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WATER DEFENDER USING IOT

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***Abstract*— Since the effective and efficient system of water quality monitoring (WQM) are critical implementation for the issue of polluted water globally, with increasing in the development of Wireless Sensor Network (WSN) technology in the Internet of Things (IoT) environment, real time water quality monitoring is remotely monitored by means of real-time data acquisition, transmission and processing. This paper presents a reconfigurable smart sensor interface device for water quality monitoring system in an IoT environment.. The smart WQM system consists of Field Programmable Gate Array (FPGA) design board, sensors, Zigbee based wireless communication module and personal computer (PC). The FPGA board is the core component of the proposed system and it is programmed in very high speed integrated circuit hardware description language (VHDL) and C programming language using Quartus II software The proposed WQM system collects the five parameters of water data such as water pH, water level, turbidity, carbon dioxide (CO2) on the surface of water and water temperature in parallel and in real time basis with high speed from multiple different sensor nodes.**

***Index Terms*—Wireless sensor networks, Monitoring, Wireless communication, arrays, Temperature, Temperature measurement, Software**

I. INTRODUCTION

The Wireless Sensor Network (WSN) [1] and wireless communication technologies have been increasingly developed for assisting human's personal and professional daily tasks. The applications of wireless technologies have been developed for the data acquisition, building control, environmental monitoring systems and automation of manufacturing processes in recent years. Today's state-of-the-art WSNs have more advantages such as low costs for both installation and maintenance, and longer operating time. The remote sensor network can be used for stationary or mobile sensor networks. The remote sensor network is commonly used for different purposes such as surveying the development of city infrastructure, environmental monitoring, telemedicine or remote health care, research in agriculture, fishing surveillance, farming, border security, traffic management, forestry management, and disaster prevention [2]. A WSN consists of compactly dispersed sensor nodes for sensing, signal processing, embedded computing, and connectivity [3]. This system enables the interaction between persons or computers and the surrounding environment through wireless link [4]. Although the WSNs were used in military and heavy industrial applications originally, today's WSN applications are used for different purposes from the light industrial to heavy industrial systems. The WSN system allows users to monitor and control the connected devices from the base station through different wireless communication standards such as WiFi, General Packet Radio Service (GPRS), Bluetooth, Zigbee, Radio Frequency Identification (RFID), and cellular technologies [5]. The users can monitor the data through a wireless network which can be designed based on one of those wireless communication standards. The advantages of WSN are low power consumption, redundant data acquisition, remote monitoring, fast network establishment, wide coverage area, and high monitoring precision and low duty cycle. Thus, the WSN to the real world is practically unlimited from physical security, environmental monitoring and climate changes, positioning and tracking and health care to logistic, localization, and so on [6]. The Internet of Things (IoT) was developed in parallel to WSNs and is a physical network which connects all things in order to exchange the data and information through the data sensing devices such as sensors, actuators and computers in line with relevant protocols. In other word, many things are connected into networks in one form or another. The aims of intelligent, identifying, monitoring, locating, tracking and controlling things are achieved by IoTs [7].

II. BACKGROUND

Ensuring the safety of water is a challenge due the excessive sources of pollutants, most of which are man-made. The main causes for water quality problems are overexploitation of natural resources. The rapid pace of industrialization and greater emphasis on agricultural growth combined with latest advancements, agricultural fertilizers and non-enforcement of laws have led to water pollution to a large extent. The problem is sometimes aggravated due to the non-uniform distribution of rainfall. Individual practices also play an important role in determining the quality of water.

Water quality is affected by both point and non-point sources of pollution, which include sewage discharge, discharge from industries, run-off from agricultural fields and urban run-off. Other sources of water contamination include floods and droughts and due to lack of awareness and education among users. The need for user involvement in maintaining water quality and looking at other aspects like hygiene, environment sanitation, storage and disposal are critical elements to maintain the quality of water resources.

Poor water quality spreads disease, causes death and hampers socio-economic progress. Around 5 million people die due to waterborne diseases around the world. Fertilizers and pesticides used by farmers can be washed through the soil by rain, to end up in rivers. Industrial waste products are also washed into rivers and lakes. Such contaminations enter the food chain and accumulate until they reach toxic levels, eventually killing birds, fish and mammals. Chemical factories also dispose wastes in the water. Factories use water from rivers to power machinery or to cool down machinery. Raising the temperatureof the water lowers the level of dissolved oxygen and upsets the balance of life in the water. All the above factors make water quality monitoring essential.

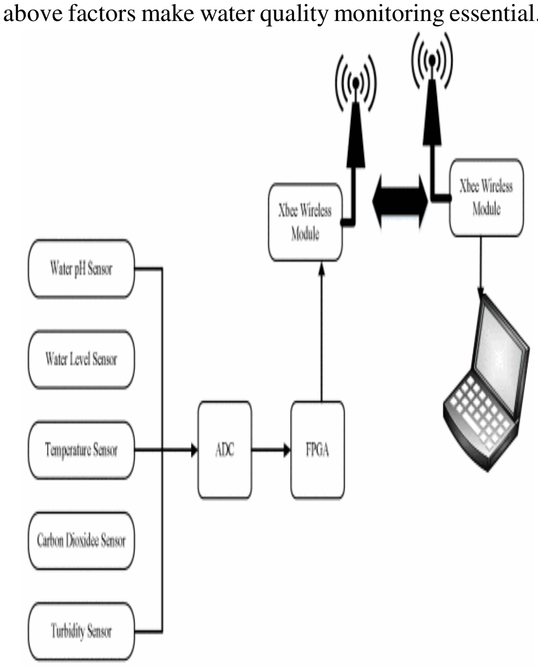

Figure: 1 the block diagram of smart water quality monitoring system

Water quality monitoring is defined as the collection of information at set locations and at regular intervals in order to provide data which may be used to define current conditions, establish trends, etc. Main objectives of online water quality monitoring include measurement of critical water quality parameters such as microbial, physical and chemical properties, to identify deviations in parameters and provide early warning identification of hazards. Also, the monitoring system provides real time analysis of data collected and suggest suitable remedial measures.

A. *Ultrasonic Sensor*

In the proposed smart WQM system, the ultrasonic sensor (LV-MaxSonar-EZ1) is chosen to monitor the water level. This ultrasonic sensor is operated by emitting high-frequency sonic wave at regular time interval starting from the front of the transducer. The sonic waves are reflected by an object and received back in the transducer. The time interval between emitting and receiving sound waves is proportional to the distance between the transducer and the object can be calculated. As the ultrasonic sensor is using sound wave instead of light wave, it is more suitable for sensing uneven surface such as water surface. According to its datasheet, the ultrasonic sensor detects objects from 0-inches to 254-inches (6.45-meters) and provides sonar range information from 6-inches out to 254-inches with l-Inch resolution.

B. *PH Sensor*

In the proposed smart WQM system, the Atlas scientific pH kit is used to detect the pH value of water. The pH kit consists of three main components: EZO TM class embedded pH circuit, BNC shield, and pH probe. In the process of collecting water pH data, the pH probe is connected to BNC shield. The BNC shield transfers the pH probe sensing data to the embedded pH circuit, and the resulted pH data is then provided to the FPGA board. The embedded pH circuit can be operated in two modes. The pH data is converted into binary by the embedded pH such as UART mode and I2C mode. In this proposed smart WQM system, the UART mode is used for its default mode with baud rate of 9600 bps, 8 data bits, 1 stop bit, no parity and no flow control.

C. *Digital Thermometer Sensor*

In the proposed smart WQM system, the temperature of the water is monitored using a l-wire protocol digital thermometer sensor (DS18B20). The DS18B20 temperature sensor provides 9-bit to 12-bit Celsius degree temperature measurements. The DS18B20 is powered from the data line. The range of power supply 3.0V to 5.5V from data line is needed to power the DS18B20.

III. PROPOSED SYSTEM:

In this, we present the theory on real time monitoring of water quality in IoT environment. The overall block diagram of the proposed method is explained. Each and every block of the system is explained in detail.

In this proposed block diagram consist of several sensors (temperature, pH, turbidity, flow) is connected to core controller. The core controller are accessing the sensor values and processing them to transfer the data through internet. Ardunio is used as a core controller. The sensor data can be viewed on the internet Wi-Fi system.

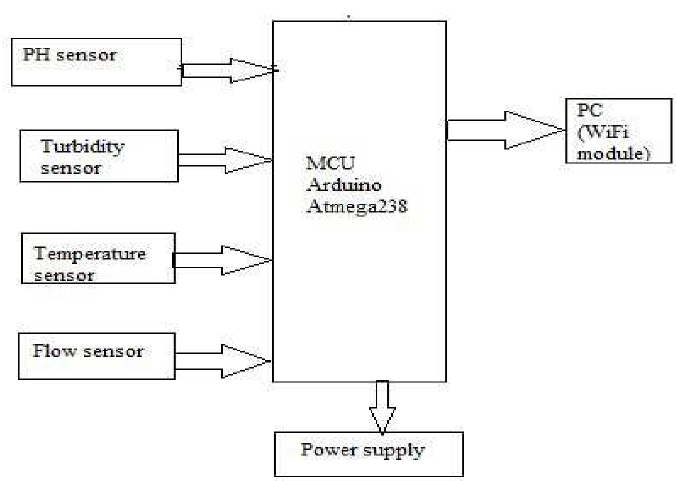

Fig: 2 Block diagram of our project

PH sensor: The pH of a solution is the measure of the acidity or alkalinity of that solution. The pH scale is a logarithmic scale whose range is from 0-14 with a neutral point being 7. Values above 7 indicate a basic or alkaline solution and values below 7 would indicate an acidic solution.

It operates on 5V power supply and it is easy to interface with arduino.The normal range of pH is 6 to 8.5.

Turbidity sensor: Turbidity is a measure of the cloudiness of water. Turbidity has indicated the degree at which the water loses its transparency. It is considered as a good measure of the quality of water. Turbidity blocks out the light needed by submerged aquatic vegetation. It also can raise surface water temperatures above normal because suspended particles near the surface facilitate the absorption of heat from sunlight.

Temperature sensor: Water Temperature indicates how water is hot or cold. The range of DS18B20 temperature sensor is -55 to +125 °C. This temperature sensor is digital type which gives accurate reading.

Flow sensor: Flow sensor is used to measure the flow of water through the flow sensor. This sensor basically consists of a plastic valve body, a rotor and a Hall Effect sensor. The pinwheel rotor rotates when water / liquid flows through the valve and its speed will be directly proportional to the flow rate. The Hall Effect sensor will provide an electrical pulse with every revolution of the pinwheel rotor.

IV. WIFI MODULE

The ESP8266 WiFi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware. The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

V. SCHEMATIC CIRCUIT WITH ITS WORKING

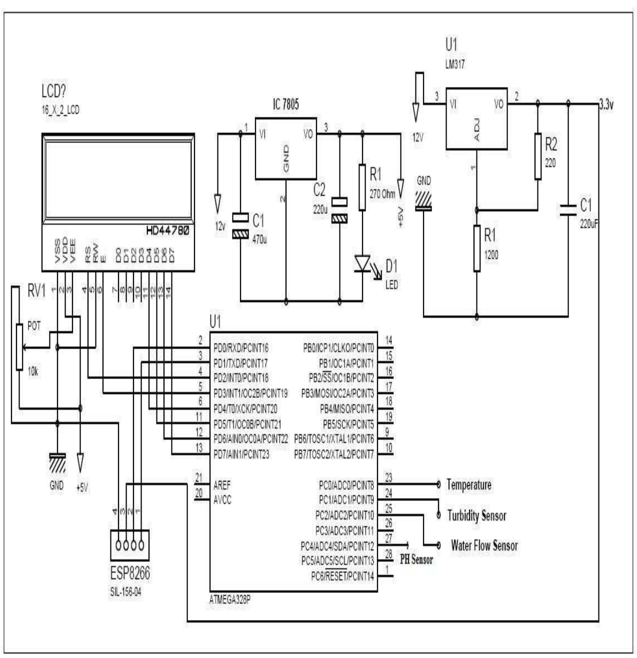

Fig: 3 schematic circuit

The whole design of the system is based mainly on IOT which is newly introduced concept in the world of development. There is basically two parts included, the first one is hardware & second one is software. The hardware part has sensors which help to measure the real time values, another one is arduino atmega328 converts the analog values to digital one, & LCD shows the displays output from sensors, Wi-Fi module gives the connection between hardware and software. In software we developed a program based on embedded c language.

A. Results and Discussion

In the smart WQM system, when the sensor board is switched on, the sensors are activated to detect the individual water parameter data. Then, the collected water parameters are transmitted wirelessly to monitoring device which is The readings of water temperature vary according to the increasing and decreasing of the water temperature by using warm water and ice water. The range of the value is displayed for the monitoring of pH, temperature, turbidity, carbon dioxide and level of water. The data is being monitored continuously and displayed in real time since the default of the system is set in continuous mode. The proposed smart WQM system reduces power consumption, which outperforms the performance of the conventional microcontrollers-based WSN.

VI. CONCLUSION

The proposed smart WQM system of single chip solution to interface transducers to sensor network using FPGA is presented with wireless method module. The results of the five parameters of water quality are verified that the system achieved the reliability and feasibility of using it for the actual monitoring purposes. The proposed system will assist in protecting the ecological environment of water resources. The smart WQM system minimizes the time and costs in detecting water quality of a reservoir as part of the environmental management. The time interval of monitoring can be changed depending on the need. By introducing the FPGA board, the proposed system inherits high execution speed and reusable Intellectual Property (IP) design. The WSN network will be developed in the future comprising of more number of nodes to extend the coverage range.

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