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Design of Wireless Sensor Network Using GSM/GPRS for Real Time Monitoring of the Pipe-Born Chlorine in Sri Lankan Water Supply System

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Abstract

There are many areas in Sri Lanka, where a large number of Chronic Kidney Decease (CKDu) patients and higher mortality rate are reported. The factors causing the disease and the reason behind the outbreak is not well identified, however, certain assumptions are made-up by researchers. The strongest believed factor is related to contamination of drinking water. The existing water quality measurement practices are not linear but discrete and lack of consistent. Therefore, a consistent linear monitoring is required to identify unknown reasons behind the decease. In this study we undertook to design a proto to read and record the chloride amount found on hosted in the CKDu positive consumer sites as the objective of study. A web based data logging server, the latest GSM/ GPRS technology, chloride sensor, Arduino Open Source Hardware Technology and SIM900 Shield development board were used to design a system for this purpose. This system enables the intended researchers to carry out the monitoring and investigation through the internet and make decision on real-time basis.

Keywords: Arduino, Chlorine, CKDu, Embedded System, GSM/GPRS, WSN, Piped Water

1. Introduction

The latest research reveals (CKDu, 2015; Amara.P., Niranjali.J., and Muhammed A.B, 2013.) that there is a high growth in kidney failure and mortality of the patients. The water samples were examined for many parameters such as anions, cations, and heavy metals. The previous researchers have suggested that Cd, Na, Ca, F and Cl as causative factors for CKDu. Even though the results of cases shown on that identified area that all those parameters are under the WHO standard level (CKDu, 2015.), recorded CKDu outbreaks are accelerating more and more. Generally, the testing was done on the post epidemic conditions, some issues cannot be identified and predictions are difficult to made without having a continuous monitoring state. Government entity like Water Supply and Drainage Board too not have the mechanism to monitor any places continuously even that is the monopoly of water quality and supply monitoring authority (NWSDB, 2015). But the existing laboratory testing is expensive and time cost.

If we consider CKDu or any other kind of water borne diseases' outbreak were severe in the piped water supply compare with traditional ground water usage, the pipe water supply network is highly promoted in order to overcome above threats. According to WHO suggestions, every government must have the systematic policy for efforts to take the water safety innovatively (WHO Guide 2011).

Above cations and Fluoride were found in most parts of Sri Lanka (Amara.P., Niranjali.J., and Muhammed A.B, 2013). Due to the usage of chlorination as a disinfection technology, which is popular and compulsory for the piped potable water supply network, bleaching powder and gaseous chlorine are used for the cleaning and water disinfection purposes. The tragedy situation there is no assurance (About Sri Lanka 2012.) and transparent about the actual quality maintenance of the concentration of chlorination. Therefore, special care and monitoring transparent mechanism should be added to Sri Lankan Water quality monitoring system.

2. Literature survey

Wireless sensor network drawn the tremendous attention on many industries due to its cost effectiveness, which has the ability to sense and do work at multiple locations without physically attend. There are numerous communication technologies and protocols such as Bluetooth, Infrared (IR), ZigBee, WiMAX, GSM, GPRS, CDMA, Wi-Fi, Li-Fi, satellite and many more were utilized to wirelessly monitoring applications. Of them, some are short-range communications while some are long end communications.

For each with an example, Bluetooth were used in irrigation management system, System will have used Programmable Logic Controller to perform the decisive action, but from the six distributed soil sensor's data were transferred to the irrigation based station (Yunseop Kim; Evans, R.G.; Iversen, W.M. 2008.). Infra-Red,

used for the turbidity monitoring of a water, were used in the intelligent turbidity system (Postolache, O.; Pereira, J.M.D.; Girao, P.S., 2002). ZigBee is another one, used to send the sensed water quality measure within locally and Wi-Fi used to transfer data to the webserver (Silva, S.; Hoang Nghia Nguyen; Tiporlini, V.; Alameh, K., 2011). GSM / GPRS were used in many applications such as Poyank Lake monitoring were carried out (Lin Yang; Cao Qun,, 2011.).

There are many research expert claims that the chlorine in the water induced the breast cancers as well "The effects of chlorine on your skin", 2014, there are many reports the women's breast cancer was accelerating in Sri Lanka.

3. System Architecture

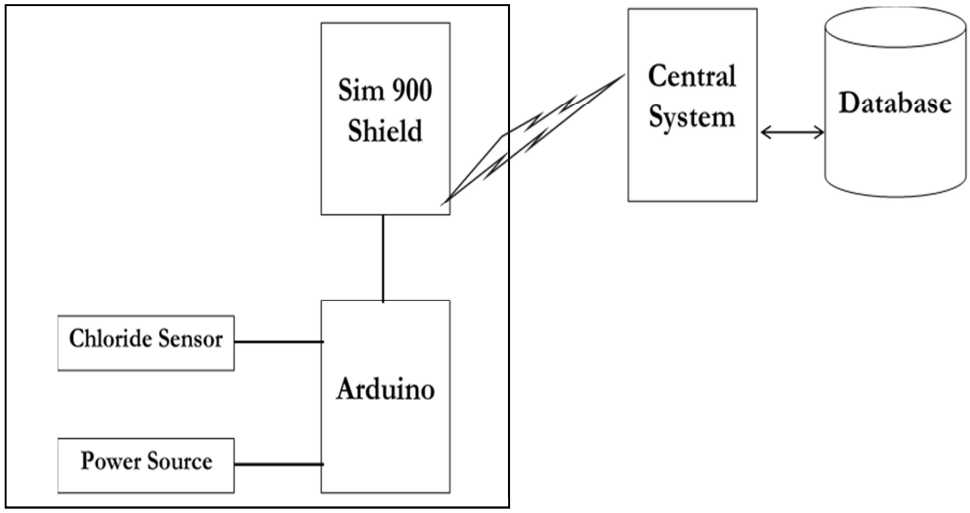

Figure 1: Wireless Chloride Sensing unit and central system

4. Materials & Methods

4.1 Microcontrollers:

This study presents the design & implementation of embedded wireless centralized chlorine monitoring system. There are many types of microcontrollers available, but PIC and AVR are very popular, but AVR microcontroller (Figure 2) was chosen for our study, because of its more features than PIC microcontroller, where AVR comfortable enough in programming, it has number of I/O ports and it is used in famous open source electronic board called Arduino.

Figure 2 : PIC Micro Controller Chip

4.2 Arduino Mega:

The Arduino Mega is simple open source hardware has an ATmega328-based microcontroller board. Which operated using 5.5 Volts power supply with the 20 MHz maximum operating frequency. This is very easy to anybody without having any electronic and programming expertise. Arduino IDE has a simple C likes a programing language with the driver and latest libraries. Arduino has some Digital and Analog Inputs / outputs ports.

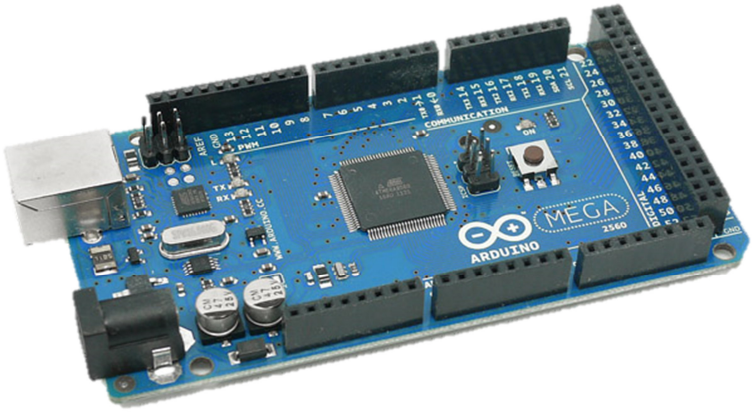

Figure 3 : Arduino Mega

4.3 Chloride ion selective electrode /BMC:

Chloride ISE/ BMC sensor probe (Figure 04) was used to measure the continuous data from the sampling pipeline spot, which sends the sensed data to Arduino board.

Figure 4: Chlorine electrode

4.4 SIM 900 Arduino Shield

SIM900 Shields (Figure 4), which delivers GSM/GPRS 850/900/1800/1900MHz performance for Data, Voice, SMS, and Fax in a small form factor with the low power usage. That will use the sim and it could send SMS or GPRS data communication through the AT command. It could be simply connected on top of the Arduino Board as a stack.

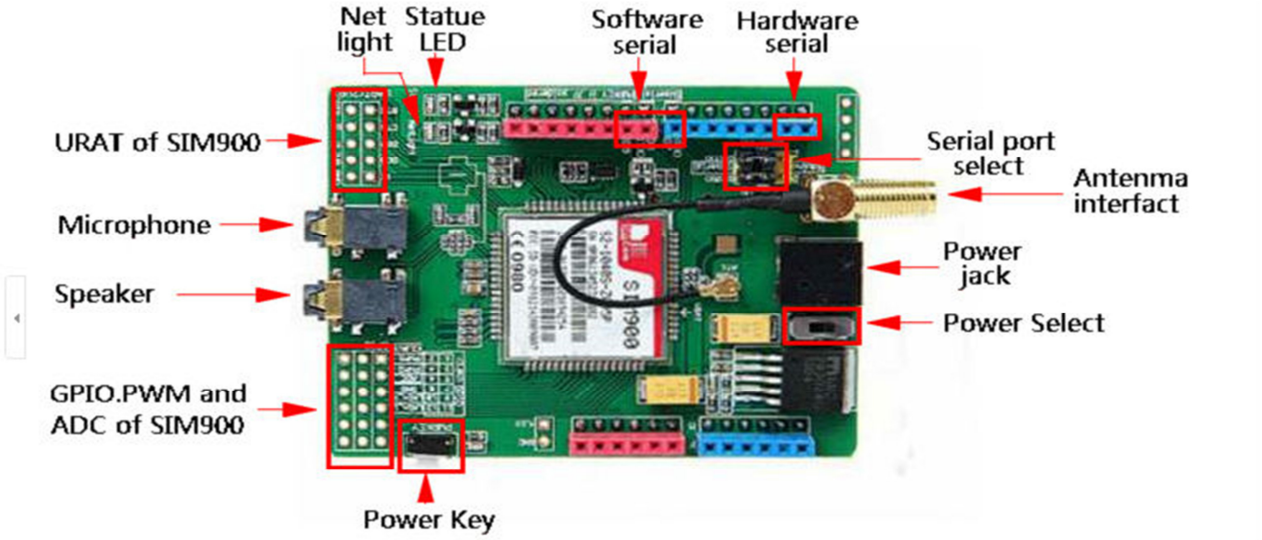

Figure 5: SIM900 Arduino Shield

(Source: Alibaba.com)

The sensor unit was fixed on to the water supply pipeline in the CKDu outbreak regions for the investigation and monitoring. The sensor unit having sensor's reading were processed and send to with the timestamp, sensor node ID (unit), reading values were transmitted particular time intervals (this could have tuned according the precision requirement) but normally we have setup interval every 15 minutes that sent the stable reading to the central system. Then the system identified through the node ID and stored the database that could be retrieved later when it is required. The transmission was used the TCP/IP for the secure communication over the data packets. Depends on the requirement the sensor number could have been increases but we used three units for the testing the system.

4.5 Software and Server technology:

There was a were some software server used here for the internet communication. H**TTP Server** was used as the standard webserver that allowed the clients to connect and observe the actual water quality changes. MySQL server had to be used as the Database Server and Sockets server had used for the secure of communication.

5. Discussion:

There are many factors involved in the CKDu and other types of kidney and skin problems. In this study, we tried to make the prototype in the context or from the consumer site monitoring. There was many water quality monitoring had been conducted but the water supply based technology enhanced mechanism has not adopted and due to the classical laboratory sampling and testing would raise the unpredictable delay and it may seriously make the consumer site damage. There was no structure to see and involves the public and researcher to make the further studies (that is the big issue in developing country compare to developed country).

6. Conclusion and future suggestion

Solving CKDu problems may take time with the various inventions of the prevention techniques. However, everything in this continuous wireless water parameter monitoring techniques will ensure the early identification. It gives the data as an evident for the predictions and prevention for the future quality monitoring of the water. Surely, it will give the basic idea to develop the future fully-fledged water quality monitoring system caring from the consumer sites.

Finally, in conclusion the outcome of this system proto monitoring will perform in this unit to have the prevention system to by the real-time data of chloride content in all area and the prevention technique also can we estimated.

We are focussing to carry out the future research to develop the multi parameter, multi station mechanism and increase the sensing accuracy with the locally replicated network and trying to reduce the cost, etc.

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