ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 11, April 2018

REAL TIME MONITORING AND CONTAMINATION DETECTION IN DRINKING WATER DISTRIBUTION SYSTEMS

BHARATHIPRIYA.A[1]
Dept. of Electronics and communication Engineering
Sri Venkateswara College of Engineering
Sriperumbudur,India
Email id: abharadhi@gmail.com

BHUVANESH K. S[2]
Dept. of Electronics and communication Engineering
Sri Venkateswara College of Engineering
Sriperumbudur,India
Email id: bhuvanesh.s0097@gmail.com

Abstract- This paper deals with Real-Time Monitoring and Contamination Detection in Drinking Water Distribution Systems. Drinking water utilities are facing new challenges in their real-time operation because of limited water resources. Intensive budget requirements, growing population and increased attention towards safeguarding water supplies from accidental or deliberate contamination. There is a need for better real time water monitoring systems in the IoT environment that gives rapid detection (and response) to instances of contamination which is critical due to the potentially severe consequences to human health than existing laboratory-based methods.The Raspberry Pi board is the core component of the proposed system and it is programmed in python language. The proposed system collects various parameters of waterusing different sensor nodes to monitor its contamination level and corresponding information was transmitted to respective mobile user.

Keywords-Internet of Things (IoT);water parameters; sensors

I. INTRODUCTION

An Embedded System is a Computer System which includes a larger mechanical or electrical system to perform dedicated function, especially for real time applications. It is a blend of hardware equipment and programming designed to perform a specific task within a larger system.

Low power consumption, rugged operating ranges, small size and low per-unit cost are the most advantageous properties of embedded computers compared with general-purpose counterparts. Limited processing resources results in lesser interaction and limited programming. Intelligence mechanisms are made on top of the hardware, thereby individuals can manage available resources and network levels by taking advantage of possible existing sensors and the existence of a network of embedded units. For example- Power consumption management was made by designing with proper intelligent techniquesin the embedded systems.In 1965, Charles Stark Draper developed the Apollo Guidance Computer, the very first recognizable modern embedded systems at the MIT Instrumentation Laboratory. Due to the development of monolithic integrated circuits to reduce the size and weight, Apollo guidance computer was consideredas the riskiest item. In 1961, D-17 was the mass produced embedded system guidance computer for the Minuteman missile. Further it was replaced with a new computer that was the use of more number of integrated circuits.

Dramatic rise in processing power and functionality occurs with reduction in the price of embedded systems applications. For almost any computer-based controllers, such as single board computers event and numerical-based controllers a "standard" has been released. General-purpose computer would be too costly when microcontrollers find its applications.

Microcontroller with low cost can be programmed instead of large number of individual components. Instead of large number of separate components, low-cost microcontroller can be programmed. Most of the complexity is contained within the microcontroller itself which makes the embedded system complex. Most of the Design effort in software was made with few additional components. Compared with the design and construction of a new circuit without embedded processor, software prototype and test require lesser time.

Due to the pollution of water bodiesand the depletion of water resources, providing clean drinking water is a challenge with in increasing population. There is a need for good water monitoring systems. Where the traditional methods are too slow, public health protection is very less in real time. Rapid detection (and response) to instances of contamination is critical due to the potentially severe consequences to human health.

For Real-Time monitoring and contamination detectioning in drinking water systems MCU based boards are used. Itreceives information from the central measurement node through an

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 11, April 2018

interconnected ZigBee RF transceiver and provides local near-tap notifications to the user in limited coverage area [12]. Also A sensor node with a temperature, conductivity, pH, ORP and flow sensors was designed, and a wireless node was implemented using two XBee modules configuredfor peer-to-peer communication which is able to display the parameters in real-time, however a history of the readings is not available [6].

There is a need for better real time water monitoring systems that gives rapid detection (and response) to instances of contamination which is critical due to the potentially severe consequences to human health, than existing laboratory-based methods. The main goal of this project is to monitor the water 24 hours a day for the purpose of detecting the contaminated water and that information will be immediately transmitted to registered users.

II. HARDWARE COMPONENTS

This project comprises the following components:

- Raspberry Pi
- Analog To Digital Convertors
- Ph Sensor
- Conductivity Sensor
- Turbidity Sensor
- Temperature Sensor
- Gas Sensor
- Ultrasonic Sensor

A. Raspberry Pi

The raspberry pi used in this project is raspberry pi zero.The Raspberry Pi was developed in the United Kingdom by the Raspberry Pi Foundation. It includes a series of small single-board computers It is especially used in the field of robotics. It does not include peripherals such as mice, keyboards and cases.

Raspberry Pi models are provided with on-chip graphics processing unit (GPU), Broadcom system on chip (SoC) with an integrated Arm compatible central processing unit (CPU) and these varies based on the generations.

Processor speed of raspberry pi ranges from 700 MHz to 1.4 GHz and for the Pi 3 on-board memory ranges from 256 MB to 1 GB RAM. Program memory and the operating system are stored in either SDHC or MicroSDHC sizes with the help of Secure Digital (SD) cards. The boards are provided with four USB ports. For video output, HDMI and composite video are supported, with a standard 3.5 mm phono jack for audio output. Protocols like I²C are supported by a number of GPIO pins, where low level output are possible.

The Raspberry pi 0 uses a 32- bit 900 MHZ quad-core ARM cortex-A7 processor.

More versions of raspberry pi vary with memory capacity and peripheral-device support.

Figure 1: Raspberry pi used in the proposed system

Raspberry pi models A, B, A+, and B+. Model A, A+, and the Pi Zero lack the Ethernet and USB hub components. Using additional USB port, the Ethernet adapter was internally connected. The USB port is connected directly to the system on a chip (SoC) for the Model A, A+, and the Pi Zero. The Pi 1 Model B+ and in later models the USB/Ethernet chip contains a five-point USB hub, of which four ports are available, while the Pi 1 Model B only provides two. On the Pi Zero, micro USB (OTG) port are used whereas the USB port is connected directly to the SoC.

The Raspberry pi was operated with any generic USB computer keyboard and mouse. It can also be used with USB storage, USB to MIDI converters, and with any other device/component with USB capabilities.

Through various pins and connectors on the surface of the Raspberry Pi, other peripherals can be attached.

B.Analog To Digital Converter

The analog to digital converter used here is MCP3008. The MCP3008 is a low cost 8-channel 10-bit analog to digital converter. It is similarto Arduino Uno, with 8 channels that read quite a few analog signalsfrom the Pi. It is suitable to read simple analog signals, like from a temperature or light sensor.

It provides easier way to install and use new Python code to run with MCP3008 ADC.

The ADC MCP3008 connects to the Raspberry Pi using a SPI serial connection. Either the hardware

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 11, April 2018

SPI bus, or any four GPIO pins and software SPI are used to talk to the MCP3008. Software SPI works with any pins on the Pi and hence more flexible, whereas hardware SPI is slightly faster but less flexible because it works only with specific pins. Practically software SPI is easier to setup.

In this project after wired the MCP3008 to the Raspberry Pi withSPI wiring, library and source filesare installed.The library files are installed from the Python package index with a few commands.

C.PH Sensor

In the proposed system, atmega au 1720 pH kit is used to detect the pH value of water. pH indicates the acidity or alkalinity based on the hydrogenion activity in water-based solutions, measures using pH sensors. The pH meter is sometimes referred to as a "potentiometric pH meter" as it measures the difference in electrical potential between a pH electrode and a reference electrode. The difference in electrical potential relates to the acidity or pH of the solution. pH value indicates the converted voltage between two electrodes. It is made up of combination electrode, and some form of display calibrated in pH units or alternatively simple electronic amplifier and a pair of electrodes.

D.Conductivity Sensor

In the proposed system, atmega au 1720 conductivity sensors are used to measure conductivity in water as how well a solution conducts an electrical current. This type of measurement assesses the concentration of ions in the water. These conductive ions arrive from dissolved salts and inorganic materials such as sulphides, carbonate compounds alkalis, and chlorides. The more ions that are in the solution, the higher the conductivity. It is used to monitor the amount of nutrients, salts or impurities in the water. Drinking water has a conductivity range of 5–50 mS/m, high quality deionized water has a conductivity of about 5.5 µS/m, while sea water about 5 S/m.

E.Turbidity Sensor

In the proposed system, atmega au 1720 turbidity sensor is used to detect water quality by measuring level of turbidity.Turbidity refers to the cloudiness or haziness of a fluid caused by large numbers of invisible individual particles.Gastrointestinal diseasesarise with high turbidity level drinking waters. Because of contaminants like viruses or bacteria attached to the suspended solids, the immunity of people will be affected.Turbidity is measured inFormazin Turbidity Unit (FTU). ISO refers to its units as FNU (FormazinNephelometric Units). The determination of turbidity was included under ISO 7027. By measuring the incident light scattered at right angles from the sample, the concentration of suspended particles in a sample of water would be determined. The electronic signal generated by photodiode by capturing scattered light was converted to a turbidity. Open source hardware has been developed to measure turbidity reliably using a Raspberry pi microcontroller and inexpensive LEDs. The effective measuring range of CO2 sensor is 0-5000 ppm. The accuracy of the CO2 sensor is ± (50 ppm + 3% reading).

F.Temperature Sensor

In the proposed system, lm35 temperature sensor is used to detecttemperature of water as few microorganisms will destroy automatically with certain temperature. This sensor is powered from the data line.The operating temperature ranges from -55°C to 150°C. For every oC rise/fall in ambient temperature output voltage varies by 10mv, and its scale factor is 0.01V/ oC.

G.Gas Sensor

In the proposed system, mq2 gas sensor is used to detect the concentration of CO2. It is measured in parts per million (ppm). The MQ series of gas sensors use a small heater inside with an electro-chemical sensor. It is used indoors at room temperature which is sensitive for a range of gasses.According to the analog input of the Raspberry pi, the output analog signal is obtained.The MQ-2 Gas Sensor has more applications in home and industry for detecting gas leakage. It can detect LPG, i-butane, propane, methane, alcohol, hydrogen and smoke.

Some modules have a built-in variable resistor to adjust the sensitivity of the sensor. One ppm is equivalent to 1 milligram of something per litre of water (mg/l) or1 milligram of something per kilogram soil (mg/kg).

H.Ultrasonic Sensor

In the proposed system, atmegaultrasonic sensor 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. With transducer the sonic waves are reflected by an object and received back. The time interval between emitting and receiving sound waves is proportional to the distance between the transducer and the object can be calculated. It is more suitable for sensing uneven surface such as water surface as the ultrasonic sensor uses sound wave instead of light wave.Sonar range information from 6inches out to 254-inches with 1-inch resolution was provided by ultrasonic sensor by detecting objects from 0-inches to 254-inches (6.45-meters).

TABLE 1

Various parameters with quality range

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 11, April 2018

S.No	Parameter	units	Quality range
1	Distance	Cm	-
2	PH	PH	6.5-8.5
3	Turbidity	NTU	5-100
4	Electrical conductivity	uS/cm	500-1000
5	Temperature	° Celsius	-55 to 125 ° Celsius

III. SOFTWARE DESCRIPTION

The raspberry pi works on python programming language. All the required GPIO pins are enabled by calling the pin no. The collected data is sent to the registered mobile number via IoT(Internet of Things). The Raspberry Pi Foundation recommends the use of Raspbian, a Debian-based Linux operating system. Third-party operating systems are also available throughtheofficialwebsite like Ubuntu MATE, Windows 10 IoT Core, RISC OS etc.Many other operating systems can also run on the Raspberry Pi.

A.Python Language

In this project, code works for interfacing different components with raspberry pi was done with python language. Python is an interpreted high-level programming language especially for general-purpose programming, Python accommodates design philosophy that emphasizes code readability, and a syntax that allows all programmers to express their concepts in fewer lines of code. Especially using significant whitespace. It issues constructs, that permit clear programming on both small and large scales.

Python characteristics includesdynamic type system and automatic memory management. It also adds additional features such as multiple programming paradigms, includes objectoriented,functional and procedural, imperative, and has a large comprehensive standard library.

Many operating systems are available with Python interpreters.CPython,is an open source software which is guided by the non-profit Python software Foundation.

Python 2.0 had many new features, including a cycle-detecting garbage collector and support for Unicode.

After a long testing periodPython 3.0 (initially called Python 3000 or py3k) was released. It is a major revision of the language that is not completely backward-compatible with previous versions.Python is a multi-paradigm programming language.

Python utilizes a blend of dynamic typing, reference counting, and a cycle-detecting garbage collector for memory management. It likewise receives dynamic name resolution, which consolidates methods and variable names during program execution.

Recently the Python Package Index, the third-party Python software, contains130,000 packages with more functionality, includingWeb frameworks, Graphical user interfaces, Multimedia, Databases, Networking, Test frameworks, Automation, Web scraping, Text processing, Image processing, Documentation, System administration, Scientific computing.

Python executions (counting CPython) incorporate a read– eval– print loop(REPL), allowing them to operate as a command line interpreter for which the client enters sequential statements and gets output immediately. Other shells, including IDLE and IPython, includes facilities such as auto-completion syntax highlighting and session state retention. And also standard desktop integrated development environments adopt Web program based IDEs; SageMath; Python Anywhere, a browser-based IDE; and Canopy IDE, a business Python IDE emphasizing scientific computing.

The software used in this project is python 2.7.14.

IV.IMPLEMENTATION

The block diagram of the proposed system is given in Figure 2 below.

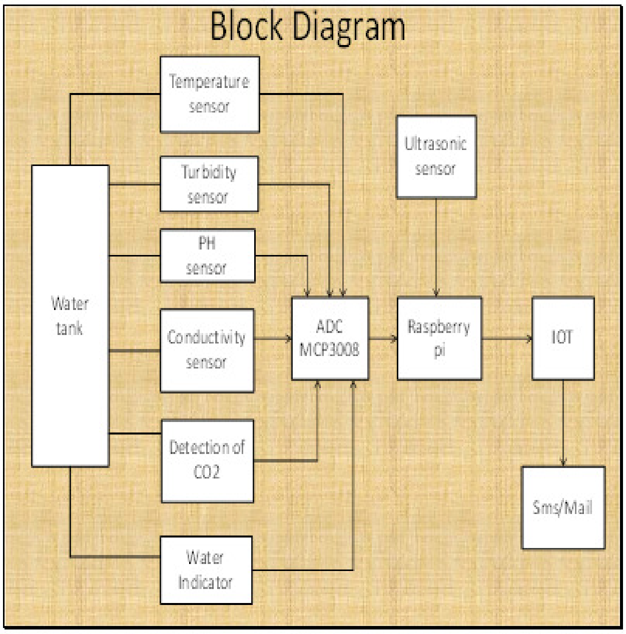

Figure 2: The block diagram of the proposed system

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 11, April 2018

The proposed system consists of both hardware and software part. All the sensors are connected to the raspberry pi and the sensors are placed in water. Each and every sensor is enabled using python coding. The embedded system reads data from input sensors.

The data is then processed and the result is displayed in monitor to the user. When the water is polluted by means of dust, sand or chemicals the parameters of the water changes, then immediate message will be sent to the registered mobile number using IoT (Internet of things).

V.EXPERIMENTS AND RESULTS

The experimental results are specified in the following sections.

A. Connections as per the block diagram

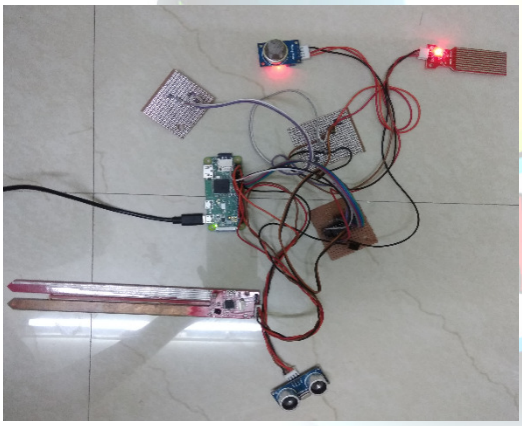

Figure 3: The hardware experimental set-up of the proposed system

B. Parameters Evaluation through sensors

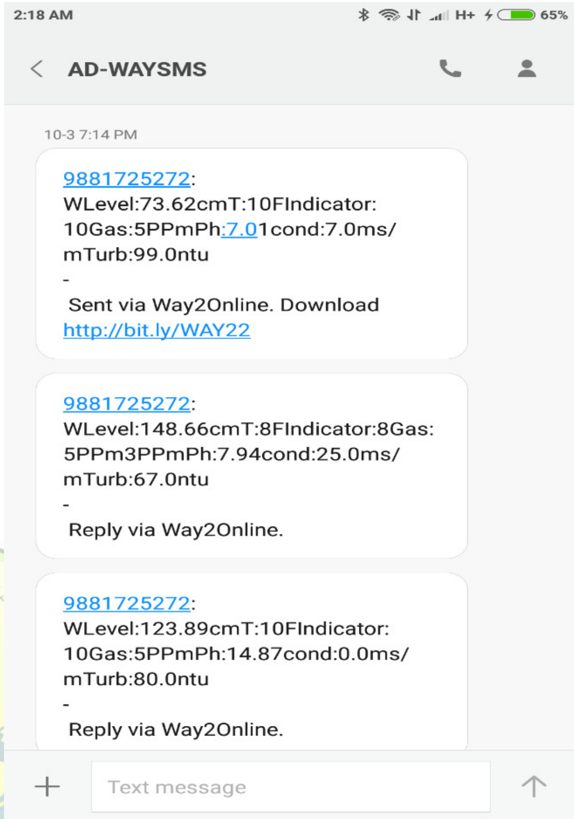

Figure 4: The experimental result displaying water parameteres

Various sensors are interfaced with Raspberry pi in figure 3 and python codes are used in the proposed system.

The result for all the sensors are obtained. Water level, temperature, turbidity, conductivity, gas level, pH level of water is noted which will be compared with its threshold values given in table 1. And the water is monitored continuously for any contamination. Any change in parameter of the water is immediately notified via message to the registered mobile number. The screenshot obtained from the mobile is shown in Figure 4.

VII. CONCLUSION AND FUTURE WORK

In the proposed system different parameters of water was measured using sensors and continuosly monitored with suitable threshold values to detect any contamination in water, and that information was transmitted to respective registered mobile. The main advantage of the project is the use of IoT. Also analog sensors used in the proposed system take 10 to 20 seconds to display each values. The future improvement can be made using digital sensors and

ISSN2394-3777 (Print)
ISSN2394-3785 (Online)
Available online atwww.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 11, April 2018

also including some more sensors. Due to cost constraint only limited sensors are placed.

REFERENCES

[1] Chen et al., "A Vision of IoT: Applications, Challenges, and Opportunities With China Perspective", IEEE Internet of Things Journal, vol.1, No.4, Aug 2014.

[2] Chi,Q.; Yan,H.; Zhang,C.; Pang,Z.; Xu,L,D., "A Reconfigurable Smart Sensor Interface for Industrial WSN in IoT Environment", in IEEE Transactions on Industrial Informatics, vol. 10, no. 2, pp. 1417-1425, May 2014.

[3] Hsia,S,C.; Hsu,S,W.; Chang,Y,J., "Remote monitoring and smart sensing for water meter system and leakage detection", IET Wireless Sensor Syst., vol. 2, no. 4, pp. 402-408, Dec. 2012.

[4] J. A. Stankovic, "Research directions for the Internet of Things," IEEE Internet Things J., vol. 1, no. 1, pp. 3–9, Feb. 2014

[5] Li,S.; Xu,L.; Wang,X.; Wang,J., "Integration of Hybrid Wireless Networks in Cloud Services Oriented Enterprise Information Systems," Enterp. Inf. Syst., vol. 6, no. 2, pp. 165–187, 2012.

[6] Niel Andre Cloete1, Reza Malekian Member,IEEE, and Lakshmi Nair 3, Member, IEEE1;2;3 Department of Electrical, Electronic and Computer Engineering, University of Pretoria, Pretoria, 0002, South Africa "Design of Smart Sensors for Real-Time Water Quality Monitoring" Journal OF LATEX CLASS FILES, VOL. 13, NO. 9, 2014

[7]. Peris-Ortiz, M.; Bennett, D.; Yábar, D. P., "Sustainable Smart Cities:Creating Spaces for Technological, Social and Business Development", Springer, p.103,2016.

[8] Purohit,A and Gokhale,U., "Real Time Water Quality Measurement System based on GSM", IOSR Journal of Electronics and Communication Engineering (IOSR-JECE), vol. 9, no. 3, pp. 63-67, May - Jun. 2014.

[9]R.AbdulSikkandhar,R.NaveenKumar, "A Low-Cost sensor Network for Real-Time Monitoring And Contamination Detection In Drinking Water Distribution Systems", IEEE Sponsored 2nd InternationalConference on Innovations in Information, Embedded andCommunication systems (ICIIECS), 2015.

[10] Rizzello,M.; Distante,C.; Siciliano,P., "A Standard Interface for Multisensor Systems", Sensor.Environ. Control, pp. 224-228. [19] Vijayakumar,N., and Ramya,R., "The Real Time Monitoring of Water Quality in IoT Environment", IEEE Sponsored 2nd International Conference on Innovations in Information, Embedded and Communication systems (ICIIECS), 2015.

[11] Sharma,H and Sharma,S., "A Review of Sensor Networks: Technologies and Applications", in Engineering and Computational Sciences (RAECS), 2014 Recent Advances in, Chandigarh, pp.1–4, 2014.

[12]Theofanis P. Lambrou, Christos C. Anastasiou, Christos G. Panayiotou, and Marios M. Polycarpou, "A Low-Cost Sensor Network for Real-Time Monitoring and Contamination Detectioning Drinking Water Distribution Systems" IEEE Sensors Journal, VOL. 14, NO. 8, 2014.