Analysis of Wireless Sensors For Environmental Monitoring

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Abstract- *The recent changes in climate have increased the importance of environmental monitoring, making it a topical and highly active research area. This field is based on remote sensing and on wireless sensor networks for gathering data about the environment. Recent advancements, such as the vision of the cloud computing model, and cyber-physical systems, provide support for the transmission and management of huge amounts of data regarding the trends observed in environmental parameters. In this context, the current work presents different wireless sensors for environmental and ambient monitoring: one employing IOT communication, one communicating through IOT and Hypertext Transfer Protocol (HTTP). All of the presented systems provide the possibility of recording data at remote locations and of visualizing them from every device with an Internet connection, enabling the monitoring of geographically large areas. The development details of these systems are described, along with the major differences and similarities between them. The feasibility of the three developed systems for implementing monitoring applications, taking into account their energy autonomy, ease of use, solution complexity, and Internet connectivity facility, was analyzed, and revealed that they make good candidates for Cloud computing model.*

Keywords- IOT, Temperature Sensor, Humidity, Rain detector, Environmental monitoring.

I. INTRODUCTION

The Internet of Things is a network of physical objects that consists of sensors, software and electronics which have the ability to communicate with each other as well as with users. It is rapidly evolving due to the convergence of information and communication technologies and the internet. One of the applications of Internet of Things (IoT) in the urban context is the smart city that promises to improve the quality and performance of urban services by the use of Information and Communications Technology (ICT). It also improves the life style of the citizens by providing better facilities and simultaneously reduces the administrative efforts for management of the city enabling effective utilization of resources and better quality of services. The services for which quality can be enhanced in a smart city are monitoring the strength of buildings, waste management, air quality management, weather monitoring, noise monitoring, traffic management, parking management, energy consumption management and automation buildings. Temperature, humidity and CO2 are the basic parameters for services like; (i) air quality management for reduction of pollution and healthy environment [1], (ii) weather monitoring for future agricultural actions and human comfort [2] and (iii) automation of public buildings for reducing human effort and energy consumption [3]. To achieve this a wireless sensor node is required to collect and monitor the data wirelessly. There have been numerous efforts on microclimate monitoring using Wireless Sensor Network (WSN).

The initial efforts of using ICT based technology for microclimate monitoring system that monitors parameters like temperature and humidity on a mobile device in [4] and [5] is discussed. The deployment and networking and routing issues for similar microclimate monitoring systems is discussed in [6]. In [2], [3] and [7] authors report indoor air quality monitoring by measuring pollution levels for indoor environments, the importance of energy consumption and the requirements of very low-power WSNs for microclimate monitoring. In an earlier work, we have developed independently a battery less wireless temperature sensor node for smart building applications in [8] and [9] attaining energy autonomy. By doing so, the problem of replacing batteries, often a cumbersome and expensive process is addressed. More recently, in [1], authors discuss the importance of technologies and architecture for urban IoT and a proof of concept monitoring system for a smart city. This paper discusses our efforts to develop a customized IoT enabled environment monitoring system to monitor important parameters such as temperature, humidity and CO2. To the best of our knowledge, this is the first effort to monitor environmental parameters within one of the smart cities in India.

Present innovations in technology mainly focus on controlling and monitoring of different parameters. An efficient environmental monitoring system is required to monitor and assess the conditions in case of exceeding the prescribed level of parameters (e.g., temperature, humidity and rain levels). When the objects like environment interfaced with sensor devices, microcontroller and various software applications becomes a protecting and monitoring environment and it is also called as smart environment. In such environment when some event occurs the alarm or LED alerts automatically. Projecting the embedded intelligence into the environment makes the environment interactive with other objectives. Initially the sensor devices are deployed in environment to detect the parameters (e.g., temperature, humidity and rain levels etc.) while the data acquisition, computation and controlling action brings awareness about the variations in the environmental parameters . Sensor devices are placed at different locations to collect the data to predict the behavior of a particular area with variations in parameters. The main aim of the this paper is to design and implement an efficient monitoring system through which the required parameters are monitored remotely using internet and the data gathered from the sensors are stored in the cloud and to project the estimated trend on the web browser.

This paper is organized as follows. Section II presents the architecture of the proposed WSN and the methodology used for data transmission. Section III reports the experimental results derived during the implementation and validation of the presented system, through its deployment. Section IV concludes this paper and provides some prospective on possible future work.

II. SYSTEM DESCRIPTION

The proposed IoT enabled sensing and monitoring system consists of a transmitter node (TX node) and receiver node (RX node) as shown in Fig 1. The sensed data from the TX node is transmitted to RX node through wireless communication. Finally, the data received at the RX node is transferred to a personal computer (PC) through a USB interface. The sensed data is depicted graphically and recorded in an excel sheet through a customized Graphical User Interface (GUI), which is developed in PROTEUS. This data is then transmitted to a MySQL database via internet. The PHP API execution, on internet enables transfer of data from the MySQL database to the android based smart phone, thereby enabling IoT based applications.

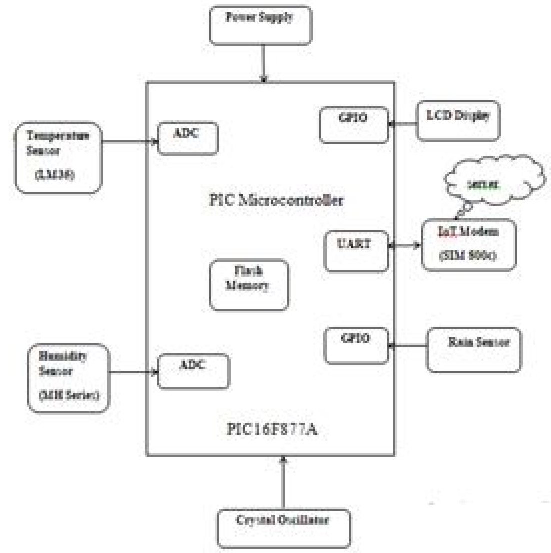


Fig 1. Block Diagram of Wireless Sensors for Environmental Monitoring

A. EXISTING SYSTEM

The existing model describes the original value of the environmental parameters with the help of the sensor networks. The environmental parameters are sensed primarily by the respective sensor devices. The sensor devices are based on three parameters. They are threshold value, duration which Time or Space and LED. If the monitored value exceeds the fixed value then there is an indication given by the LED. The next target is done by the data acquisition and the decision making devices. These devices specify the condition which represents the parameters. The intelligent environment identifies the variations in the sensor data and fix the threshold value depending on the identified level of sensors .The sensed data's are stored in the Google spread sheets and also it will show a trend of the sensed parameters with respect to the specified values. The end users can browse the data using mobile phones, PC's etc. and wireless sensors for environmental and ambient monitoring: one employing User Datagram Protocol (UDP)-based Wi-Fi communication, one communicating through Wi-Fi and a third one using Bluetooth Smart.

B. PROPOSED SYSTEM:

In proposed system the environment field is based on remote sensing and on wireless sensor networks for gathering data about the environment. Recent advancements, such as the vision of the cloud computing model, and cyber-physical systems, provide support for the transmission and management of huge amounts of data regarding the trends observed in environmental parameters. In this context, the current work presents different wireless sensors for environmental and ambient monitoring: one employing IOT communication, one communicating through IOT and Hypertext Transfer Protocol (HTTP). All of the presented systems provide the possibility of recording data at remote locations and of visualizing them from every device with an Internet connection, enabling the monitoring of geographically large areas. The development details of these systems are described, along with the major differences and similarities between them. The feasibility of the three developed systems for implementing monitoring applications, taking into account their energy autonomy, ease of use, solution complexity, and Internet connectivity facility, was analyzed, and revealed that they make good candidates for Cloud computing model.

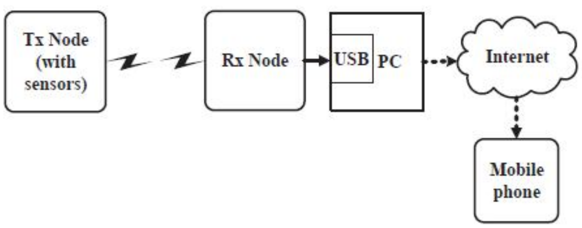


Fig 2. Architecture of the IoT enabled sensing and monitoring system

III. WORKING

1. Environmental monitoring

Environmental monitoring applications of the IoT usually use sensors to lend a hand in environmental protection by monitoring air or water quality, atmospheric or soil conditions, and can even include areas like monitoring the movements of wildlife and their habitats. Development of resource constrained devices connected to the Internet also means that other applications such as tsunami or earthquake early warning systems can also be used by emergency services to provide effective aid. The analysis will be carried out for pollution due to changes in parameters because of Climate (Rain, Temperature, Environment, and Dust) change.

2. TX Node

The proposed IoT enabled sensor node (IoT-SN) consists of a temperature and humidity sensor, CO2 sensor, an ultra-low power µcontroller and a wireless transceiver as shown in Fig 2. The temperature, humidity and rain detector readings are processed by the µcontroller and transmitted through the wireless transceiver. The receiver node has the same components except the onboard sensors. Data sensing and aggregation on the node can be configured by a customized software code and is dependent on the application. Further to this, a custom voting algorithm is implemented at TX node for data reliability. Power is supplied to the TX node by three AA batteries, while the receiver node attached to a PC is powered through the USB interface. Below figure shows the flowchart for analysis of wireless sensors for environmental monitoring.

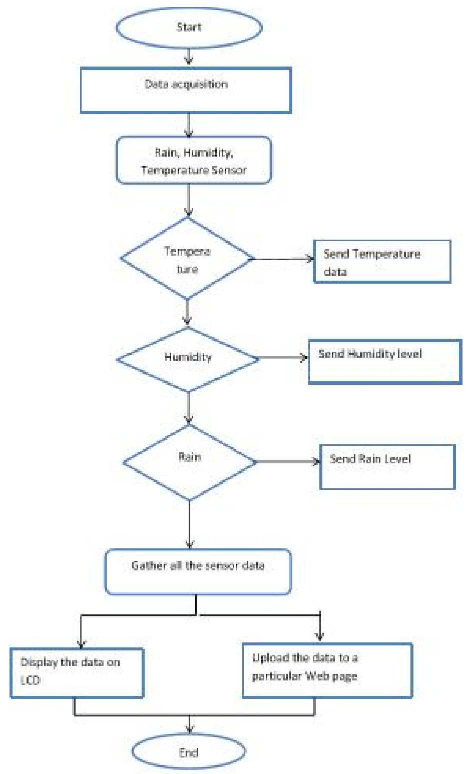


Fig 3. Architecture of the IoT enabled sensing and monitoring system

3. SENSOR

Temperature sensor (LM35)

The LM35 is a digital temperature sensor capable of reading temperatures from -55°C to +125°C. Temperature data is measured from an integrated temperature sensor and converted to digital word with a user selectable 9 to 12-bit Sigma Delta Analog to Digital Converter. The MCP9800 notifies the host controller when the ambient temperature exceeds a user programmed set point. The ALERT output is programmable as either a simple comparator for thermostat operation or as a temperature event interrupt. Communication with the sensor is accomplished via a two-wire bus that is compatible with industry standard protocols. This permits reading the current temperature, programming the set point and hysteresis and configuring the device. Small physical size, low installed cost and ease of use make the MCP9800 an ideal choice for implementing sophisticated temperature system management schemes in a variety of applications.

4. Rain Detector

Water is basic need in every one's life. Saving and proper usage of water is very important. Here is an easy method which will give the alarm when there is rain, so that we can make some actions and save the rain water. The rain detector is suitable for outdoor use. The sensing part of the probe is an etched area which consists of three carbon electrodes separated by a waterproof resin. The sensing area is smooth to allow water droplets to run off more easily.A slower, longer beep may be had by increasing the 1 uF capacitor. The 10 k resistor may be increased for a longer beep time without decreasing the beep rate but at some point the circuit will cease to function properly, depending on the gain of the transistors.

Fig 4. Prototype for Rain detector sensor

5. PIC MICROCONTROLLER

The PIC 16F877A PIC microcontroller is one of the most popular general purpose microcontrollers. It is of 8-bit which means the most available operations are limited to 8-bits.It is a 40-pin IC Peripheral Interface Controller (PIC) is introduced by Microchip technology. PIC 16F877A is a family of CMOS 8-bit Flash microcontroller. Power consumption is very low. PIC16F877A is a 40/44-pin device which can operate at up to 20 MHz clock speed. It has 8K * 14 words flash program memory, 368*8 RAM data memory, 64bytes of EEPROM nonvolatile data memory, 8-bit timer with watchdog timer, Only 35 single-word instructions to learn, external and internal interrupt sources and large sink and source capability.

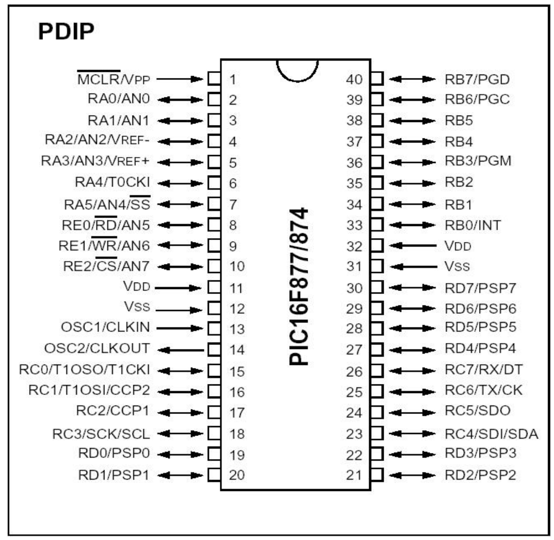


Fig 5. Pin Diagram of PIC16f877A

PIC microcontrollers have a data memory bus of 8-bit and a program memory bus of 12, 14 or 16 bit length depending on the family. AC voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired DC output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes.

HARDWARE REQUIREMENTS

- PIC Microcontroller
- IOT Modem
- Temperature sensor
- Humidity sensor
- Rain Detector
- Buzzer
- LCD
- Power Supply

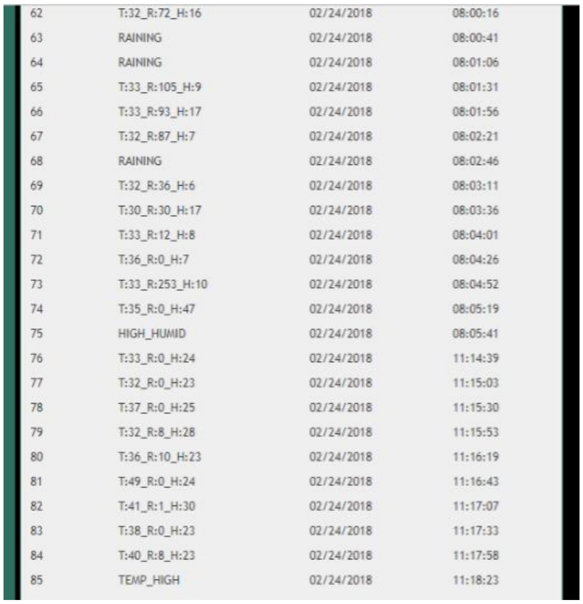
SOFTWARE REQUIREMENTS

- Development Tool: MPLAB IDE
- Programming language: Embedded C

IV. IMPLEMENTATION AND RESULT ANALYSIS

• Any Smart Phone.
• Sensors.
• Cloud / Big Data.
• Internet of Things.

- Internet connection is also required.
- Any Locality.



62	T:32_R:72_H:16	02/24/2018	08:00:16
63	RAINING	02/24/2018	08:00:41
64	RAINING	02/24/2018	08:01:06
65	T:33_R:105_H:9	02/24/2018	08:01:31
66	T:33_R:93_H:17	02/24/2018	08:01:56
67	T:32_R:87_H:7	02/24/2018	08:02:21
68	RAINING	02/24/2018	08:02:46
69	T:32_R:36_H:6	02/24/2018	08:03:11
70	T:30_R:30_H:17	02/24/2018	08:03:36
71	T:33_R:12_H:8	02/24/2018	08:04:01
72	T:36_R:0_H:7	02/24/2018	08:04:26
73	T:33_R:253_H:10	02/24/2018	08:04:52
74	T:35_R:0_H:47	02/24/2018	08:05:19
75	HIGH_HUMID	02/24/2018	08:05:41
76	T:33_R:0_H:24	02/24/2018	11:14:39
77	T:32_R:0_H:23	02/24/2018	11:15:03
78	T:37_R:0_H:25	02/24/2018	11:15:30
79	T:32_R:8_H:28	02/24/2018	11:15:53
80	T:36_R:10_H:23	02/24/2018	11:16:19
81	T:49_R:0_H:24	02/24/2018	11:16:43
82	T:41_R:1_H:30	02/24/2018	11:17:07
83	T:38_R:0_H:23	02/24/2018	11:17:33
84	T:40_R:8_H:23	02/24/2018	11:17:58
85	TEMP_HIGH	02/24/2018	11:18:23

Fig 5. Block Diagram of wireless sensors for environmental monitoring

Cloud Storage: Cloud storage1T 1Tis a model of data storage in which the digital data is stored in logical pools, the physical storage spans multiple servers, and the physical environment is usually owned and managed by a1T 1Thosting1T 1Tcompany. These cloud storage providers are responsible for keeping the data obtainable and accessible, and the physical environment protected and running.

V. CONCLUSION AND FUTURE WORK

The proposed IoT enabled environmental monitoring system for monitoring temperature, relative humidity and rain detector has been successfully implemented and validated at various places. The proposed IoT enabled environmental monitoring system compares well with the similar designs discussed in [1-3]. Apart from sensing temperature, humidity and rain detector; the sensor node has a lower power consumption of 4.99mW. The reliability (valid data at the receiver's side) of the system is approximately 65%. On a multi hopping mechanism whereas the single hopping ensures more than 99% reliability that could be improved and is left as a future work.

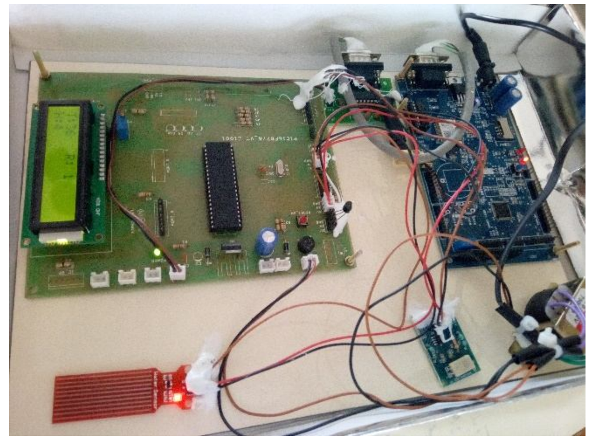


Fig 5. Block Diagram of wireless sensors for environmental monitoring

Furthermore, the predicted network lifetime can be increased simply by expanding the sleep time of the microcontroller which reduces the power consumption significantly. Power consumption of the sensor node is calculated from the different states of the node and is measured that could be further optimized and is also left as a future work. The quantification of the time along with the current consumption of the proposed IoT-SN provides an intuitive way to deploy the sensor nodes based on the available power. Furthermore, the proposed IoT-SN has an added advantage of remote access to the sensing data through an application that is tested on a smart phone based on Android.

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