WIRELESS SENSOR NETWORK BASED INTERNET OF THINGS FOR ENVIRONMENTAL IMPACT ANALYSIS

Ms. MRUNALI SATISH KOLHE[1], PROF.VAISHALI LONDHE[2]

[1],Student, Dept of Computer Engineering, SES's Yadavrao Tasgaonkar Institute of Engineering Technology, Affiliated to University of Mumbai, India.
[2], Professor, Dept of Computer Engineering, SES's Yadavrao Tasgaonkar Institute of Engineering Technology, Mumbai, India.

Abstract - *This paper represents the wireless sensor network system and Internet of things (IOT) that allows to develop a low cost sensor network that will monitoring the environment that collect the data from the local wireless sensor network and upload it to the local server . This is based on real time environmental monitoring applications. wireless sensors & IOT by using raspberry pi , zigbee and sensors where Sensors are used for Environmental Monitoring which is used to collect details regarding environmental conditions like temperature, humidity, pressure etc. at different locations. This is low cost, low-power sensors devices and highly scalable in a type of sensors and the number of sensor nodes. . It allows people and devices to be connected in anyplace, anywhere with any device and anybody.*

The real time data is given to Raspberry Pi which acts as a control station or base station that connects the number of distributed sensor nodes via zigbee protocol. . It stores the data collected from different sensor units and analyzes the stored data. ZigBee protocol is used for communication between different sensor nodes. , Zigbee protocol consist of a three modes such as end tags, router, and coordinator in which Coordinator directly communicates with a base station. The system also provides a web interface for the user so that the user can control and monitor the system remotely. A lightweight web server built on the Arduino displays this information on a web page.

Key Words: **IoT, Raspberry pi , Arudino , WSN, XBee , Sensor Node, ZigBee.**

1.INTRODUCTION

Internet of Things has expanded the network of Internet through which people and devices can be connected from anyplace, anywhere with any device and anybody. One of the greatest opportunities in this IoT lies in environmental monitoring are broad: environmental protection, extreme weather monitoring, water safety, endangered species protection, commercial farming, and more. Wireless Sensor Networks (WSNs) are connecting things to the Internet through a gateway that interfaces the WSN to the Internet. The advancement of technologies such as micro-electro-mechanical systems (MEMS) technology, wireless communications, and digital electronics has resulted in the development of small devices having the ability to sense, compute, and communicate wirelessly in short distances.

In this paper we have tried to present wireless sensor network system that developed using open-source hardware and software platforms, Raspberry Pi and the ZigBee module. These systems are low cost ,easy to build, and easy to maintain methods that are connect the current devices to the internet. Recently, many wireless technologies are evolved, e.g. Wi-Fi, ZigBee, Bluetooth etc. the wireless devices that are using such technologies have moving towards lower-power, faster data speeds technologies will enable more devices to be connected and will be useful for many applications Though they are small and can be easily connected to a sensor node. This paper describes a possible way to use Arduino and Raspberry Pi for monitoring, describing advantages of doing so and how to implement it efficiently.

2. THE OVERALL SYSTEM ARCHITECTURE

In the fig-1 there is the overview of a how the system architecture is present in environmental monitoring which is combination of a coordinator ,end tags and router, various sensor nodes, data aggregator nodes for local (Arduino) and remote storage (Raspberry Pi). Data collection and processing is done through the Arduino and XBee devices. This system consists of raspberry pi, many distributed wireless sensor nodes, ZigBee protocol etc.

Raspberry Pi works as a base station which connects the number of distributed sensor nodes via zigbee protocol. As shown in the Fig-1 ,

In this system architecture, we have combined the gateway node of wireless sensor network, that is raspberry pi

1. Raspberry pi (base station)

Raspberry pi consist of database server and web server in one single-board computer hardware platform, it reduces the cost and complexity of deployment. It interconnects with multiple sensor nodes.

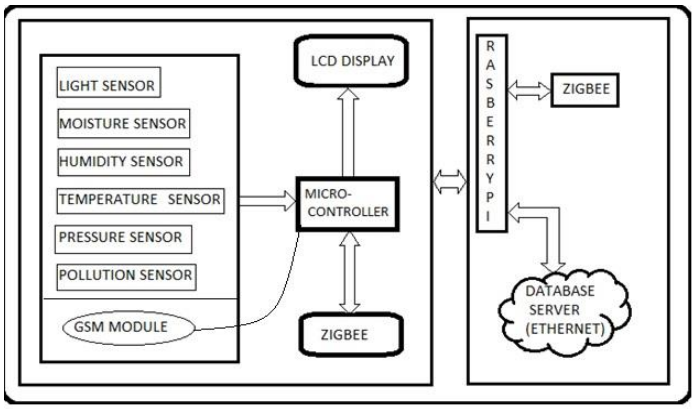

Fig-1: Overall System architecture

2. Sensor Node

Each sensor node is combination of sensors, microcontroller and zigbee radio transceiver (Xbee module) and it is responsible for information or sensor data collection and distribution. There are various types of sensor which is used for different purpose for environmental monitoring.

3. GSM Module

Global System for Mobile Communications (GSM) is a TDMA based cell phone technology used in different parts of the world. For long distance communication GSM Module is used. The GSM module uses AT commands to send the SMS on house owner mobile phone. Zigbee technology is used for wireless personal area networking. GSM is used to send the SMS on Mobile.

2.1 AURDINO

Aurdino is an open source platform with a simple and accessible user experience. Arduino is inexpensive as compared to other microcontroller platforms and also it is easily available. There are various types of controllers available on aurdino platform, each of them having a different version of flash memory and IO pins. Aurdino Uno is easily available and a low cost device and therefore it is one of the best choices for making the nodes of sensor.

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. Arduino Mega is the advanced version of UNO. It has lots of digital input/output pins (14 can be used as PWM outputs), 16 analog inputs, a USB connection, a power jack, and a reset button. It contains everything needed to support the microcontroller.

Fig-2: Arduino Uno

2.2 RASPBERRY PI

The term Raspberry Pi as Data Processing Module . It is a credit-card size circuit board and featuring ports for HDMI, USB 2.0, composite video, analog audio, power, Internet and SD card and small, less expensive personal computer that needs less space. It is a small computer that uses an ARM 11 processor running at 700MHz with512MB RAM. A webpage will be made using HTML5,PHP and Javascript which will update itself at regular intervals and display the data being collected by the Raspberry Pi[1].

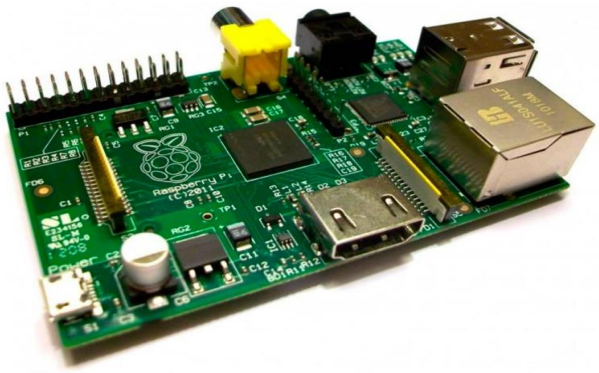

Fig-3: RASPBERRY PI

This board runs an ARM11 microcontroller @1GHz and comes with a 1GB of RAM memory[4,5], as this model has better specifications as compared to other raspberry pi models such as raspberry pi B and B+ model which can be easily configured to run without monitor, keyboard, and mouse, which helps to reduce the cost and complexity of deployment[2].

2.3 XBEE MODULE

The term xbee as The Data Transfer Module .All devices are equipped with a 2.4 GHz XBee module for data transmission and for network composition .The fig-4 shows Xbee module . The main advantages are it is low cost and it is possible to create wireless networks . The XBee device is able both to receive and transmit the data through the network.It is

possible to initiate communication between two devices with each other without interfering with other modules present in the surroundings.

Fig-4: Xbee Module

Zigbee is a high-level communication protocols used to create wireless networks. It is a easy and low cost than other wireless personal area network such as Bluetooth and Wi-Fi. Its low power consumption limits transmission 10–100 meters depending on power output and environmental characteristics, ZigBee devices can transmit data over long distances by passing data through a mesh network topology and it connects node to node, in which a node (device) transmits its own data to the other nodes .The Zigbee transmission data rate is 250 Kbit/s [7]. Zigbee consist of a two nodes that including coordinator node and sensor node (Router/End devices), it is best suited for intermittent data transmissions from a sensor or input device. The technology defined by the ZigBee specification is supposed to be simpler and less expensive than other wireless personal area networks (WPANs), such as Wi-Fi or Bluetooth. For example DigiXbee series modules S1 and S2 implement the IEEE 802.15.4 radio and ZigBee networking protocol [3,6].

2.4. ARM 11 MICROPROCESSOR

ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, which offers high performance and very low power consumption, and the instruction set and decode mechanism are much simpler than those of Complex Instruction Set Computer[9]s. The ARM11 is a microcontroller for RISC Machines. This are general purpose 32 Bit microprocessors, which offer high performance and very low power consumption. The ARM11 is a high performance ARM controller/processor with 256Mbytes RAM and 1 GB flash, RTC and audio and Ethernet on board. It has integrated RS232, USB, keyboard, LCD, camera, SD cord and other functions on board[10].

Fig-5. ARM 11 MICROPROCESSOR

2.5 MQ 5 GAS SENSOR

A gas sensor is a device which detects the presence of gas in the environment. This sensor detects a gas to measure its concentration. Each gas has a unique breakdown. Sensor identifies gases by measuring these voltages. Gas Sensor(MQ5) module is useful for gas leakage detecting(in home and industries). It can detect hydrogen, carbon monoxide, methane and LPG ranging from 100ppm to 3,000ppm.. Based on its fast response time. Wide detecting scope are Stable , long life and Fast response and High sensitivity High sensitivity to LPG, natural gas , town gas.

Fig-6: MQ 5 GAS SENSOR

There are various sensors which are used for environmental conditions like temperature, humidity sensors and some sensors measures gases in environments like smoke and other substances. Some sensor are widely used in smart homes.

3. WSN & WORKING OF SENSOR NODE

Wireless sensor network (WSN) is includes various technologies and bring out the best in them. WSN's are localised and its nodes are Used in gathering information, processing it and delivering results without a backbone network for support. Also, more importantly it is capable of manage networks and environmental conditions.

4. Environment monitoring has been around for years and is one of the most widely used applications of a WSN.

5. Sensor node is used in the end device side to sense the environmental conditions. It also consists of ZigBee protocol based radio transceiver unit, temperature sensor, humidity sensor, pressure sensor and power supply unit.

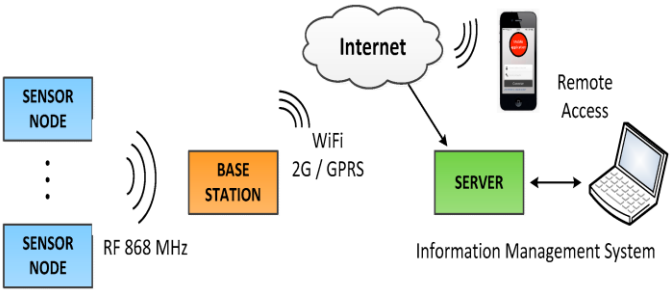

Fig-7: WORKING OF SENSOR NODE

As mentioned in above fig-7 working of sensor nodes. Sensor node includes some important factors like base stations ,sensor node and remote acess. sensor node is a device that is able to sense, compute, store, transmit and receive data.

1. Base station

Base station is used to communicate between sensor nodes and database server. It transfer the data to the server that were fetch by sensor node.

2. Sensor node

Sensor nodes are used to sense the data from environmental parameters or conditions.

3. Server

Database server is used for data processing. Server is gather information from the device and processed this information to devices from the network. Multiple servers are designed in gateway, which start at the same time and receive various forms of data.

4. INTERFACING BETWEEN RASPBERRY PI AND XBEE

Raspberry pi acts as a base station which connects to various sensor nodes by zigbee communication protocol and users by external network (internet etc.). For wireless communication and multihop networking protocol, we used XBee series module S2 from Digi international. Xbee module is configured as coordinator on the raspberry pi. Raspberry pi can be connected to XBee module directly through USB cable and also by UART serial communication interface [8,2].

Fig-8: XBEE CONFIGURED WITH RASPBERRY PI

UART (universal asynchronous receiver-transmitter) is used to control serial communication . As XBee module can be configured into three types of devices: coordinator, router, and end device. Coordinator has the capability to control the entire network. The base station also acts as a gateway in this application. The data collected or detected by sensor node sends to the base station and inserts the data received from sensor nodes into database of raspberry pi. Multiple users can access the raspberry pi through Ethernet or Wi-Fi connection within local area network or from anywhere on the internet [9,2].

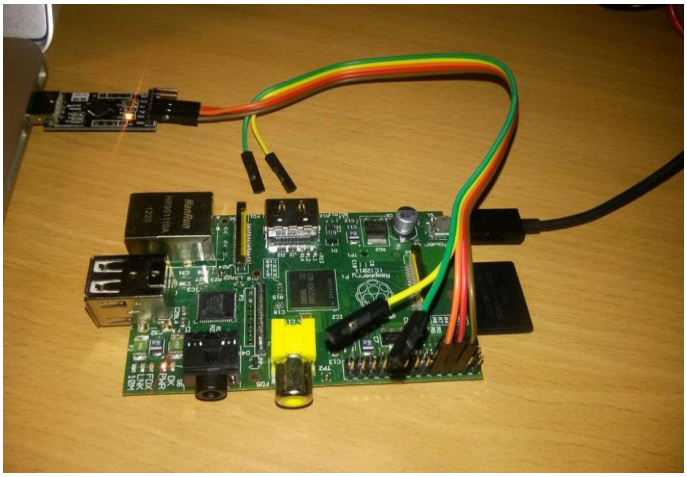

Fig-9 : RASPBERRY PI CONNECTS WITH UART

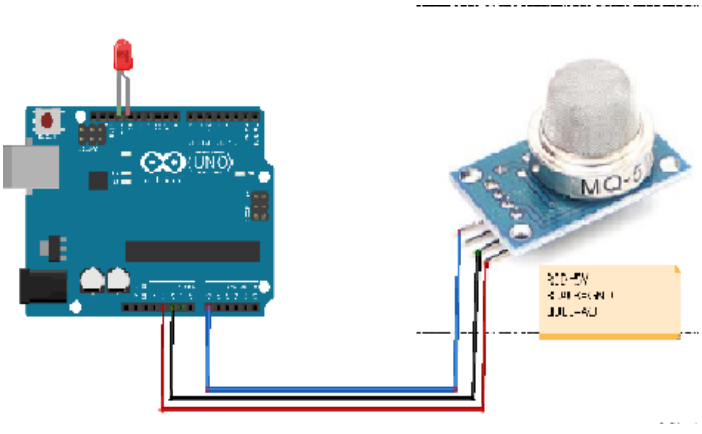

Fig-10: ARDUINO CONNECTED WITH MQ 5 GAS SENSOR

5. SYSTEM OVERVIEW

Fig-11 shows the functional block diagram of system architecture.These are includes various types devices and shows communications between them.

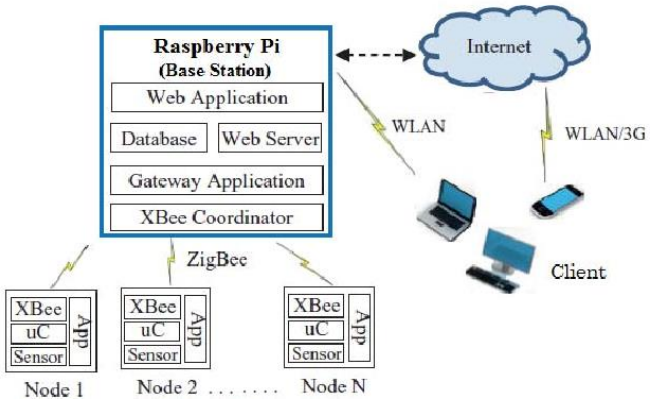

Fig-11: FUNCTIONAL BLOCK DIAGRAM OF SYSTEM ARCHITECTURE

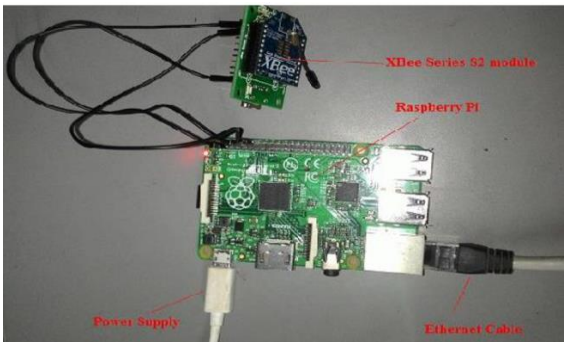

Fig-12: BASE STATION SETUP

In system architecture there are various devices that are communicate with each others and this procedure and devices are defined as follows –

1. Sensor node
   First , Sensor node sense the data from the sensor and this data is received at end tags.

2. End tag
   Second, end tag receives the data from sensor node, After receiving this data end tag search the nearest router if router is in range then the data will be send instantly to the router

3. Router to Coordinator
   Third , router send data to coordinator and coordinator is directly communicate with the base station.

4. Base Station
   Fourth ,Base station sends all data to the cloud or Ethernet (Database server).

5. End users
   Finally , End Users or clients can interact with the web application within the local area network from any terminal on the Internet to access the sensor data, otherwise it perform remote configuration and management of deployed sensor nodes [3].

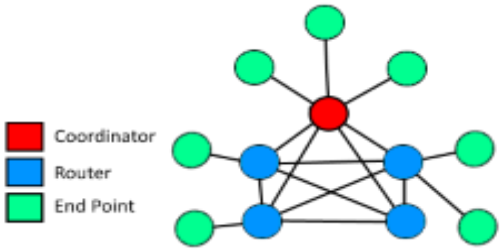

Fig-13: DESIGN & TYPES OF DEVICES

In above fig-13 it is a mesh network that uses router nodes in addition to its coordinator node and endpoints. These router radios can pass messages to other routers as well as their child endpoints. In this topology, the coordinator is simply a special router that also maintains and secures the PAN.

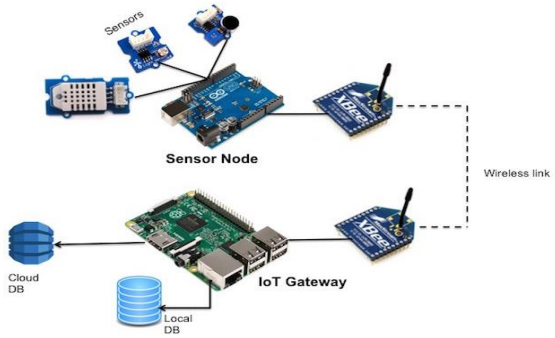

Fig-14: OVERALL SYSTEM DESIGN

Fig-15: Router-R1-Received-Data-Send-by-End-Tag-E52

Fig-16: Router-R1-Received-Data-Send-by-End-Tag-E52

6. RESULT

This paper designs a wireless sensor network system using Raspberry Pi as a base station, XBee as a networking protocol, sensor node as combination of sensors, controller and zigbee. This system has low-cost, low power consumption, and easy to maintain . Benefit of system is consist in the combination of the gateway node of wireless sensor network, database server, and web server into one single compact, low-power, credit-card-sized computer that is Raspberry Pi, which can be easily run without monitor, keyboard, and mouse. These system is helpful in many environmental monitoring applications.

7. CONCLUSION

This paper proposes a WSN based on IOT for environment monitoring using a simple, cost-effective and low-power method, easy to use and easily accessible by the users due to the open source platforms used in the systems.. An Arduino platform connected with a Raspberry Pi is used for data processing and data storage independently. Data sense by the sensor node and it is stored in database & web interface which is provided to client. As web interface is provided, the client can easily monitor the system at any time and thus it helps to reduce human actions. This system is design as low cost , low power along with high transmission rate & processing ability.

REFERENCES

1. 1ANJUM SHEIKH, 2TUSHAR UPLANCHIWAR – "IMPLEMENTATION OF A LOW COST WIRELESS SENSOR NETWORK FOR INTERNET OF THINGS" Volume-5, Issue-5, May-2017

2. 1Nagaraj Patil, 2Anand K Warad-"IOT and Raspberry PI Based Environmental Monitoring Application" Volume -4, Issue-4, 2016

3. Soniya Sunny,Rejin Mathew, Kuruvilla John-" Automatic Environmental Monitoring System using Wireless Sensor Network" Volume 8 Issue 1 – February 2017

4. Vujovic, V.; Maksimovic, M., "Raspberry Pi as a Wireless Sensor node: Performances and constraints," Information and Communication Technology, Electronics and Microelectronics (MIPRO), 2014 37th International Convention on, vol., no., pp.1013,1018, 26-30 May 2014,

5. Kochlan, M.; Hodon, M.; Cechovic, L.; Kapitulik, J.; Jurecka, M., "WSN for traffic monitoring using Raspberry Pi board," Computer Science and Information Systems (FedCSIS), 2014 Federated Conference on, vol., no., pp.1023,1026, 7-10 Sept. 2014

6. DigiInternational Inc., available at http://www.digi.com.

7. ZigBee Specification.ZigBee Alliance 2006.http:// www.zigbee.org/.

8. Sheikh Ferdoush, Xinrong Li "Wireless Sensor Network System Design using Raspberry Pi and Arduino for Environmental Monitoring Applications", Elsevier The 9th International Conference on Future Networks and Communications (FNC-2014)

9. Srinivasa, R.V, Nageswara, R and Kumari, E.K. (2009). Cloud computing: An overview. Journal of Theoretical and Applied Information Technology, 9(1), 71-76.

10. Sudhir G. Nikhade – "Wireless Sensor Network System using Raspberry Pi and Zigbee for Environmental Monitoring Applications" 2015 International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials (ICSTM)

11. Aarti Rao Jaladi 1, Karishma Khithani2, Pankaja Pawar3, Kiran Malvi4, Gauri Sahoo5 –" Environmental Monitoring Using Wireless Sensor Networks(WSN) based on IOT." Volume: 04 2017, IRJET | Impact Factor value: 5.181 | ISO 9001:2008 Certified Journal

12. Tarun Agarwal – "Wireless Sensor Network Architecture and Its Applications" Sensor & sensor node - Scott Broscious.

13. C. Pfister, Getting Started with the Internet of Things. Sebastopol, CA: O'Reilly Media Inc., 2011.

14. Matt Richardson and Shawn Wallace Getting Started with Raspberry Pi.,2011

15. Sheikh Ferdoush, Xinrong Li "Wireless Sensor Network System Design using Raspberry Pi and Arduino for Environmental Monitoring Applications", Elsevier The 9th International Conference on Future Networks and Communications (FNC-2014)