unit is built upon automated supply, proper flow measurement and monthly billing alert along with assurance of quality of water.
Prototype implementation of water quality monitoring and automatic billing system was simulated using proteus IDE. The communication through GSM is replaced with direct switch connection in simulation.

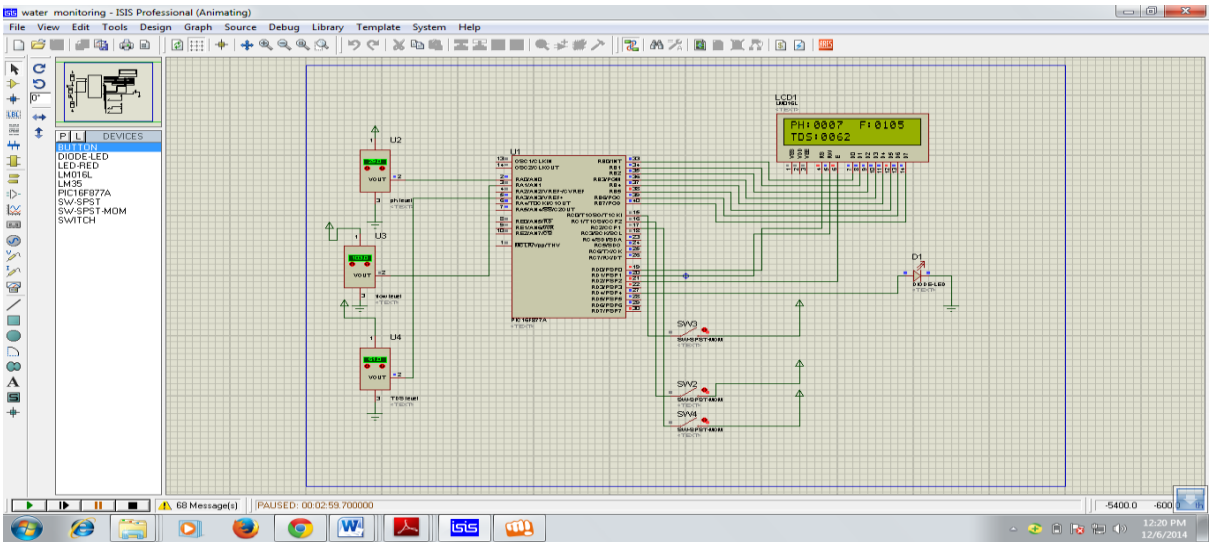

Fig. 4 For normal condition

Fig 4 shows the implementation of water quality and billing system designed in proteus environment.it represents the output of normal values of water quality. LCD is used to display thevalues pH :0007, TDS :0062, water flow:0105 to the user.

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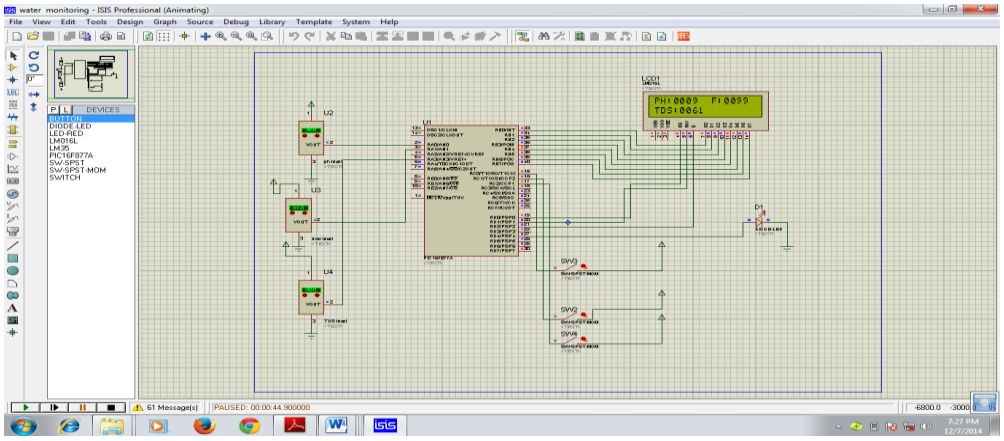

Fig. 5Forabnormal condition

Fig .5 shows the abnormal condition in water quality. LCD is used to display the values pH :0009, TDS :0061, water flow:0099 in this stage the warning message is displayed to the customer.

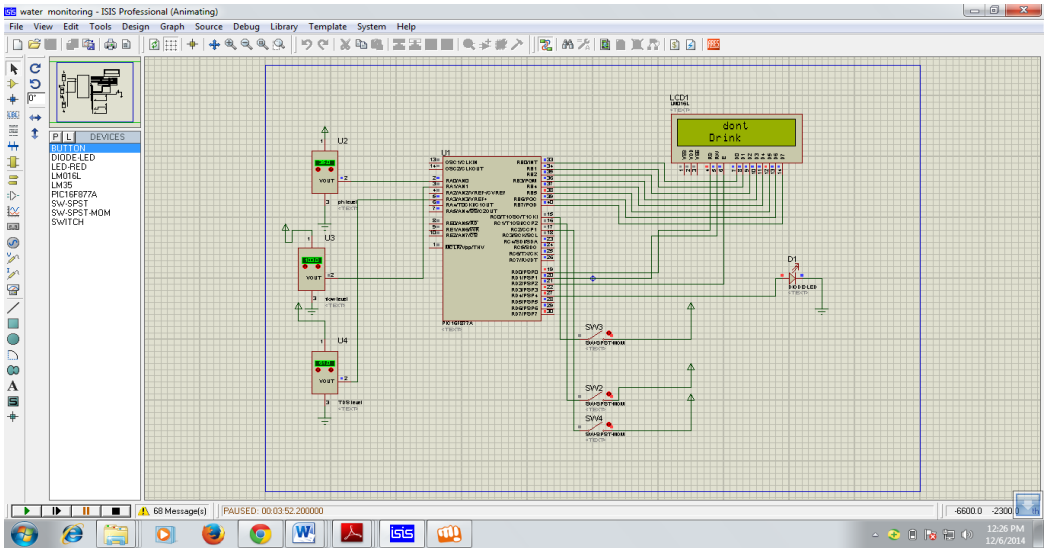

Fig .6 Alarm indicated the warning message

Fig .6 shows the warning messageof Don't drink.When the pH and TDS exceed threshold value, the LED is blinking and alert message is displayed in LCD.

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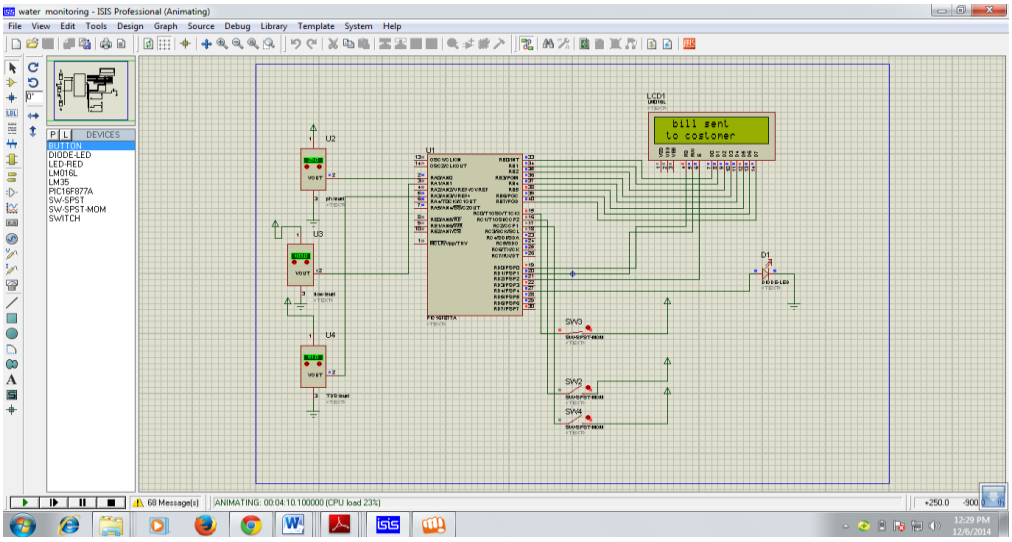

Fig.7 Usage of water the bill amount sent to the customer through SMS.

Fig 7 shows the implementation of water quality and billing system designed in proteus environment.it represents the output of normal values of water quality. If its exceeds 30 days then the switch(sw3) is closed. at that time usage of water the bill amount sent to the customer through SMS.

VII.CONCLUSION

In this paper, to design real time monitoring of drinking water quality at consumer sites is presented. The proposed sensor node consist of several in-pipe water quality sensors is low cost, low power, lightweight and capable to process of data and validated to enable these sensor nodes to make decisions and trigger alarms when anomalies are detected. Then the automated water utility billing will overcome the difficulties in existing Water distribution system. The proposed system will provide accurate meter readings for billing thereby increases the efficiency of the system. The total costing of the meters is supposed to reduce so as the system will be economical along with power consumption reduction will be achieved by programming it as per requirement that is for monthly billing cycle it will be in active mode once in a month and rest of the time it will be sleep mode.

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