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Build Out of Embedded PLC to Increase Water Supremacy

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Abstract

Water pollution is one of the key threats for the green globalization. To prevent the water pollution, we have to detect the pollutant. For past few decades, water pollution was detected by chemical test or laboratory test with bulky and stationary equipments and water samples will be fed to testing equipment. In order to increase the pervasiveness, testing equipment can be placed in the water and detection of pollution can be done remotely. Here aim is to implement an embedded PLC to increase water supremacy by measuring parameters like pH and total dissolved solids in water. Traditional PLCs here are to be superseded with the embedded ones to overcome hurdles such as bulky size, large amount of power consumed and complex design.After exploration of the conception and the trademarks of PLC in combination with embedded systems, the development of an economical embedded PLC for real time water quality monitoring is elaborated with combination of the Keil, Flash magic and MATLAB software and the ARM cortex M3 Microcontroller with analog signal conditioning for pH and Total Dissolved Solids meter sensor input data. For cases of inference value above the threshold, warning SMS alert will be sent to the authentic agent via GSM module Sim 900 with knowledge of AT commands also real time graphic user interface giving voice alarms with computer interaction.
Keywords: Green Globalization, Threshold, ARM Cortex M3, AT Commands, GSM Module, Computer Interaction

I. INTRODUCTION

Programmable logic controllers (PLCs) are a specialized type of embedded systems used to control machines and processes. These controllers have been introduced in the early 1970s to supersede the existing relay control logic that became obsolete and expensive for implementing systems at that time. Moreover, PLCs have offered flexibility, higher reliability, better communication possibilities, faster response time, and easier troubleshooting. PLCs have been mainly of industrial control engineers that introduced, expanded and standardized their own design methods and programming languages. A detailed understanding of the operation and interfacing of PLCs to sensors to improve water supremacy is very crucial for following reasons.Excessive wrenching of ground water to meet agriculture, industrial and indigenous demands, drinking water is not available during the critical summer months. About 10% of the rural and urban populace are abandoned to safe drinking water and many more are threatened. Most of them depend on defenseless and unsafe water headspring to meet their daily needs.

Water shortages in cities and villages have led to large volumes of water being collected and transported over great distances by tankers and pipelines .Chemical contaminants viz. fluoride, arsenic and selenium pose a serious health peril. It is estimated that about 70 million citizenry in 20 States are at risk due to excess fluoride and around 10 million citizenry are at risk due to excess arsenic in ground water. Increase in the concentration of Chloride, TDS, Nitrate, Iron in groundwater is of great concern for a sustainable drinking water programme. With over wrenching of groundwater the concentration of dissolved constituents/ionic concentrations is increasing regularly. Ingress of seawater into coastal aquifers as a outcome of over extraction of ground water has made water supplies more saline, unsuitable for drinking and irrigation. Filthiness of surface and groundwater from agro-chemicals and from industry poses a major environmental health peril, with potentially significant costs to the country. All these need to be tackled holistically, hence based on parameters like pH, electrical conductivity and TDS, a sensor muster is explored along with several micro systems for analog signal conditioning, processing, logging and if the threshold values are crossed the vital data is transmitted to the authentic source via GSM. In this paper primarily interfacing of pH meter to embedded PLC is proposed.

II. LITERATURE SURVEY

Water resources have been the most exploited natural system, since man strode the earth. As a result of increasing industrialization, urbanization, civilization and other developmental activities, our natural water system is being polluted by different origins. The pollutants coming as a waste to the water bodies are likely to create nuisance by way of physical appearance, odour, taste, quality and render the water harmful for utility. So there is an urgent need for the rapid supervision of the quality of water resources.

Theofanis P. Lambrou has proposed a Low-Cost Sensor Network for Real-Time Monitoring and Contamination Detection in Drinking Water Distribution Systems. They performed experiments to evaluate and validate on intentional and accidental contamination events of various con -centrations of escherichia coli bacteria and heavy metals (arsenic). Water distribution pipeline itself is mounted here with sensors. They have come forward with different algorithms like the fusion and event detection algorithm[1].Sensor array is deployed for measurement of different parameters like dissolved oxygen, turbidity, electrical conductivity, pH, temperature etc.

Pornjit Pratumsuwan et.al has presented development of embedded PLC for teaching the subject Mechatronics to students with use of ARM7 and LABVIEW software. They have used the functional block diagram for control of embedded PLC because the LabVIEW Embedded Module for ARM Microcontrollers is a comprehensive graphical development environment for embedded design. This module seamlessly desegregate the LabVIEW graphical development environment and ARM microcontroller.[2].

Joseph E. Angello et.al has explored Rapid Adaptive Needs Assessment Kit for Water Quality Monitoring in Humanitarian Assistance & Disaster Response Applications. They have made remarkable contribution in making the RANA kit which is small in size, inexpensive and robust and is useful in detecting clean and clear water in areas suffering from natural calamities, war breakouts and epidemics. In the 72 hours immediately after a disaster, long-term water supply systems are not syndicate, so soldiers rely on costly imported bottled water. Their work outlines the approach used to enhance the kit and describes the physical design, anchoring system, data communications system, decision algorithm, user interfaces, continuance, and integration of parts into a portable, remote water monitoring system[3].

III. PROPOSED METHODOLOGY

A. Hardware Design:

The hardware components used here are ARMcortex M3, GSM module sim 900,pH sensor,MAX232,USB to serial converter, total dissolved solid sensor, power supply, simcard holder and the amplifier circuit.Fig.1 shows block diagram of embedded PLC and Fig.2 shows the pH meter.

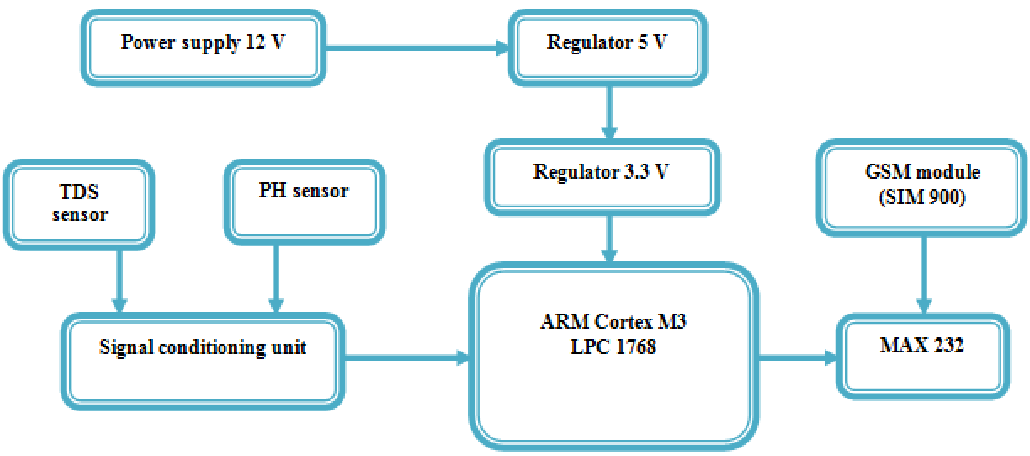

Fig. 1: Block Diagram

pH is an important parameter to be measured and controlled. The pH of a solution indicates how acidic or basic (alkaline) it is. The pH term translates the values of the hydrogen ion concentration- which ordinarily ranges between about 1 and 10 x -14 gram-equivalents per litre - into numbers between 0 and 14.On the pH scale a very acidic solution has a low pH value such as 0, 1, or 2 (which dovetails to a large concentration of hydrogen ions; 10 x 0,10 x -1, or 10 x -2 gram-equivalents per litre) while a very basic solution has a high pH value, such as 12, 13, or 14 which concur to a small number of hydrogen ions (10 x -12, 10 x -13, or10x-14gram-equivalentsperlitre).A neutral solution such as water has a pH of approximately 7.

The Danish biochemist Soren Sorensen invented the pH scale in 1909. Modern pH meters also have a thermistor temperature probe which allows for automatic temperature correction, since pH varies with temperature. When used frequently, it is better to keep the electrode moist, since moisturizing a dry electrode takes a long time, accompanied by signal drift. Modern pH meters do not mind their electrodes drying out provided they have been rinsed thoroughly in tap water or potassium chloride.

When on expedition, measuring sea water, the pH meter can be left moist with sea water. But for prolonged periods, it is recommended to moist it with a solution of potassium chloride at pH=4 or in the pH=4.01 acidic calibration buffer.pH meters contain microprocessors that make the necessary corrections for temperature and calibration. Modern pH meters still suffer from drift (slow changes), which makes it necessary to calibrate them frequently. pH sensor shown in fig.2.

Fig. 2: pH Meter

Hardware design technical aspects are stated in the following table 1. When the pH values drops below 6 and raises above 8 the SMS from GSM module is fired to an authentic agent.GSM module is shown in figure 3.

Fig. 3: GSM Module

TDS represents the total concentration of dissolved substances in water. TDS is made up of inorganic salts, as well as a small amount of organic matter. Common inorganic salts that can be found in water include calcium, magnesium, potassium and sodium, which are all cations, and carbonates, nitrates, bicarbonates, chlorides and sulphates, which are all anions. Cations are positively charged ions and anions are negatively charged ions. These minerals can originate from a number of sources, both natural and as a result of human activities. Mineral springs contain water with high levels of dissolved solids, because the water has flowed through a region where the rocks have a high salt content.

These minerals can also come from human activities. Agricultural and urban runoff can carry excess minerals into water sources, as can wastewater discharges, industrial wastewater and salt that is used to de-ice roads.

Water treatment facilities can use reverse osmosis to remove the dissolved solids in the water that are responsible for elevated TDS levels. Reverse osmosis removes virtually all dissolved substances, including many harmful minerals, such as salt and lead. It also removes healthy minerals, such as calcium and magnesium, and ideally such water should be filtered through a magnesium and calcium mineral bed to add the minerals to the water. The mineral bed also increases the pH and decreases the corrosive potential of the water.

It is important to monitor the TDS level and the pH of drinking water for several reasons. When a water source has a high level of TDS or a low pH, it is likely that there are other harmful contaminants in the water.

Fig. 4: TDS Meter with Case

Both TDS and pH are measured and if something absurd is happening to water, such as pollution, chances are both TDS and pH levels will change so keeping track of those changes can act as an early warning signal that something is happening to the water. For these reasons, it is important to monitor the TDS and pH levels, so that if they change, action can be taken immediately.

Highly efficient and accurate due to its advanced microprocessor technology. Hold Function: saves measurements for convenient reading and recording. Auto-off function: the meter shuts off automatically after 10 minutes of non-use to conserve batteries. Built-in digital thermometer. Display: large and easy-to-read LCD screen. Factory Calibrated: The EC-3 has been factory calibrated to a 1413 μS KCl solution. Meters can be recalibrated with a mini-screwdriver.TDS meter shown in Fig.4.For potable water which is excellent in taste has TDS as 65 ppm (parts per million) which is measured practically.

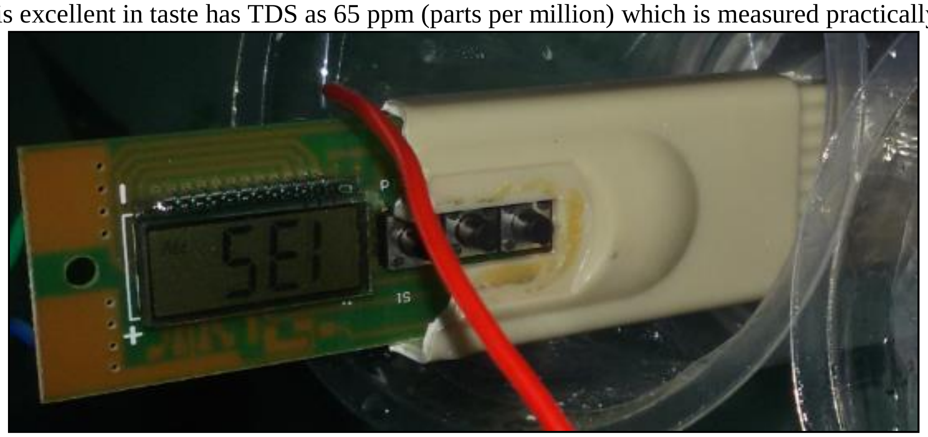
Fig. 5: TDS Meter without Case

B. Software Design:

KeilµVision4 software is used for programming. Eagle-eye software is used to design layout of PCB. Terminal for debugging of traces. Flash magic to burn the code. For Flash magic code is downloaded in the controller with baud rate 9600. Terminal is used to test AT commands to communicate with GSM module. Embedded C language is used to code in C.IDEs like Eclipse or Microsoft visual studio can also be used.

Table - 1
Hardware Design Technical data

Component	*Specification*
ARM cortex M3	**LPC1768* **On chip 512KB Flash.* **GPDMA on the AHB multilayer matrix that can be used with SSP, I2S-bus, UART, ADC and DAC peripherals, timer match signals, and for memory-to-memory transfers.*
pH sensor	**3 in 1 multifunctional moisture, pH and light meter.* **Probe length: 21cm.* **pH measure range 3.3 to 8.* **Soil moisture in the range 1 to 10*

GSM Module	**Sim 900 standard serial RS232 interface.* **Onboard 3V Lithium Battery holder for internal RTC.* **GSM based Voice communications, Data/Fax, SMS, GPRS and TCP/IP via AT commands.* ** Baud rate 1200 to 115200 bps (9600 default).* ** Low power consumption of 0.25A during normal operations and 1A during transmission*
OPAMP	**LM358*
Regulator ICs	**7805 and LD33V*
TDS meter	**EC Range: 0 - 9990 µS (µS/cm)* **Temp. Range: 0 – 80 degrees Celsius* **Accuracy: +/- 2%* **ATC: Built-in sensor for Automatic Temperature Compensation of 1 to 50o C(33 to 122o F)* **Power source: 2 x 1.5V button cell batteries(included) (LR44 or equivalent)* *Weight with case: 76.5g*

The graph for pH & TDS values is displayed in Figure 6. Matlab is used to show the graph with real time values. The system uses low-cost sensors and open-source hardware to deliver continuous measurement of water quality at substantially reduced cost. Preliminary results demonstrate that with appropriate calibration and signal processing, the prototype can maintain accurate results over an extended period of time. Thus the prototype is suitable for field deployment to provide continuous long term water quality measurement.

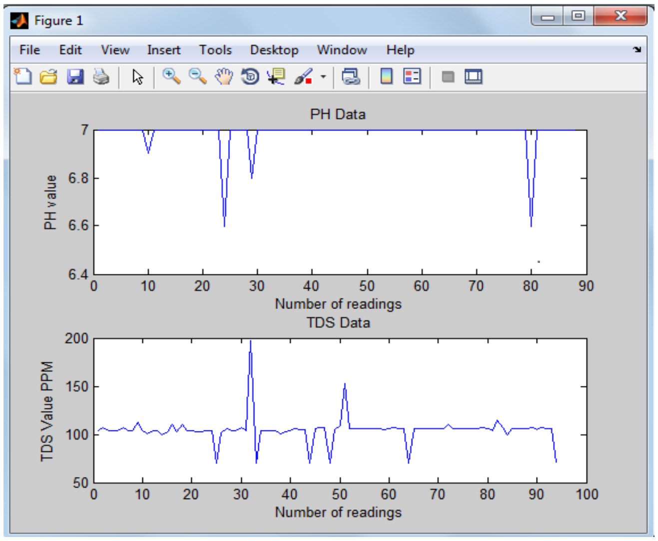

Fig. 6: Graph for pH & TDS Real Time Values

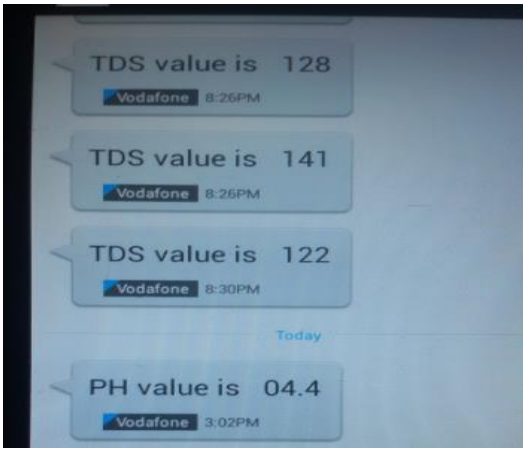

Fig. 7: SMS from GSM When Threshold Exceeded

IV. CONCLUSION

Thus embedded technology is changing the face of mankind and bringing dreams to reality just by a module on board. We have got awareness about the quality of water can be improved we can save water from getting contaminated and protect mankind from serious water borne diseases. We have obtained a detailed study of embedded PLC and its pros and cones. Addition of extra hardware like camera, LCD, SD card, Ethernet, LAN with many allied techniques we can widen its area of application.Fig.7 shows the results via SMS when threshold values are exceeded.

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