IOT BASED WATER QUALITY MONITORING SYSTEM

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Abstract— To ensure the safe supply of drinking water the quality should be monitored in real time for that purpose new approach IOT (Internet of Things) based water quality monitoring has been proposed. In this paper, we present the design of IOT based water quality monitoring system that monitor the quality of water in real time. This system consists some sensors which measure the water quality parameter such as pH, turbidity, conductivity, dissolved oxygen, temperature. The measured values from the sensors are processed by microcontroller and this processed values are transmitted remotely to the core controller that is raspberry pi using Zigbee protocol. Finally, sensors data can view on internet browser application using cloud computing.

Keywords— Water Quality Monitoring, IOT, Zigbee, Cloud Computing.

I. INTRODUCTION

Over the past decade, online water quality monitoring has been widely used in many countries known to have serious issues related to environmental pollution [2]. The water is limited and essential resource for industry, agriculture, and all the creatures existing on the earth including human being. Any imbalance in water quality would severely affect the health of the humans, animals and also affect the ecological balance among species [5]. In the 21st century there were lots of inventions, but at that time were pollutions, global warming and so on are also being formed, because of this there is no safe drinking water for the world's population [1]. The drinking water is more precious and valuable for all the human beings so the quality of water should be monitored in real time. Nowadays water quality monitoring in real time faces challenges because of global warming, limited water resources, growing population, etc. Hence, there is a need of developing better methodologies to monitor the water quality parameters in real time.

The WHO (world health organization) estimated, in India among 77 million people is suffering due to not having safe water. WHO also estimates that 21% of diseases are related to unsafe water in India. Also, more than 1600 deaths alone cause due to diarrhea in India daily. Therefore, various water quality parameters such as dissolved oxygen (DO), conductivity, pH, turbidity and temperature should be monitored in real time.

The water quality parameter pH show water is acidic or basic. Pure water has 7 pH value, less than 7 values indicate acidity and more than 7 indicate alkalinity. The normal range of pH is 6 to 8.5. In drinking water if the normal range of pH doesn't maintain it causes the irritation to the eyes, skin and mucous membranes. Also, it causes the skin disorders. The dissolved oxygen (DO) is indicated the oxygen that dissolved in water. It makes the drinking water taste better. The conductivity indicates the ability of water to pass an electrical current. In water it is affected by various dissolved solids such as chloride, nitrate, sulfate, sodium, calcium, etc. Turbidity has indicated the degree at which the water loses its transparency. It is considered as a good measure of the quality of water. Water temperature, indicates how water is hot or cold.

The deterioration of water resources becomes a common human problem [3]. The traditional methods of water quality monitor involve the manual collection of water sample from different locations. These water samples tested in the laboratory using the analytical technologies. Such approaches are time consuming and no longer to be considered efficient. Moreover, the current methodologies include analysis of various kinds of parameters of water quality such as physical and chemical. Traditional methods of the water quality detection have the disadvantages like complicated methodology, long waiting time for results, low measurement precision and high cost [4]. Therefore, there is a need for continuous monitoring of water quality parameters in real time.

By focusing the above issues, we have to develop and design a low cost water quality monitoring system that can monitor water quality in real time using IOT environment. In our proposed system water quality parameters are measured by the different water quality monitoring sensors such as pH, turbidity, conductivity, dissolved oxygen and temperature. These sensor-values are processed by the microcontroller and theses processed values are sent to the core controller remotely using Zigbee IEEE 802.15.4 protocol. In the proposed system, IOT module is used to access processed data from the core controller to the cloud. The processed data can be monitored through a browser application using a special IP address. Furthermore, with the help of IOT environment, we can provide facility to access data remotely from all over the world.

The overview of the following sections of this paper is as provided here: Section II provides the Zigbee protocol, Section III provides Internet of Thing, Section IV provides a literature review of existing

systems, Section V provides methodology and section VI provides a conclusion of the proposed system.

II. ZIGBEE PROTOCOL

The ZigBee specifications were introduced in December 2004 and the ZigBee network specification is one of the first standards for ad-hoc and sensor networks [8]. Zigbee is developed by the Zigbee Alliance for personal-area networks (PANs). Zigbee Alliance is an association that promotes the Zigbee standard for a wireless network using low cost, low power consumption and low data rate connectivity devices [6]. The Zigbee is an IEEE 802.15.4 based specification, which defines the Media Access Control (MAC) layer and physical layer for low-rate wireless personal-area network (LR-WPAN) that provide high-level communication for PANs. The Zigbee specification is an open standard that allows manufacturers to develop their own specific application which require low cost and low power. Zigbee adds network structure, routing, and security to complete the communication suite [9]. A ZigBeenetwork, is always created by the coordinator node. The coordinator controls the network and allocates a unique address to each device in the network, regardless of its topology [10]. Zigbee devices use a mesh topology for sending data to the long distance.

There is also another protocol available for wireless data communication such as Wi-Fi and Bluetooth. Zigbee is supposed to do what Wi-Fi or Bluetooth which do not provide both way communication between multiple devices over a simple network using very low power and at very low cost [7]. The following table shows the reason why Zigbee is used instead of former mention wireless technologies.

Table1: Comparison of different Wireless Communication protocol

FEATURES	Zigbee	Bluetooth	Wi Fi
IEEE Standard	IEEE 802.15.4	IEEE 802.15.1	IEEE 802.11.x
Operating Frequency	2.4GIIz	2.4 to 2.485 GHz	2.4GHz, 5GHz
Channel Bandwidth	1MHz	1MHz	0.3, 0.6 or 2MIIz
Network Range	100m	10m	100m
Data transfer speed	250kbps	1mbps	11mbps
Bit Time	4µs	1 µs	0.00185 µs
Power Profile	Months	Days	Hours
Node Density	64,000	7	32
Extensibility	Yes	No	Roaming possible
Complexity	Simple	Complex	Very complex

From the above table, we can say that Zigbee provides low data rate, low power consumption, high node density, large network range and simple networking that makes it suitable for our system compare to other wireless data communication protocol.

III. INTERNET OF THING

In the past decade, all human life changed because of the internet. The internet of things has been heralded as one of the major development to be realized throughout the internet portfolio of technologies [15]. The Internet of Things (IOT) is concerned with interconnecting communicating objects that are installed at different locations that are possibly distant from each other [11]. Internet of Things represents a concept in which, network devices have ability to collect and sense data from the world, and then share that data across the internet where that data can be utilized and processed for various purposes. The internet of things describes a vision where objects become part of internet: where every object is uniquely identified and access to the network [14]. IOT communication is quite different from the traditional human to human communication, bringing a large challenge to existing telecommunication and infrastructure [12]. Furthermore, IOT provides immediate information regarding access to physical objects with high efficiency. The concept of Internet of Things is very much helpful to achieve real time monitoring of sensor data.

Internet of Things (IOT) is a kind of network technology, which is based on information sensing equipments such as RFID, infrared sensors, GPS, laser scanners, gas sensors and so on, can make anything join the Internet to exchange information, according to the protocol, which gives intelligent identification, location and tracking, monitoring and management [13]. In proposing system we introduce cloud computing technique for monitoring sensor values on the internet. Cloud computing provides the access of applications as utilities, over the internet. The cloud computing characteristic and development approaches are explained in [16], [17], [18]. Cloud computing is a large scale processing unit which processes in run time and it is also a very low cost technology based on the IP. The application area of IOT includes building and home automation, smart city project, smart manufacturing of various products, wearables, health care systems and devices, automotive etc.

IV. CASE STUDY OF EXISTING SYSTEMS

In this section of the paper provides a literature review of the existing water quality monitoring system that gives a short explanation of the systems that are as below:

Fiona Regan, Antóin and Audrey [19] designed smart water quality monitoring system. In that system they made water quality smart sensors so the sensors send data wirelessly to the device which collects data from all the nodes. This data is given to the remote server

through GPRS network and user can see data remotely. This system is highly scalable, faster and user friendly, but it is costly because of smart sensors. Furthermore, the size of sensors are not reliable for water tap.

ZulhaniRasin and Mohd Rizal Abdullah [20] developed a water quality monitoring system using Zigbee based wireless sensor network. In proposing system the sensors are connected to a single circuit which is connected to the Zigbee ZMN2405HP module. The receiver side Zigbee is connected to the PC that shows the GUI of the network circuit. In this system the high power Zigbee is used and it can be applied to small area network, also the base station is necessary for data storage.

NazleeniSamihaHaron, MohdKhuzaimi B Mahamad, Izzatdin Abdul Aziz, MazlinaMehat [21] developed a water quality monitoring system for eliminating cost-consuming jobs of manual monitoring. In this system the measured data of water quality monitoring sensors are collected by the data kit which gives data to the data processing unit through GSM modem. In data processing unit the data from different sensors are differentiated and it is continuously compared with the ideal parameters of the sensor value. If the water isn't meeting its quality parameter value the alert signal is there which is connected to the buzzer. This system is not reliable for long distance also it will apply to only single unit of water source.

AN Ning., [22] designed monitoring system for water quality. In this system the water quality sensors collect data, from industrial water and municipal water storage, are gathered at the sub-station at which the data are processed. This processed data are sent to the main station through Ethernet networks running on TCP/IP and from the main station that data is again differentiated and given to the environment department and public department using the internet. This system has increased data accuracy, reliability and efficiency, also it gives effective data management and fully integrated information systems. But the drawback is that it cannot provide real time monitoring of water parameters.

Qiao Tie-Zhu, Song Le [23] designed Online Monitoring System of Water Quality Based on GPRS. The system is used to process the sample and send the relevant data to the monitoring center via the GPRS data transmission. The aim of developing this system is the remote monitoring of water quality parameter and makes it real time and faster than previous system used for water quality monitoring, also to control water quality.

Dong He, Li-Xin Zhang [24] developed The Water Quality Monitoring System Based on WSN. This system based on wireless sensor network that consists of Wireless Water Quality Monitoring Network and Remote Data Center. The wireless sensor network is built on Zigbee network protocol. WSN sample the water quality, and sends the data to the Internet with the help of the GPRS DTU, having built-in TCP/IP protocol used for data transmission. With the help of internet data is collected at a remote data center and analyzed and used for further processing. This system can be a long-term, stable and real-time regional water quality monitor. This system is low cost for small area, but for large area it will become costly.

NazleeniSamiha, [25] designed Remote Water Quality Monitoring System using Wireless Sensors. In proposing system the wireless water quality sensors send data digitally to the data acquisition kit which collects the data transmitted from all sensors. The received digital data is processed by the data acquisition kit and processed data send to the database at which the processed data is compared with the tolerance value of that data. If the water quality parameters cross their threshold value, then the alert message will send using the GSM module, otherwise data keep continuously comparing with its tolerance value. This process is mainly developed for monitoring the water of ponds or lake.

KulkarniAmruta, TurkaneSatish [26] developed Solar Powered Water Quality Monitoring system using wireless Sensor Network. In this system the WSN technology powered using solar panel. The system consists node and base station in which the node collects that receive from the different wireless sensor. The node is connected to the base station through the Zigbee technology that powered by the solar panel. This system is low cost but if the solar panel cannot be charged because of the some environment effect then the system will stop working.

From, all above mention methodology we come to know that every different system consist some limitation though it cannot meet the aim of real-time, low-cost continuous monitoring of water quality parameters. So, to overcome all this limitation, that lead us to be developed and design the new methodology that will low-cost, real-time and user friendly.

V. METHODOLOGY

This section explains the complete block diagram of the proposed system. Also, it presents the detail explanation of each and every block.

The overall block diagram of the proposed system is as shown in figure 1. This proposed block diagram consist number of devices having respective sensors, and the collected data from all devices are gathered at the core controller raspberry pi via Zigbee protocol IEEE 802.15.4.

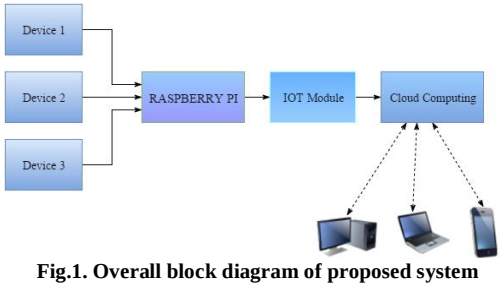

Fig.1. Overall block diagram of proposed system

Tacking close look of the device, which shown in figure 2. The device consist several sensors for measuring water quality parameter such as pH, turbidity, conductivity, dissolved oxygen, temperature. The data of sensors are not in a proper manner for sending them directly to the core controller using Zigbee protocol. So, the microcontroller is introduced in a proposed system for getting data from sensors and processes on them to make compatible for Zigbee module.

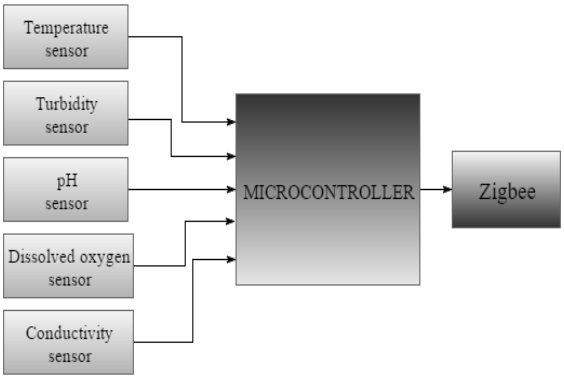

Fig.2. Block diagram of Device

As described in section II Zigbee has low data rate, low power consumption, more node density that makes it suitable for sensor networking in the proposed system. A Zigbee module consists router Zigbee, which located on all devices that transmit the processed data to the coordinator Zigbee, which collects data from devices connected in the same network. The router Zigbee and coordinator Zigbee are connected in same network using a same PAN ID (personnel are network) for all Zigbee devices in the network. The PAN ID provides the personal area network for wireless data communication for sensor networking. Coordinator Zigbee is connected to the core controller, the core controller manages data coming from different devices. The core controller puts the data in a text file which is transmitted to the IOT module. For transmitting data to the IOT, gateway is created on the raspberry pi using FTP (file transfer protocol) protocol. The brief introduction of IOT gateway is discussed in [12]. In the proposed system, for monitor processed data on the internet cloud computing technology is use which provides the personal local server. In cloud computing, separate IP address is provided which make possible to monitor data from anywhere in the world using the internet. To access that monitor data and make system user-friendly browser application is introduced which work on HTTP. So, by using browser application user can access and monitor the data from all over the word.

CONCLUSIONS

Based on a study of existing water quality monitoring system and scenario of water we can say that proposed system is more suitable to monitor water quality parameters in real time. The proposed system introduces wireless sensor networking using several sensors to measure water quality, microcontroller and Zigbee module which make sensor network simple, low cost and more efficiently. Furthermore, to monitor data from all over the word IOT environment is provided using raspberry pi for creating gateway and also, cloud computing technology is used to monitor data on the internet. Moreover, to make system user-friendly web browser application is there. Therefore, the system will be low cost, faster, more efficient, real time and user friendly. Thus, we can fulfill aim and objective of the proposed system.

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