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IMPLEMENTATION OF EMBEDDED SYSTEM FOR DRINKING WATER TESTING BASED ON WSN

HARSHWARDHAN V. KHARPATE[1], T. H. NAGRARE[2]

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1. Asst. Professor, Department of Information Technology, Cummins College of Engineering for women, Nagpur, India

2. Asst. Professor, Department of Information Technology, G. H. Raisoni College of Engineering, Nagpur, India.

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Corresponding Author

Mr. Harshwardhan V. Kharpate[1]

Abstract

It has been observed that most of the diseases that affect the human population mostly rural population nowadays are because of the low quality of water. It is true that providing drinking water of an acceptable quality to such a large population is an enormous challenge. Also the wastewater from an industry is discharged into rivers & lakes which leads to degradation of water quality. Thus Close monitoring of water quality is compulsory, especially since water, supports life & we are lacking of water quality monitoring system. Water system should be monitored at frequency that is sufficient to ensure that the system is under control & continues to produce water of an acceptable quality. The aim of this paper is to implement the water quality monitoring system implemented on a microcontroller system for monitoring different parameters of drinking water. ZIGBEE modules are used for wireless transmission and reception of water quality parameters. The parameters taken into account in this paper in order to perform the monitoring system are: water PH, hardness, temperature, turbidity taste and color. Once parameter values are received they are transferred to the computer through RS-232 serial communication.

I. Introduction

The rural population of India comprises of more than 700 million people residing in about 1.42 million habitations spread over 15 diverse ecological regions. It is true that providing drinking water of an acceptable quality to such a large population is an enormous challenge. Water quality problems are caused by pollution and over-exploitation. Water quality is affected by both point and non- point sources of pollution. These include sewage discharge, discharge from industries, run-off from agricultural fields and urban run-off. Water quality is also affected by floods and droughts and can also arise from lack of awareness and education among users. Water system should be monitored at frequency that is sufficient to ensure that the system is under control & continues to produce water of an acceptable quality.

It has been observed that most of the diseases that affect the human population nowadays are because of the poor quality of water. In our country as well, as everywhere in the world, the efforts are taken by the specialists aim at finding solutions that may contribute to increasing the quality of water, considering the direct connection between water quality and health. This is why continuous water quality monitoring and control systems is an essential element for any human community and for this purpose great efforts are made with a view to performing efficient, modern and complete systems in order to assure water quality. [1].

Using different sensors, this system can collect various environmental parameters from water, such as temperature, pH, turbidity, color, taste, hardness and so on. The rapid development of wireless sensor network (WSN) technology provides us a novel approach to real-time data acquisition, transmission and processing. ZIGBEE modules are used for wireless transmission and reception. The users can get real time water quality data from faraway. [2].

By placing wireless sensor node on the surface of the wells and lakes, it makes the networking automatically so as to provide 24-hour unmanned service. Water Quality Monitoring System based on WSN makes

up of many different nodes. Every terminal node has several water quality parameters, like the PH value, temperature, turbidity, hardness & so on. WSN gets water quality data, and then sends the data onto the computer. Once Remote Data Center gets the data through Zigbee, it will analysis, process and record the water quality data. The system is real-time, and low cost. Obviously it can meet people's most important requirements of water quality monitoring. [3][4].

The aim of this paper is to implement the water quality monitoring system implemented on a microcontroller system for monitoring different parameters of drinking water. This work can be extended to other industrial applications such as quality control department of water purification, wastewater discharges, and, in general, the system is useful in cases where it is essential to conduct quality analysis of water quickly, easily, economically, and especially without any specialized personnel.

II. Literature Review

The main idea is to monitor water quality parameters continuously. This can be done by various approaches discussed in the different papers. One of the way in which the system measures data from sensors sends to data acquisition board and then to PC. Parameters to read are PH, ORP, DO, Conductivity, Turbidity based on Zigbee transmission. [1].In the other approach the system contains base station and several sensor nodes. The base station contains a wireless receiver and a PC, where users can receive data from sensor nodes ananalyze it. Same parameters can be detected for harm based on SunSpot technique [2]. The paper introduces different architectures for the same. The GPRS DTU is another common transmission technique. In this the system consists of WSN and Remote Data Center. First WSN collects water quality data, and then send the data to Remote Data Center with the help of GPRS DTU. [3].The star network topology is used for a special local area located in near pollution emission port. and the Zigbee cluster-tree network is used for some open and wide river or lake [4]. The Zigbee and GPRS are two most efficient methods in wireless data

transmission. The system can be made up of data collection monitoring module, wireless communication module and monitor center. In another approach the system is composed of three components: The water quality monitoring stations, the GPRS modem and the monitoring center. The parameters of water to test can be PH, Temperature, Turbidity, Hardness, Clarity and Dissolved oxygen etc [5]. Some chemical Contamination in water due to wastewater discharge can also be tested using the set of electrodes.

A. Parameters of Drinking water.

Water testing is divided into three sections viz. Physical analysis of the water Chemical analysis of water Microbiological examination of water.

When the problem of monitoring drinking water and especially drinking water quality is concerned, some of the physical-chemical and bacteriological parameters should be considered as follows:[4].

1. The physical parameters of water are: Color, taste, odor, turbidity, Conductivity and pH, total hardness etc.

2. There are numerous chemical parameters for water. The chemical parameters of water are: Ca, Mg, Cu, Iron, Flouride, Nitrates, Lead, Zinc, Arcenic, Chlorides, residual free chlorine, pesticides etc.

3. The bacteriological parameters of water are: Coli form bacteria, Sulphite reducing clostridia, etc. [4].

For each of these parameters there is an established compulsory calculated concentration according to the bureau of Indian standards as shown in table 1. The different parameters can be taken into account to perform the online monitoring depending upon the priority of the hazardousness.

Parameters	Desirable limit	Permissible limit	Adverse Effects
pH	6.5-8.5	6.5-8.5	Mucous membrane
Color Hazen unit	5	25	Acceptance Decreases
Hardness (as $CaCO_3$)mg/l	300	600	Domestic use
Turbidity-NTU	5	10	Acceptance decreases
Odour	Unobjectiona-ble	--	--

Parameters	Desirable limit	Permissible limit	Adverse Effects
Calcium mg/l	75	200	Domestic Use
Magnesium mg/l	30	100	Domestic Use
Taste	Aggreeable	-----	-----
Fluoride mg/l	1	1.5	Fluorosis
TDS	500	2000	Gastro

Table 1.Indian standard specification for drinking water

IS: 10500

III.System Design for drinking water quality monitoring

The proposed scheme of the system is based on three particular areas namely measurement unit, communication and display unit. The structure of the monitoring system for drinking water quality is show in fig.1. The basic water parameters are transmitted through a multi-sensor system and registered in a data collection board, then they are transmitted by radio connection (wireless network), using Zigbee transmission at regular intervals, to the central station, where they are permanently displayed on LCD monitors and then to the computer using the RS 232 serial communication for storage purposes in a database or in order to be visible to the public. At the central station the data is processed and filed in order to facilitate the monitoring, to carry out long-term statistics regarding the operation of the data collection network. Continuous monitoring may be carried out through in-situ sensors connected through a cable to the power supply, the data logger and the Zigbee transmission-reception system and computer with program for serial communication.

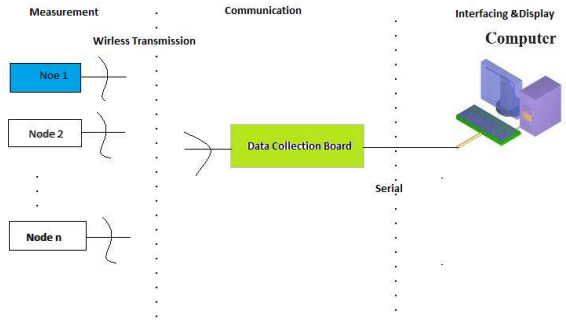

Fig.1.Structure of system for monitoring the water quality parameters with wireless data transmission

IV. Methodology

The main idea is to monitor water quality parameters continuously. The study of different water quality parameters and their effects on human health is done. Entire proposed scheme consists of measurement, communication and display on PC & LCD. For actual model construction parameters that are finalized are ph, turbidity, temperature, hardness, color, taste. The entire system consists of three parts: the coordinator node, sensor node

and PC.The model design is first simulated for communication using proteus software & then the actual design is constructed. The sensor node collects water quality data, and then sends the data to data collection board with the help of Zigbee transmission & reception module. After which an interfacing is done with PC as the collected data is transferred to the computer continuously serially using RS 232 serial communication for monitoring and controlling the quality of water. The block diagram of the drinking water monitoring system is shown in the fig. 2.

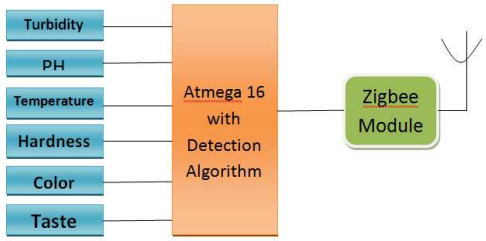

Fig 2(a): system Architecture (Sensor Node).

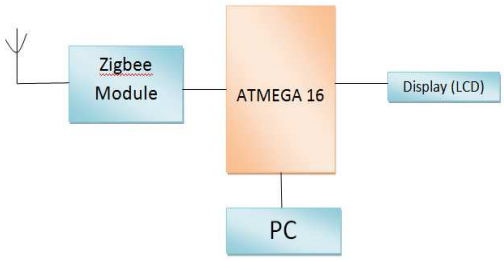

Fig 2(b): system Architecture (Collection board).

Some of the parameters of water can be analysed using different sensors like for ph, turbidity, hardness; temperature etc.These parameters are controlled and collected by AVR Atmege 16 microcontroller with detection algorithm. The software was coded in C language for the microcontroller. Once all parameters that are collected by the node are then sent onto the Zigbee network. On the receiver side the another Zigbee module receives the transmitted data continuously through wireless networks. The data is displayed on LCD and then transferred serially onto the computer for storage & controlling purpose.

In order to perform the analysis system of the 6 drinking water proposed parameters requirements are as follows.

1. Sensors for detecting ph, temperature, turbidity, temperature, hardness.

2. Data collection board, LCD to display the data.

3. ZIGBEE modules required for wireless transmission and reception.

4. SPDT Switches for manual controlling.

5. Electronic computing system with software for the Display of analyzed parameters, e.g. PROTEUS software, CODE VISION AVR software, JAVA & EDITPLUS.

The signals transmitted by the different sensors on slave are sent to the master board using the ZIGBEE wireless transmission network; the receiver is fitted with a LCD display where the selected water quality parameters are simultaneously shown. Also using the Zigbee wireless network the signals are transmitted from the board to the computer system, the monitor of which shows values as it is and stores them. The data received is presented in numerical form. The communication status is shown.

V. Topology structure of ZIGBEE

Wireless transmission & reception of parameters is done through the Zigbee module. Out of the three techniques available for wireless communication Zigbee is selected for better range & better current consumption. The comparison among the three different WSN techniques is shown in following table2.

Point of Comparison	ZigBee	Bluetooth	Wi-Fi
Type of Network	WPAN	WPAN/WLAN	WLAN
Transmission Speed	250 kbps	1 Mbps	Up to 54 Mbps
Current Consumption	Standby: 2µA	Standby: 200µA	Standby: 20µA
Memory	32-60 KB memory	100+KB memory	100+ KB memory
Topology	Mesh networking	Point to multi-point	Point to multi-point
Applications	Lighting sensors, RC peripherals	Telecom audio, cable replacement	Enterprise, home access points
Range	100-300 ft	32 ft	65 ft

Table 2.WSN Comparison

ZigBee networks can be configured to operate in a variety of different ways to suit the application and environment. Supported topologies include: Star, Mesh and Cluster Tree. In our model they are configured to operate as PAN Coordinator which will send the data & the slave node which will collect the parameters values.Zigbee is an IEEE802.15.4 standard low cost, low data rate (< 250 KBPS) and works in 2.4 GHz and 868/928 MHz wireless technology. It is used for personal area network and a peer-to-peer network. It is the base of ZigBee application layer and the network layer. ZigBee is a new kind of low complexity, low power consumption, low data rate and low cost wireless network technology. It's mainly used for close wireless connections. According to the

standard IEEE 802.15.4, it can hold 64000 sensor nodes communicated with each other. The sensor node only needs tens of micro-ampere current to ensure network connection. Through radio waves, data will be transferred from one node to another one. So their transmission efficiency is very high. [6].

There are mainly three types of network topology for a ZigBee Network [1]. It is respectively shown as in following figures.

In the three figures, F, R, C represents respectively the node of the full function device, reduced function device and network coordinator. [1].

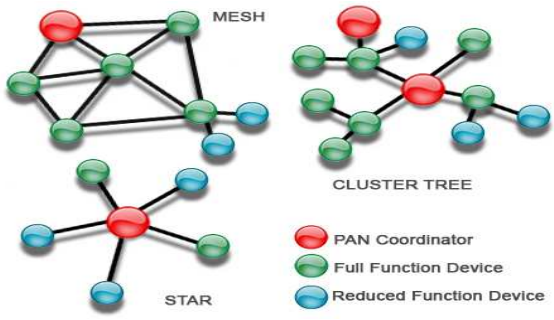

Fig 3: Zigbee Network Topology.

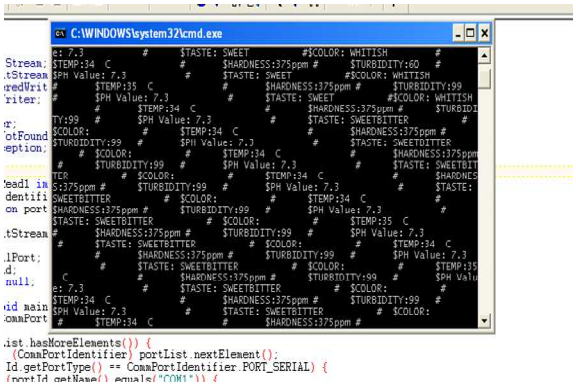

Fig 4: Interfacing with PC

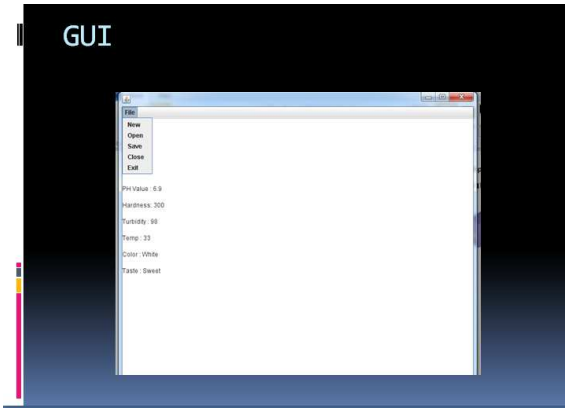

Fig 5: Values continuously displaying on GUI.

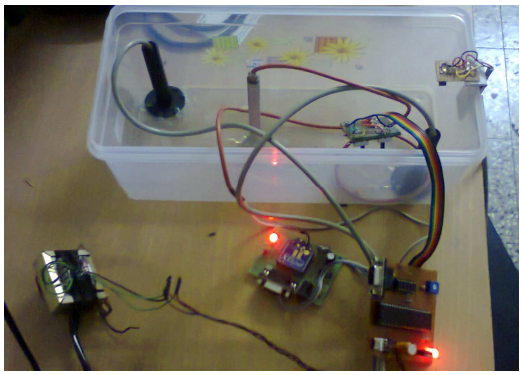

Fig 6: Sensor node with Sensors & Zigbee module

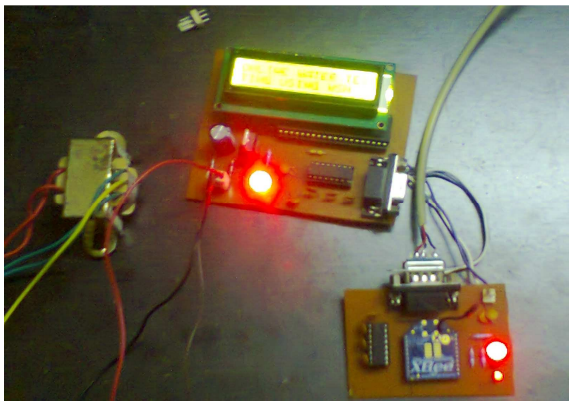

Fig 7: Data collection board with LCD & Zigbee module.

VI. Applications

The online water quality monitoring system is applicable to be used in various industries as well as for domestic purposes. The main application of the system is in Borewell, Well, lakes in water environment monitoring. It can be considered as an integral element in purification process on mass level. The system is applicable to be used in boilers for maintaining the balanced ph, hardness, temperature of condensed water.

VII. Conclusion & Future work

Finally, an embedded system with a Single node and data collection board is designed and implemented. A microcontroller-based drinking water testing system, capable of collecting the readings for different parameters & transferring them onto the Zigbee network is successfully developed. We mention that the system provides monitoring of some quality parameters like ph, turbidity, hardness, temperature, color and taste. These parameters are transferred on wireless network & displayed on LCD as shown and then to PC (computer).

Based on this system numerous difficulties can be solved. The system makes people aware about the quality of water whether it is drinkable or not. The system is useful where it is appropriate to conduct qualitative measures quickly & economically.

The system can be extended for monitoring other parameters of water analysis with some more sensor nodes. Again the system can be extended to interface & display the parameters value in an organized manner for making the system long-term, stable and real-time regional water quality monitor.

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