Adopting IOT in Wireless Sensor Networks for Environmental Monitoring

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Abstract: In wireless sensor network system, the sensor node sense the data from the sensor and that data collects the end tags, end tags send its data to the router and router to coordinator and supply multi-clients services including data display, the whole data will be stored in base station and the stored data will send to the cloud and the client can visit the base station remotely via (website) Ethernet. Such a sensor are temperature, vibration, pressure, moisture, light, and pollution. Now a days we have seen a short range of wireless technologies like Wi-Fi, Bluetooth [7], Zig Bee [6], becoming prominent in front of us. In this paper we aims at building a system which can be used on universally at any scale to manage the parameters in each and every environment. Raspberry-pi and sensors collects all the real-time data from environment and this real-time data is fetched by the web server and display it. User can access this data from anywhere through Internet. Raspberry Pi works as a base station which connects the number of distributed sensor nodes via zig bee protocol. Wireless Sensor Networks (WSN) has been employed to collect data about physical phenomenon in various applications such as habitat monitoring. The Internet of Things (IOTs) can be described as connecting everyday objects like smart-phones, Internet TVs, sensors and actuators to the Internet where the devices are intelligently linked together enabling new forms of communication between things and people, and between things themselves.

Key Words: (Raspberry pi; Zig bee; Sensor node; Sensors)

I.INTRODUCTION

The Internet of Things (IOT) is an emerging key technology for future industries, and environmental monitoring. The Internet of Things (IOTs) can be described as connecting everyday objects like smart-phones, Internet TVs, sensors and actuators to the Internet where the devices are intelligently linked together enabling new forms of communication between things and people, and between things themselves. Building IoTs has advanced significantly in the last couple of years since it has added a new dimension to the world of information and communication technologies. The development in wireless sensor networks can be used in monitoring and controlling various parameters in the agriculture field, weather station field. The sensor network hardware platforms are basically low-power embedded systems with some different sensors such as onboard sensors and analog I/O ports to connect sensors. Like hardware, software should also be developed, including OS, sensor/hardware drivers, networking protocols and application-specific sensing and processing algorithms. The purpose or objective of environmental monitoring is different in different situations, but important aims to environmental monitoring to find risks to human and wildlife, scope to population migration from high density areas to low density areas and to restrict emission of gases.Wireless sensor network (WSN) is a low cost, low power wireless network made up of thousands of smart sensor nodes which monitor physical or environmental conditions, such as temperature, pressure, moisture, etc. at different area or different location.

II. INTERNET of THINGS (IOT)

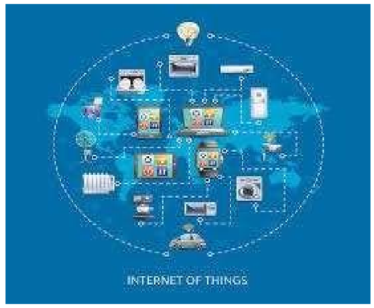

Fig-1: Internet of Things (IOT)

The phrase of Internet of things (IOT) heralds a vision of the future Internet where connecting physical things, from banknotes to bicycles, through a network will let them take an active part in the Internet exchanging information about the physical world and the objects in it-leading to innovative services and increasing efficiency and productivity. During the past few years, in the area of wireless sensor networks and communications, a novel paradigm named the (IOT which was first introduced by Kevin Ashton in the year 1998,has gained increasingly more attention in the academia and industry.By embedding short-range mobile transceiver into a wide array of additional gadgets and everyday items, enabling new form of communication between people and things, and between things themselves, IOT would add a new dimension to the world of information and communication.

III. WIRELESS SENSOR NODE (WSN)

The main components of a sensor node are a microcontroller, transceiver, external memory, power source and one or more sensors. The controller performs tasks, processes data and controls the functionality of other components in the sensor node.

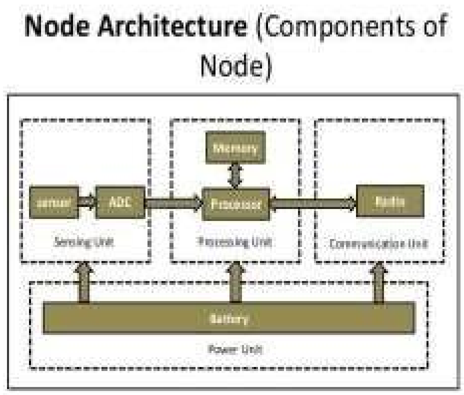

Fig-2: Architecture of Wireless Sensor Network (WSN)

While the most common controller is a microcontroller, other alternatives that can be used as a controller are: a general-purpose desktop microprocessor, digital signal processors, FPGAs and ASICs. A microcontroller is often used in many embedded systems such as sensor nodes because of its low cost, flexibility to connect to other devices, ease of programming, and low power consumption. Transceiver Sensor nodes often make use of ISM band, which gives free radio, spectrum allocation and global availability. The possible choices of wireless transmission media are radio frequency (RF), optical communication (laser) and infrared. Radio frequency-based communication is the most relevant that fits most of the WSN applications. WSNs tend to use license-free communication frequencies: 173, 433, 868, and 915 MHz; and 2.4 GHz. The functionality of both transmitter and receiver are combined into a single device known as a transceiver. From an energy perspective, the most relevant kinds of memory are the on-chip memory of a microcontroller and Flash memory—off-chip RAM is rarely, if ever, used. A wireless sensor node is a popular solution when it is difficult or impossible to run a mains supply to the sensor node. However, since the wireless sensor node is often placed in a hard-to-reach location, changing the battery regularly can be costly and inconvenient. An important aspect in the development of a wireless sensor node is ensuring that there is always adequate energy available to power the system. The sensor node consumes power for sensing, communicating and data processing. More energy is required for data communication than any other process.

IV. OVERALL ARCHITECTURE

Sensor node is a major part in this system it is responsible for information or sensor data. Raspberry pi manages multiple sensor nodes. Design and Implementation of Environment monitoring system using Raspberry-Pi which contains interfacing with various sensors (temperature, Humidity, CO2, Vibration). Real time data will be collected by all the sensors and will be fetched by the Webserver. The gateway node of wireless sensor network, that is raspberry pi (base station) consist of database server and web server in one single-board computer hardware platform, it reduces the cost and complexity of deployment. Sensor node sense the data from the sensor and that data receives the end tag, end tag search the nearest router if router in its range it immediately sends the data to the router, next router to coordinator, here coordinator is directly communicating with the base station. Base station sends all data to the cloud or Ethernet (Database server). The WSN is built using a coordinator node and several sensor nodes, a workstation and a database.

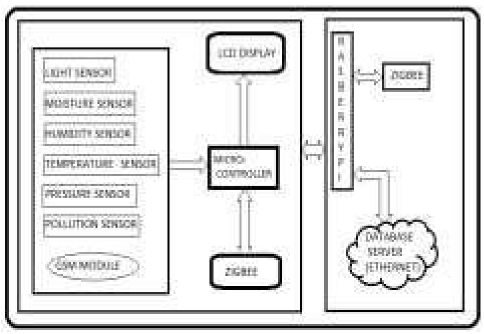

Fig-3: The overall system architecture

a) Raspberry PI

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. The raspberry pi is the cheapest ARM11 powered Linux operating system single board computer board. This board runs an ARM11 microcontroller @1GHz and comes with a 1GB of RAM memory [16,17], as this model has better specifications as compared to other raspberry pi models such as raspberry pi B and B+ model [4]. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games. It supports 32GB external SD or micro SD card, the device consists a 4USB ports.

Fig-4: Raspberry PI

b) Arduino

The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila. Arduino Mega, etc. I used Arduino Uno in this development. Arduino is based on ATmega328. The package contains a 16 MHz ceramic resonator, a USB connection, a power jack and ICSP header and a reset button. Instead of using the FTDI USB-to-serial driver chip our Arduino features the Atmega16U2 chip programmed as a USB-to-serial converter.

Fig-5:Arduino Mega

c) XBee Module :

The XBee Shield simplifies the task of interfacing an XBee with your_Arduino. This board mates directly with an Arduino Pro or USB board, and equips it with wireless communication capabilities using the popular XBee module. ZigBee devices can transmit data over long distances by passing data through a mesh network topology. The ZigBee transmission data rate is 250 Kbit/s [6]. Zigbee is an established set of specifications for wireless personal area networking (WPAN), i.e. digital radio connections between computers and related devices. For the wireless communication between sensor nodes and the gateway node ZigBee RF modules were used. All the ZigBee devices are based on ZigBee standard which has adopted IEEE 802.15.4 for its physical layer and MAC protocols. The wireless devices based on this standard operate in 868 MHz, 915 MHz and 2.4 GHz frequency bands having a maximum data rate 250Kbps. ZigBee protocol layers are based on OSI model. When the pan is to use ZigBee, it is necessary to mention IEEE 802.15.4 standard. One of the finest characteristics about this standard is it allows user to use PHY and MAC layer defined by IEEE 802.15.4 and lets user to define the upper layers of the OSI model. Similarly, ZigBee also use the MAC and PHY layer of IEEE 802.15.14 standard.

Fig-6: XBee Module

V. SENSORS AND Its CHARACTERISTICS

a) MQ7 Sensor

MQ-7 gas sensor composed by micro AL2O3 ceramic tube, Tin Dioxide (SnO2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-7 have 6 pin ,4 of them are used to fetch signals, and other 2 are used for providing heating current.

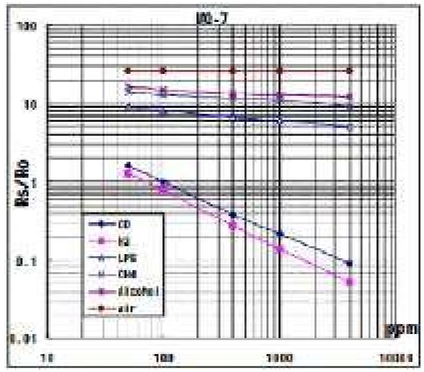

Fig-7: Sensitivity Characteristics

VI. INTERFACING BETWEEN RASPBERRY PI AND XBEE

XBee module is configured as coordinator on the raspberry pi. Raspberry pi can be connected to XBee module directly through USB cable and by UART serial communication interface [3]. 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. Raspberry pi acts as a base station which connects to sensor nodes by zig bee Communication protocol and clients by external network (internet etc.). Python is a widely used general-purpose, high-level programming language, its syntax allows programmers to express concepts in fewer lines of code than would be possible in languages such as C++ or Java. For wireless communication and multi-hop networking protocol, we used XBee series module S2 from Digi international. Multiple users can access the raspberry pi through Ethernet or Wi-Fi connection within local area network or from anywhere on the internet.

Fig-8: Interfacing between raspberry pi and sensor

VII. RESULTS

In wireless sensor network, there are three types of devices: coordinator, router and end tags shows in figure 8. Open source data platform for the Internet of Things provides access to a broad range of embedded devices and web services. So, here one XBee is configured as a coordinator, which is connected with the raspberry pi using UART protocol shows in figure-8 Here sensor node is configured as router (R1and R2) and end tag(E52), it will send its real-time data to the nearest router. There is only one coordinator in the network, which communicates with the base station (raspberry pi).

Step1: In WSN system the sensor node sense the data from the sensor.

Fig-8: Interfacing sensors with Arduino

Step2: Sense data receives the end tags and end tag search the nearest router.
Step3: If router it in range than end tag sends the data to the router.
Step4: router to coordinator and coordinator directly communicate with base station.

VIII. CONCLUSIONS

Comparing with collection and forwarding information or data of traditional base station (gateway), this system has low-cost, low power consumption, and easy to maintain. 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. Hence, we can create sensor-logging application, location-tracking applications, and a social network of things with status updates, so that you could have your location parameter control itself based on your current location. One major advantage of the system lies in the integration of the gateway node of wireless sensor network, database server, and web server into one single compact, low-power, credit-card-sized computer Raspberry Pi, which can be easily configured to run without monitor, keyboard, and mouse. Such a system is very useful in many environmental monitoring and data collection.

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