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IOT based Real Time Water Quality Measurement

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ABSTRACT

Water is essential to human life and health of the environment. In order to improve the water quality for safe supply and to reduce water pollution, water quality monitoring is must. In this paper we present a design and development of a low cost system for water monitoring in real time in IOT (Internet of Things) environment. The system consists of a several quality measurement sensors which are used to measure the physical and chemical properties of the water. Different parameters such as temperature, pH, light and dissolved oxygen can be measured. The core controller processes the in situ measured values from the different sensors. ARM7 LPC 2148 is used as the core controller. Finally, the sensor data can be monitored on Internet anytime and from anywhere using cloud computing.

Keywords- Cloud Computing, Core Controller, Internet of Things, Sensors, Water Quality Monitoring.

I. INTRODUCTION

Water is essential for every living being on earth. Especially it is a critical resource for humans for various purposes which include drinking water, agriculture, industrial processes, production of edible fish, shell fish, production of aquatic ecosystems etc. Especially in real time the drinking water utilities are facing new challenges limited water resources, increase of population, globalization, industrial wastes, ageing infrastructure, increasingly stringent regulations and increasing attention towards safe guarding water supplies from accidental or deliberate contamination. Hence there is a need of better methodologies for water quality monitoring in real time.

Traditional methods of water quality measurement involves the collecting of water samples and then sending them to lab to characterize the water quality by different laboratory analytical techniques. These approaches are more time consuming and are not efficient in the present scenario [1], [2], [3], [4], [5]. These measure various chemical and biological parameters but have several drawbacks: (a) the lack of real time information of water quality (b) poor spatiotemporal coverage (c) requires more labour and has relatively high costs. So there is a necessity for online continuous water quality monitoring. The chemical and biological contaminants used have an effect on various water parameters which include temperature, pH, conductivity, turbidity. So these are measured at the in situ for real time measurement of water quality.

IOT based water quality measurement systems were proposed. The online water monitoring technologies have made a significant progress for source water surveillance and water plant operation. A large number of online

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reagent free water monitoring systems are commercially available but these systems are bulky and remain cost prohibitive for large scale deployments.

By focusing on the above problems in this paper we presented a low cost system I IOT environment for real time water quality measurement. In the proposed system ARM7 LPC2148 is used as core controller. In this a Wi-Fi module is used to access the sensor data to the cloud from core controller. A special IP address is used to view the sensor data on the cloud.

The rest of this paper is organized as follows: In section 2, shows the relation with IOT. In section 3 shows the bock diagram of the proposed system and its corresponding theory. In section 4 shows theexperiment done and its corresponding results are presented. In section 5 shows the conclusion of our proposed system.

II. THE RELATION WITH IOT

The internet has changed the human lives in the past decade. The IOT becomes a foundation and a paradigm for connecting things, sensors and other smart technologies [6]. IOT is an extension of the internet of things [7]. The main objective of IOT is immediate access to information about physical objects especially in everyday life that are readable, recognisable, locatable, addressable and/or controllable via the internet irrespective of the communication means. There are several important technologies related to IOT are LAN, wide area networks, RFID (radio frequency identification), WSN (wireless sensor network) technologies, ubiquitous computing, ZigBee, cloud computing.

Cloud computing started with a risk free concept. An environment used for construction, deployment, and management of applications is called PaaS (Platform as a Service). It is a large scale, low cost processing unit. An IP address is used for establishing the connection, Calculation and storage. The characteristics of the cloud computing has been discussed in [8], [9], [10], [11]. The IOT application areas include home automation, smart city implementation, patient health monitoring, smart agriculture, environment monitoring, water quality monitoring etc. The water quality monitoring application involves large distributed array of sensors for monitoring and a large distribution network [12], [13]. It also requires separate monitoring algorithms as reviewed in [14]. In our proposed system we used things speak for viewing sensor values on the internet. The rest of this paper is organized as follows.

III. METHODOLOGY

In this section the theory on real time water quality monitoring in IOT environment is presented. In section 3 A, the block diagram of the designed system is explained. In section B, the complete details are explained.

3.1 Block Diagram

The block diagram of the proposed system is shown in the Fig1. below.

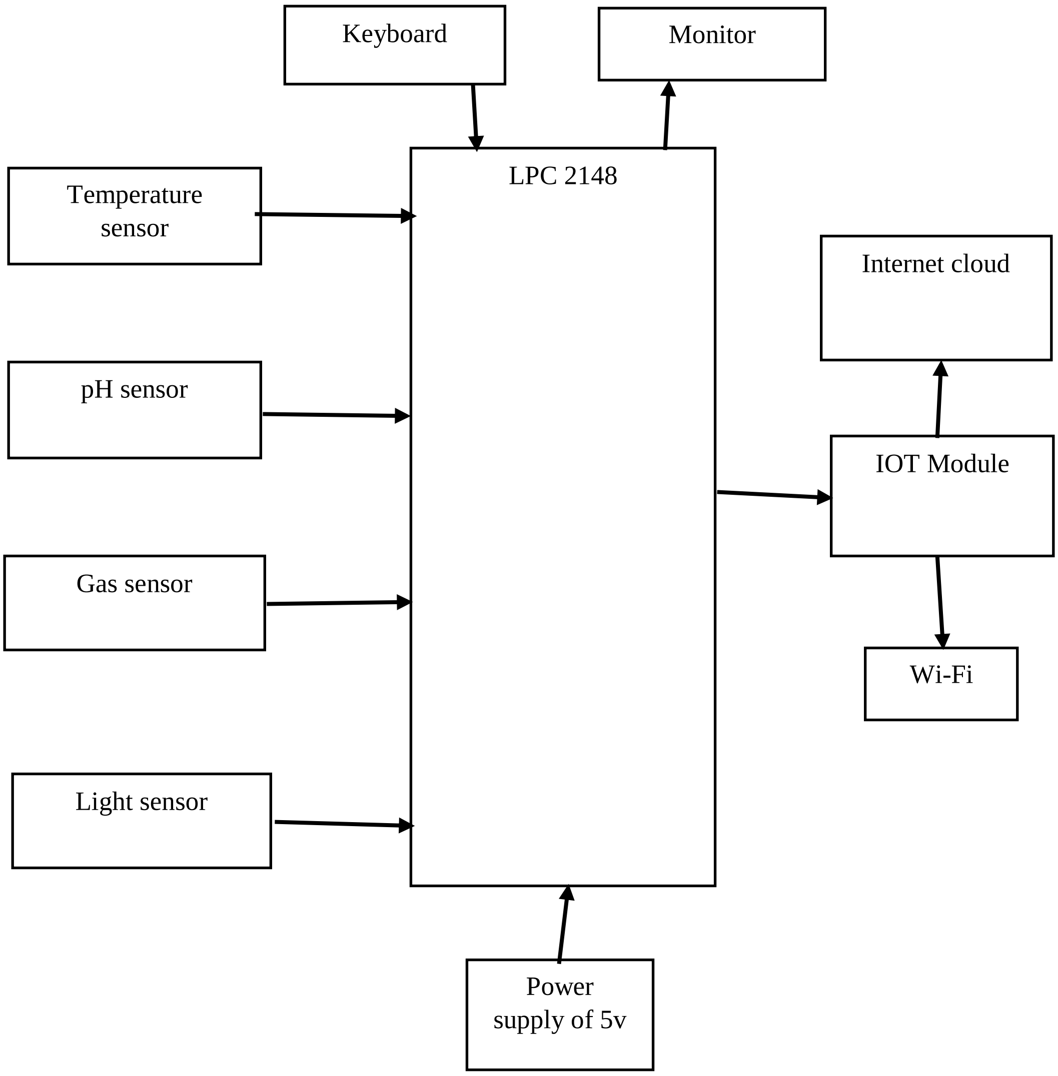

Figure 1 Block Diagram

The proposed block diagram consists of several sensors like temperature sensor, pH sensor, gas sensor and light dependent resistor (LDR) which are connected to the core controller. The sensor values are accessed by the core controller and then sends the data through internet using ESP 8266 Wi-Fi module. The sensor data can be viewed on the internet using Thinks speak with the creation of an account with a specified IP address.

3.2. Proposed System

In our proposed method, ARM7 LPC 2148 is used as core controller. Keil µVision 4.0software is used as embedded software. Flash magic is used to debug the program into the core controller.

3.2.1 Software Implementation

In this system two software packages are deployed for software implementation. First one Keil µVision 4.0 and the second one is Flash magic. The Keil µVision Debugger accurately simulates on-chip peripherals (I²C, CAN, UART, SPI, Interrupts, I/O Ports, A/D Converter, D/A Converter, and PWM Modules) of ARM7device. Flash magic is used to dump the code to microcontroller from PC. Flash Magic is a free, powerful, feature-rich Windows application that allows easy programming of Philips FLASH Microcontrollers.

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Simulation helps to understand hardware configurations and avoids time wasted on setup problems. With simulation, we can write and test applications before target hardware is available. The system program written in embedded C using KEIL IDE software will be stored in Microcontroller.

The Flash Memory In-System Programmer is a tool that runs under Windows 95/98/NT4/2K. It allows in-circuit programming of FLASH memories via a serial RS232 link. Computer side software called Flash Magic is executed that accepts the Intel HEX format file generated from compiler Keil to be sent to target microcontroller. It detects the hardware connected to the serial port.

3.2.2 Hardware Implementation

3.2.2.1 ARM7 LPC 2148

The LPC2148 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine microcontroller with embedded high speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate.

3.2.2.2 Temperature sensor (LM 35)

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages.

3.2.2.3 pH meter

A pH Meteris a scientific instrument that measures the hydrogen-ion concentration in water-based solutions, indicatingits acidity or alkalinity expressed as pH. The pH meter measures the distinction in electrical potential between a pH electrode and a reference electrode, and so the pH meter is sometimes referred to as a "potentiometric pH meter". The difference in electrical potential relates to pH of the solution. The pH meter is employed in several applications starting from laboratory experimentation to internal quality control.

3.2.2.4 Gas sensor(MQ2)

This Grove - Gas Sensor (MQ2) [10] module is useful for gas leakage detection in home and industry. It can detect H2, LPG, CH4, CO, Alcohol, Smoke, and Propane. Based on its fast response time measurements can be taken as soon as possible. Also the sensitivity can be adjusted by the potentiometer. When the target combustible gas exist, the sensor's conductivity is higher along with the gas concentration rising.

3.2.2.5 Light sensor (LDR)

LDR sensor module is used to detect the intensity of light. It is associated with both analog output pin and digital output pin labelled as AO and DO respectively on the board. When there is light, the resistance of LDR

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will become low according to the intensity of light. The greater the intensity of light, the lower the resistance of LDR [5]. The sensor has a potentiometer knob that can be adjusted to change the sensitivity of LDR towards light. LDR's are less sensitive than photo diodes. It operates at DC 3.3V to 5V.

3.2.2.6 ESP8266

ESP8266 is an UART to Wi-Fi module, a really cheap and easy way to connect any small microcontroller platform having network connectivity is good for any computing system. And add to a system utility we can fetch any data from www. We can push data to cloud for storage, computation or monitoring. We need an external hardware that convert Wi-Fi data into data format that understood by common microcontroller like UAT, SPI, and I2C.

IV. EXPERIMENTS AND RESULTS

The water quality monitoring is important for many applications such as safe drinking water supply, environmental monitoring of water resources, contamination detection in water resources etc. Such applications need a separate technique for water quality monitoring. In our proposed system the water measured water quality parameters are viewed through online using Things speak by using cloud computing. The water quality parameters are stored on the web server on the cloud. These parameters can be viewed by using a separate IP address. The following figures shows the results from the web server on the intern

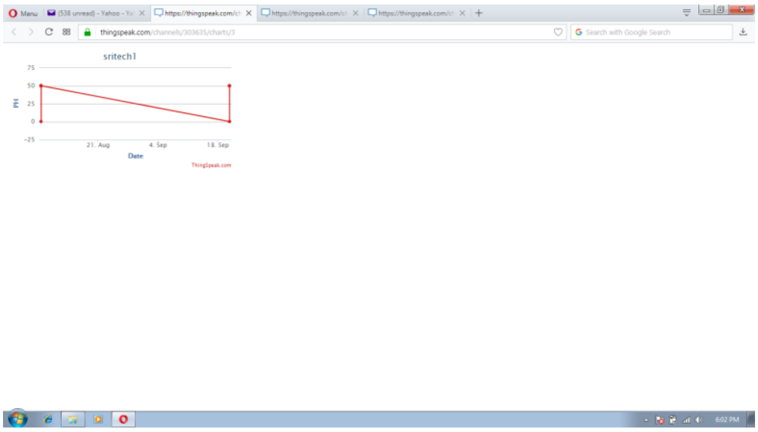

Fig 2: pH measurement of WQM

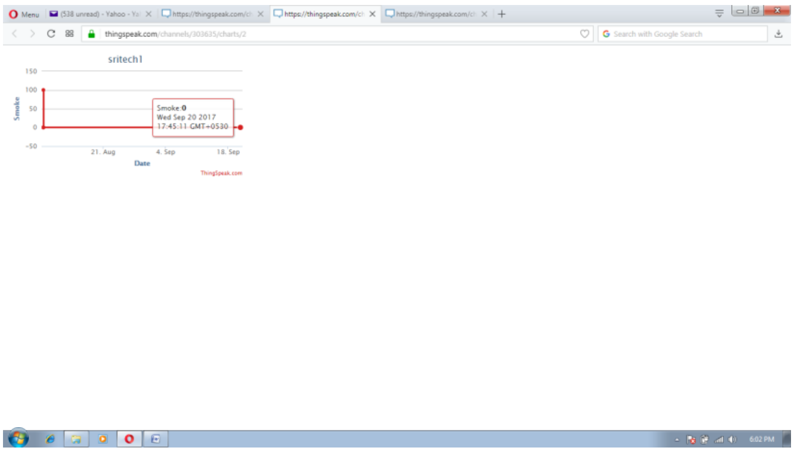

Fig 3: Smoke measurement of WQM

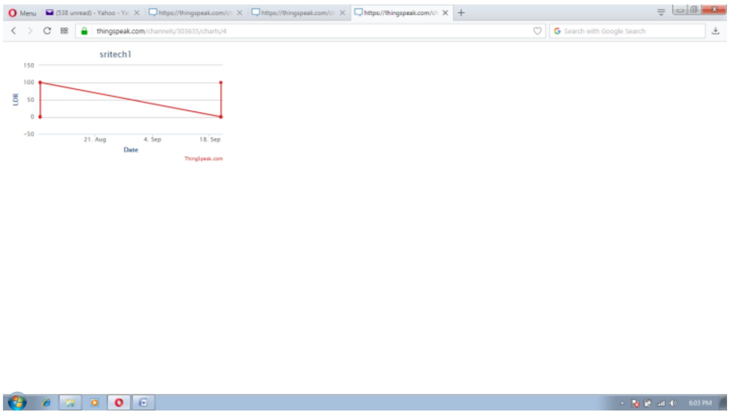

Fig 4: Light Measurement of WQM

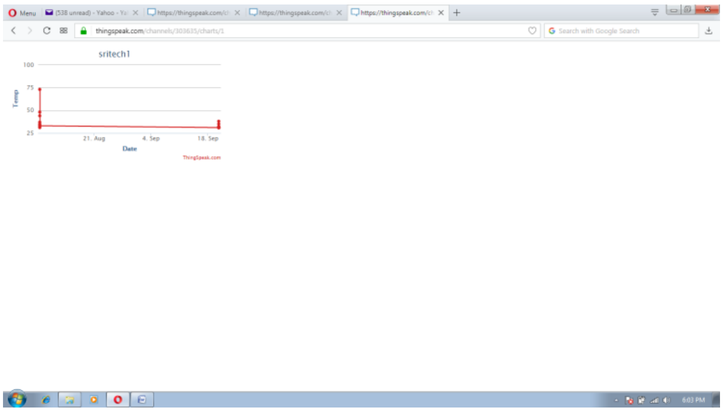

Fig 5: Temperature Measurement of WQM

V. CONCLUSION

In this paper, the design and development of the real time water quality parameters are monitored in IOT environment is presented. The proposed system consists of LPC 2148 core controller, several water quality monitoring sensors and an IOT module (ESP8266). These devices are low cost, more efficient and capable of processing, analysing, sending and viewing the data on cloud. This implementation can be used for environmental monitoring, eco system monitoring, aqua culture etc. and data can be viewed from anywhere in the world. In the future, we can implement biological parameters of the water and install the system in water distribution networks to collect and monitor water quality.

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