A System Architecture for Regional Temperature and Humidity Monitoring based on Mobile Sensor Nodes

Mustafa Onder Geren
Maltepe University
Faculty of Engineering
Istanbul, Turkey
onder.geren@bte.tubitak.gov.tr

Senol Zafer Erdogan
Maltepe University
Faculty of Engineering
Istanbul, Turkey
senole@maltepe.edu.tr

ABSTRACT
In this paper, we describe an architecture, continuously monitors a particular region’s heat and humidity. The sensor node in the architecture delivers the data in a real time basis to the center point after request or every specific period of time. The collected data is visualized in the center point which is called “server”. The proposed architecture has three different areas. In the first area, the sensor devices which read the region’s temperature and humidity values are defined. These sensor devices are used as a mobile sensor agents in the architecture. General Packet Radio Services (GPRS) and GPS module are integrated on the agents. There is a continuous contact with sensor agents. In the second area, the components which get the data read from sensor agents and record to the database in the server are defined. In the third area, the data mining and data visualization studies are performed on the recorded data. The knowledge which is obtained after the data mining and data processing is presented on all different platforms such as web and mobile devices.

1. INTRODUCTION
Wireless technologies and communications are growing up in academic and commercial sectors in recent years. The field of Wireless Sensor Networks (WSN) is one of the fields in wireless technologies which is growing up. WSN consists of smart devices known as sensors. The sensor device (mote) has two modules. The first module is a radio module, which receives or sends the packet. There are many wireless standards available. IEEE 802.15.4 ZigBee protocol is a wireless technology developed as an open global standard to address the unique needs of low-cost, low power, wireless sensor network [7] [3]. The second module is sensor board, which senses the readings that can be temperature, humidity, light, acoustic, seismic, gas etc.

The sensor devices have limited computing, storage and energy sources. These devices can communicate with each other using the radio modules and they can create an ad-hoc, self organized networks that can provide intelligent, pervasive and ubiquitous applications, Akyildiz et al [2], Ye et al [9]. Furthermore, there are many studies for energy efficient algorithms and techniques as computing and energy are limited.

WSN are used in many areas such as military, system security, environment and habitat monitoring [6], health-care [8], localization, elder and disabled people monitoring [4], smart homes etc.

This paper presents an architecture based on sensor devices, continuous temperature and humidity monitoring of the region. While monitoring the region, sensor devices sense the values in the region. The data sensed by the sensor device transfer to a center point over GPRS (General Packet Radio Services) connection. Eventually, the end user can access the data. In WSN, sensor devices use the radio module integrated on board however sensor device’s radio module is not used to send readings in proposed architecture. GPRS and GPS (Global Positioning System) module is integrated to the sensor device and communication between sensor device and GPRS module are setup. Sensor continuously is sending the readings via GPRS. After the readings get into the center point, it is recorded in the database. Further, data visualization and data mining studies are performed on the recorded data.

The paper is organized as follows: The Section 3 discusses the mobile sensor node, which is an agent collecting the readings. Hardware specifications of the mobile sensor node are explained. The description about the software used in mobile sensor node is explained. Section 4 explains the proposed architecture and provides the details of the components which are involved in the architecture. The collected and stored data is shown in Section 4.1. Section 5 concludes the paper.

2. RELATED WORKS
There is an active research in monitoring by using wireless sensor networks. Some studies are interested in health mon-
3. THE MOBILE SENSOR NODE

The mobile sensor node is the sensor device sensing the readings in mobile and transfers the readings via GPRS connection to the center point. Figure 1 shows the pseudo code of the algorithm used to sense and send the readings over the GPRS connection.

The mobile sensor node can attach to any vehicles and sense the readings continuously. So the mobility for the sensor node is achieved.

```
procedure SensorReadCode()
1: Read Temperature Value
2: Read Humidity Value
3: String sendPacket="AT Command String"
4: String valuesString=FloatToString(Temperature Value) + FloatToString(Humidity Value);
5: sendPacket=sendPacket+valuesString ;
6: call send(sendPacket) to GPRS module;
```

Figure 1: Pseudo code for SensorRead and Send over the GPRS connection

Sensor node is composed of 3 parts as shown in Figure 2.

![Sensor Node Diagram]

**Figure 2: The Sensor Node**

1. **GPRS:** GPRS is a packet-based wireless communication service that promises data rates from 56 up to 114 Kbps. It provides a continuous connection to the Internet for computer users or mobile devices. The mobile sensor node uses the GPRS module to transfer the readings.

2. **Sensor Board:** Sensor board is used to sense the temperature and humidity readings. There are several sensor boards which sense light, seismic, vibration, gas, ultrasonic etc. Several companies have different sensor boards. Suitable sensor boards can be used in specific application areas. The temperature and humidity sensor board is used in proposed architecture.

3. **GPS:** Global Positioning System is a U.S. space-based radionavigation system that provides reliable positioning, navigation, and timing services to civilian users on a continuous worldwide basis (it is freely available to the public). For anyone with a GPS receiver, the system will provide location and time. GPS provides accurate location and time information for unlimited number of people in every weather, day and night, anywhere in the world [5]. The GPS module in mobile sensor agent provides the location and time information. So location of mobile sensor agent sensed the temperature and humidity in exact time will be determined. The temperature, humidity information in specific location and time will be collected.

Mobile sensor node’s hardware specifications are as below:

- **Sensor Mote:** Moteiv Tmote Sky\(^1\) sensor mote is used in the architecture. It has integrated temperature and humidity sensors and CC2420 Chipcon 802.15.4 radio.
- **GPRS Module:** Cinterion’s XT65 wireless module is integrated to the sensor node. XT65 GPRS module provides Quad-Band GSM850/900/180/1900 MHz and Internet Services: TCP, UDP, HTTP, FTP, SMTP, POP3.
- **GPS Module:** Cinterion’s XT65 wireless module has 16 channel receiver L1 1575.42 MHz, GPS dedicated AT commands and Protocols: NMEA-0183 V2.3, RTCM protocol V2.2, UBX binary protocol.

4. SYSTEM ARCHITECTURE

In Figure 3, the system architecture is shown. The architecture would contain the three areas. The first area contains the mobile sensor agent, which is called “mobile sensor node”. The mobile sensor agent is explained in Section 3.

The second area contains the components for getting the readings from GSM structure and recording to the database. The components are as below:

- **MessageViewer:** It reads the sensed values from the base station and forwards it over the TCP socket to the listener component.
- **Listener:** It gets the values from the MessageViewer component and makes it available for recording in the database.
- **Database Engine:** The sensor readings collected from the mobile sensor agents are stored in a relational database such as PostgreSQL\(^3\).

\(^{1}\)http://www.moteiv.com
\(^{2}\)http://www.cinterion.com
\(^{3}\)http://www.postgresql.org
Figure 3: System Architecture

- **Knowledge Extraction**: Knowledge extraction component extracts knowledge from the data stored in a database. The component has tools for data mining processes and reports the regional temperature and humidity maps. It has a relation with the GUI (Graphic User Interface).

- **Graphic User Interface**: It is a front-end graphical interface to allow users to view data and reports. Users see the reports for specific time and region. Time can
be hourly, daily, weekly, monthly or seasonal. Region can be street, district, borough or all city. Users see temperature and humidity values for all times and all regions. Different platforms such as web, PDAs or mobile devices can access the reports and maps.

4.1 Experimentation

In the experiment, mobile sensor node is attached to a car’s back door in a shield container. Mobile sensor node senses the readings and sends the readings to the center point over the GPRS connection. Sensor node sends three readings which are temperature, humidity and GPS. Figure 4 shows the mobile sensor node integrated with GPRS module.

![Mobile Sensor Node and GPRS Module](image)

Figure 4: The Mobile Sensor Node and GPRS Module

The collected readings from the mobile sensor nodes are stored in a database at the center point. After the one day experiment, The fetched data from the database is shown in Figure 5. In the excel file, the readings which contain the temperature, humidity, GPS and date and time information are shown.

The temperature and humidity values will be monitored based on GPS coordinates collected from the mobile sensor nodes. The values can be plotted on a region map. The map can be viewed for a specific time.

5. CONCLUSIONS

The baseline of the architecture is introduced and implemented. In one day experiment has showed the collected data from mobile sensor nodes. The collected data and the temperature and humidity maps for all parts or specific part of region will be shown on a web site. After reaching to big size data, the data mining and knowledge extraction processes will be applied on the collected data. This system will provide the temperature and humidity status for a region for a specific times such as momentary, hourly, daily, weekly, monthly, seasonally or yearly.

6. REFERENCES