MUETSenses: A Wireless Sensor Network Based Indoor Environment Monitoring System

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Abstract— **A novel approach to the design of a Wireless Sensor network (WSN) based indoor environment monitoring system, which parses data in real time, on demand and periodically is presented. The aim of this system is to monitor indoor environment remotely, through an android application. The system comprises of Crossbow Iris motes, MTS 400 Sensor board, MIB 520 data accusation board designed by UC Berkley and Intel, and a base station to monitor environmental parameters such as light, pressure humidity and temperature. The system exploits mote view software to acquire data from the wireless sensors network. At the back-end, a database has been developed to load the data from mote view and the system pushes data from the database to an android application designed for the system. The system enables users to monitor the indoor environment parameters on their android smartphones.**

Index Terms— **Indoor Environment Monitoring;Wireless Sensor Network and Android.**

I. Introduction

Wireless Sensor Networks (WSNs) typically comprise of a large number of sensor nodes. Every sensor node is connected to a single or several nodes to sense attributes of the phenomena. A sensor node has a number of components an electronic circuit, which interfaces the battery source, a radio transceiver and a micro controller. Sensor nodes may vary in size depending on the application they are used in. Wireless Sensor Networks could be deployed on a large scale for, monitoring environment, over a battlefield for military reconnaissance and surveillance, in open environments for rescue and search operations, for condition based maintenance in factories, for infrastructure monitoring in buildings, and at medical centers for health monitoring. To deploy sensor nodes several schemes may be selected from uniform regular deployment of sensor nodes to irregular random deployment of nodes. The mobility of nodes could be stationary or the nodes could be mobile or a combination of both. Sensor nodes are assumed to be self configurable by nature, which enables sensor nodes to maximize the network lifetime. In a standard setting, users could get information from a Wireless Sensor Network by inserting queries and collecting results from the base station, which works as an interface between the users and network [1].

Wireless sensor networks is an emerging area, research is being carried out world wide for the expansion and implementation of such networks in nearly every walk of life. Extensive research has been conducted on the constraints of WSNs that are the limited resources. The research aims to present a wireless sensor network based indoor environment monitoring system.

II. Related Work

Environmental monitoring has been carried out conventionally, employing a limited number of expensive and accurate sensing units.The results of such systems were retrieved straight from the sensing units. Wireless Sensor networks provide an alternate solution, where a large number of sensor nodes is deployed. Although individual nodes have low precision, the network on the whole has far better spatial resolution, with immediately accessible data [2]. A sensor network comprises of sensor nodes, densely deployed either very close to the phenomenon or inside it. The low cost, flexibility, fault tolerance, high sensing fidelity and rapid deployment features of WSNs generate several exciting application areas for remote sensing [3].

A large number of environmental monitoring projects have been completed so far. Research has been carried out employing WSNs to observe very hostile and dangerous environment of the Tungurahua volcano. Researchers positioned a sensor network inside the volcano to observe the volcanic eruptions employing acoustic sensors of low frequency, data of 54 hours was gathered [4]. The LOFAR project [5] exploits WSNs for precision agriculture. The initial research conducted on large scale applications, of WSNs in the area of Environment Monitoring was the Great-Duck Island [6-7] a project of the university of California Berkley, United States of America.

A. Outdoor environmental Monitoring

Outdoor monitoring applications typically include habitat monitoring, hazardous chemical detection, earthquake detection, monitoring traffic, volcano eruptions, weather forecasting and flood detection. Sensor networks are now being immensely used in precision agriculture. Monitoring the temperature and moisture of the soil is among the most significant application of WSNs in agriculture. Environment monitoring, forecasting and warning of landslides are an essential feature, for saving lives and assets from devastation. There are three fundamental ways for monitoring the landslide, visual, surveying and instrumentation [8].

B. Indoor Environmental Monitoring

Indoor monitoring applications generally include monitoring of offices and buildings. Such applications involve sensing light, temperature, humidity and air quality. Mostly Zigbee protocol is used in indoor networks for connecting motes and sending data, because of its lower power consumption.

III. System Description

Work places and buildings expose the inhabitants to a variety of environmental factors including heat, pressure and humidity, which need to be monitored closely as they may pose a serious threat. The existing systems are web based, complex in nature and unscalable. Mobile platforms are moving at a tremendous pace and many manufacturers are opting for mobile applications for most of their products. MUETSenses aims to deliver, an economical, scalable system that could be deployed with ease. The system employs programmed motes, a base station, a server and an android device.

A. System Architecture

The system architecture of MUETSenses is shown in Figure 1. The System comprises of sensor nodes, base station and a server. Sensor nodes are programmed through NesC language and mesh topology is used between motes for sharing and sending data. The Zigbee protocol is used between motes as it has efficient processing. The base station gets the data from all the motes. The base station is responsible for forwarding the data to the server where the data is processed. The end users could access the processed data available at the server from the android application on their handheld devices.

B. Hardware Description

The hardware used in this project for monitoring environment includes Iris motes MTS 400, Sensing Boards and Mib520 Data acquisition board. Iris motes were used for collecting data from the sensor boards.

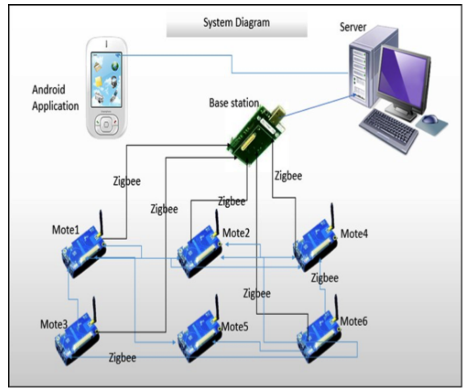

Fig. 1. System Architecture

MTS 400 sensing boards on which different sensors are mounted were used for sensing environmental parameters, MIB 520 data accusation board was used as the base station, where all sensors send data and MIB 520 was responsible to send data to database.

C. Software Description

The entire project is based on software platforms and programming languages. The platform and programming languages include:

- Mote Config
- Mote view
- Eclipse
- NesC
- Java
- Php MyAdmin

Mote config was used to load programs in motes. The NesC language was used for programming the sensors and visualizing the data coming from different types of sensors. The Mote view software was used for the transmission of information to the server. The design and the implementation of the android application, was completed on the Eclipse IDE. Java was used for coding and PHP MyAdmin managed the data stored in the database.

IV. Interfacing

Sensors are sophisticated devices that are used to sense and measure the non-physical elements. Different types of sensors are used for measuring a range of parameters, which are converted into electrical signal for further processing. Sensors are required to have a high accuracy as a marginal error may have an extreme effect. Sensors could be classified in different groups based on their nature and functionality. A number of sensors could be mounted on a single board.

Iris motes are used in this project. The IRIS mote is a 2.4 GHz module, used to deploy a low-power

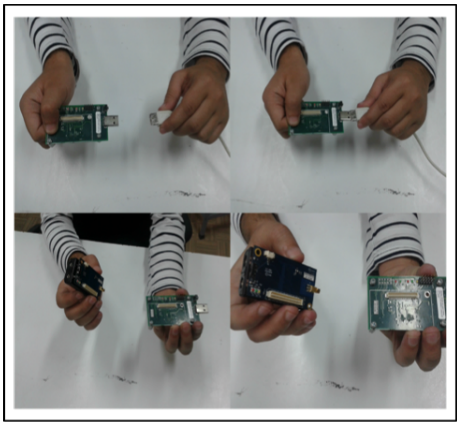

Fig. 2. Interfacing Motes

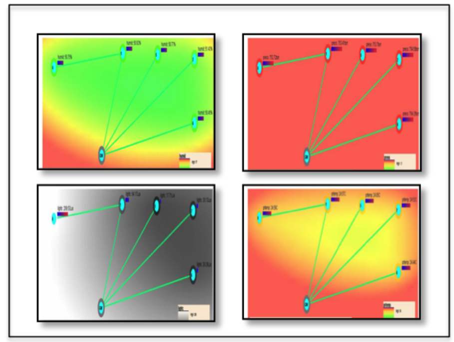

Fig. 3. (a) Humidity topology (b) Pressure topology (c) Light Topology (d) Temperature Topology

wireless sensor networks. The motes feature numerous new capabilities that enhance the functionality of wireless sensor networks. The motes are required to be programmed for operation. There are two methods for programming the motes.

- Local programming
- Remote programming

In this project motes are programmed using the technique of local programming. The MTS400 sensor was integrated with IRIS mote and readings were observed through the base station, which was connected to the host PC. The interfacing is shown in Figure 2, the base station and sensor node is shown and the usb port shows the connectivity to the server.

V. Results & Discussion

Sensor nodes were deployed in the department of Computer Systems, Mehran University, Pakistan at different locations to sense a range of environmental factors. Environmental factors including temperature, pressure and humidity were monitored employing MUET-Senses.

In Figure 3. the network topologies of sensor nodes placed in the laboratories are shown. In Figure 4(A), Figure 4(B) and Figure 4(C) the data obtained from sensors is shown in the form of histograms. The histograms summarize the distribution of sensors data. The x-axis shows the data and the y-axis shows the percentage for the instances for each sensors values. In figure 4(a) different values of temperature are present on the x-axis, which sensors sensed during a given time interval of node deployment and y-axis is shows the percentage of particular values occurring in a time interval. Variations occur in the histogram as a result of the continuous change in the temperature. The histogram shows the

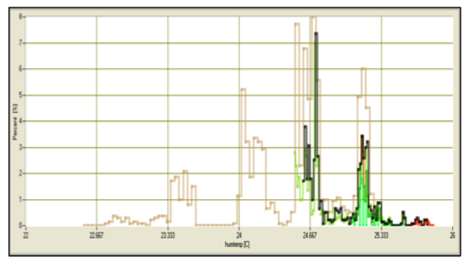

Fig. 4a. Temperature Histogram

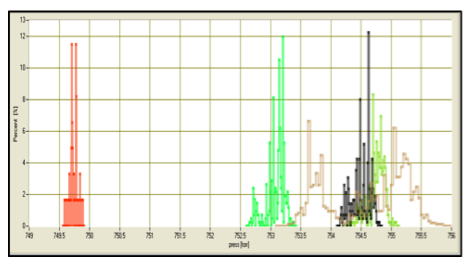

Fig. 4b. Pressure Histogram

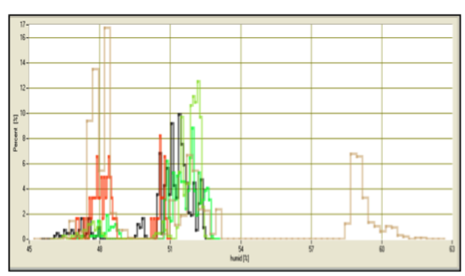

Fig. 4c. Humidity Histogram

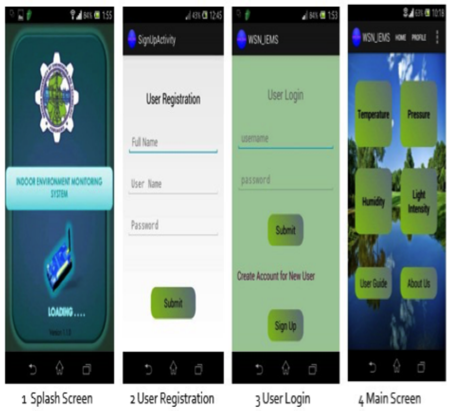

Fig. 5. Android Application

Fig. 6. Sensor's result

value in a particular instance and irregularity in the environment could be observed. The peak values shows that particular value of temperature is observed in most of the deployment time. Similarly In figure 4(b) and 4(c) pressure and humidity graphs are presented which show the variation in pressure and humidity of the environment. The variations in color represent the value of sensors deployed in various places. Figure 5. shows the user interface of the android application and Figure 6. shows the data obtained on the android application, which is the novelty of the system. The application displays the environmental conditions of the location where sensors nodes were deployed.

VI. Conclusion

MUETSenses: A Wireless Sensor Network Based Indoor Environment Monitoring System has been developed successfully by using Crossbow sensor kit. Sensor nodes were deployed in labs of computer system department to sense a range of environmental parameters such as light, humidity, pressure and temperature. Prior to deployment the sensor nodes were programmed and configured. Mote View software was used to visualize the histogram, chart, scatter plot and topology of the sensor nodes. Through the android application it is possible to monitor the environment remotely, provided an internet connection is readily available. The application is capable to show the different environmental parameters and cater to the needs of the end user.

VII. Future Work

A range of features may be added to the application such as smart alerts, notifications that appear when a set threshold is reached and haptic feedback could also be introduced. The sensor nodes may be programmed to control the environment as well as monitoring it.

This system could also be made energy efficient by programming the sensor nodes in such a way that the sensor nodes remain in sleep mode and sense data only when required. The introduction of this feature could increase the network lifetime of the sensor nodes.

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