Development of Mobile Based Online Weather Monitoring System with Disaster Alert

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Abstract— Demonstrated in this paper is the development of a remote monitoring application, which facilitates access to information from an in-situ measurement network. It is a system that can be used to remotely monitor weather variation for proper management of climate related disasters, through the use of an early warning system. This system harnesses the wide network capability of the internet to stream weather information from weather stations to a remote online server via a GSM MODEM, where the information is harvested by the mobile phone applications designed for it. In this system, predefined threshold is set as reference for disaster alerts on the server and the server alert the user via the mobile application. The weather information is analyzed by using decision tree techniques to verify parameter range and any value beyond the set range triggers on alert. This system can be installed in remote areas as the data can be accessed online and it consumes low power.

Index Terms— Disaster alert, GSM MODEM, Internet, J2ME, Weather Data, TCP/IP, remote monitoring.

1 INTRODUCTION

Statistics show that natural disasters have been on the increase in recent years. The frequency of occurrence and the severity is on the rise, often resulting to destruction of lives and properties [1]. Since natural disasters are difficult to prevent, a proactive approach to its management therefore requires early warning system where information can be sent for evacuation of lives and properties.

Enhanced monitoring system is therefore required for remotely monitoring the weather. Since most in-situ weather measurement setups are not monitored. Data collection is often conducted by designated personnels, who only visits to harvest data routinely. Real time monitoring of weather parameters is therefore important for early warning in severe weather conditions.

This study considers the use of in-situ measurement network for enhanced and real time monitoring of the weather parameters. Provision is also made for emergency alert, where the user is alerted when the recorded data is beyond the defined reference level. The parameters to be measured by the system include temperature, air pressure, moisture (humidity), rainfall rate and wind speed.

The system is dependent on the electronic weather station, while the online network is employed to cater for the problems of accessibility, setting up and maintenance cost. On the other hand, this will enable wide network coverage, easy accessibility, and enhanced mobility.

A mobile application was then designed to monitor the system from anywhere since the setup is internet based. This will facilitate the installation of the setup anywhere. The disaster alert will give information of any anomaly in cases of hash or unexpected climatic conditions. In addition, the wireless sensor network is easy to maintain, the devices are cheap and the energy requirement is less.

A GSM MODEM (SIM 300) was also used on the channel for transmitting information between the server and the Vantage Pro Weather Station, while a microcontroller IC (ATtiny2313) was used to interface the weather station to the MODEM via a serial protocol.

2 RELATED WORK

Sililar designs [7] had considered a remote monitoring system for various weather parameters, where the data gathered by the sensors is relayed via a series of repeaters to a workstation using ZigBee. This approach will require more maintenance cost and space in a large scale scenario. A single online system is preferable as it directly log weather parameters to a remote server online. An online based weather monitoring system was developed in [6]. The approach employed open geospartial consortium's sensor web enablement, a scenario where the weather monitoring system directly log data to a web based server which eliminates the use of repeater stations. This system is quite reliable but it was not designed with intelligence to give warnings or alert in cases of harsh weathers.

A wireless sensor network for weather and disaster alarm system was proposed and developed in [2], [3]. Here the weather parameters are monitored and uploeaded onto a remote server via a repeater station. Although it is very effective even with the alarm system which makes it intelligent, it also requires more maintenance cost and space than a single online system.

This study aims to develop a remote weather monitoring system, which will be easier to maintain by ensuring that it is a single package per location and that it logs to an online web server directly without a repeater station. It is also intelligent with the fact that it can alert user in severe weather conditions. One other major advantage of this system is that it has a mobile based application that users can utilizem in accessing records from the server and as well get alerts from their mobile phone just like any other messaging applications on the

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phone.

3 System Design and Implementation

The method employed for the work provides a means of monitoring weather parameters from in-situ measurement network. The mobile based online weather monitoring system with disaster alert uses the TCP network protocol to transmit weather data from the sensors through the internet to the mobile application.

The setup is divided into three sections, the Nodes, Data Storage/server and the mobile application. The system setup is as schown in Fig. 1.

3.1 Nodes

The nodes consist of the SIM300 GPRS modem, a microcontroller to interface the MODEM to the sensor, and the Vantage Pro 2 weather station from Davis Instrument Co. Ltd. This instrument has inbuilt sensors measuring temperature, humidity, wind speed, rain rate monitors. The microcontroller requests for the weather data from the weather station intermittently via the serial protocol with the Vintage Pro commands and send the information to the online server via the GPRS modem, where the mobile can request for the data to be displayed for the user.

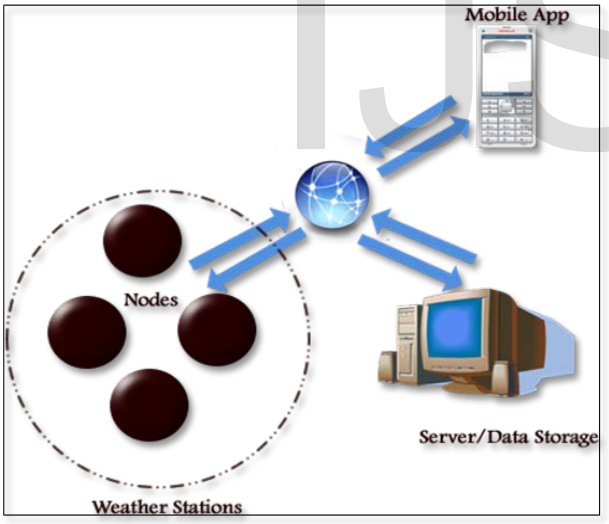

Fig. 1. System overview

Fig. 2 shows the block diagram of the node. The microcontroller was programmed using mikroBasic IDE.

3.1.1 Communication Commands

Communication command for the weather station depends on the request. There are different command formats for communicating with the device and the command used is as shown;

Command parameters are shown with "<parameter name-decimal>", "<parameter name-hex>",or "<parameter name-binary>". For the –decimal and –hex parameters, substitute an ASCII string. For the –binary parameters, character value.

"LOOP <number of LOOP packets to send-decimal>" should be realized with the string "LOOP 4" will be sent

There are several different types of command responses. These responses come before any other returned data values.

1. The "ACK" response: when this command is recognized, the console responds with an ASCII ACK (0x06) character. If the command parameters are invalid, a Not Acknowledge response of (0x21) is used. If a block of data is sent with a CRC code, the response CANCEL (0x18) means that the data did not pass the CRC check.
2. The "OK" response: when this command is recognized, the console responds with the character string "\n\rOK\n\r".
3. The "DONE" response: Certain commands take some time to complete their operation. For example the command "CLRGRA" will clear all the console graph points. The Vantage responds with "OK" when it receives the command, and "DONE" when it is finished. No attempt was made to send commands to the console until the "DONE\n\r" response has been received.

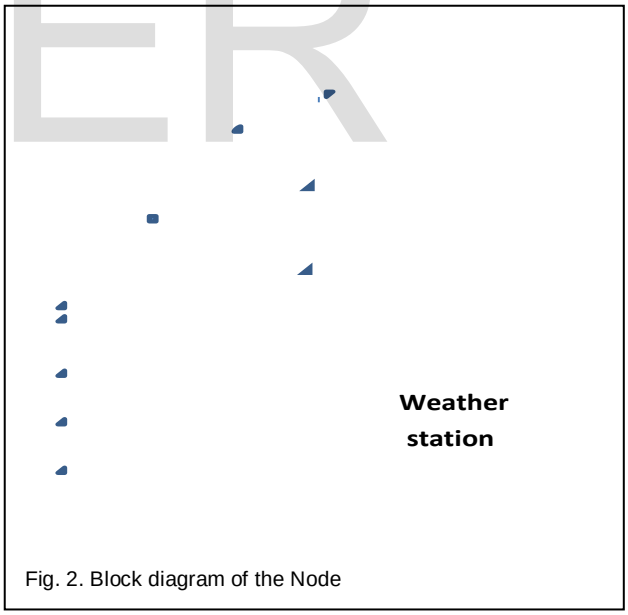

Fig. 2. Block diagram of the Node

3.2 Data Storage

This consists of a server computer with software that monitors and controls the data being sent by the nodes. The server is always connected to the internet so as to make it ready to receive information. The data received is organized and stored. On request by the mobile application, the data is been sent down to the mobile phone. The server analyses the data received and verifies if the data falls in between the define threshold, else, an alert is raised and sent to the mobile application so as to inform the user.

3.3 Application

The mobile application was designed using Java 2 micro edition (J2ME) programming. The software is used to request the weather information from the server on user demand and then displayed on the mobile device. Alert received from the server is also displayed on the user screen with the content of the alert being the node address and the parameter value. The user may choose to ignore the alert or choose repeated report as long as the event persists. The interface of the software includes the WEATHER display, the Alert, analysis, peak values all sent with time stamp. The application interface is as shown in Fig. 3.

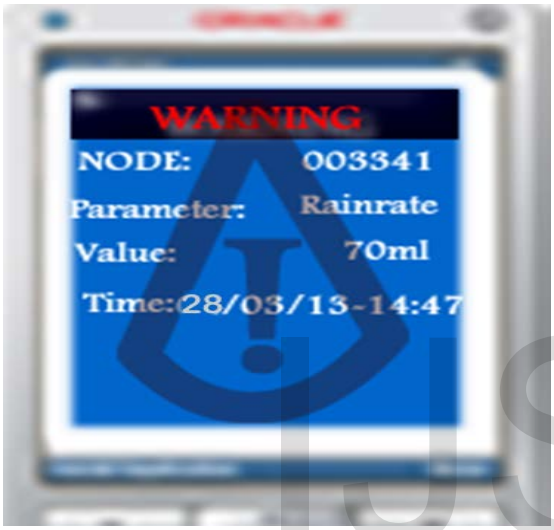

Fig. 3. Application interface

SIM300 GSM modem was used, which fits most of the space requirement for applications such as PDAs and other mobile devices, with a tiny configuration of 40mm x 33mm x 2.85 mm. A 60 pin board to board connector was used as the physical interface between SIM300 and the mobile application, which provides all hardware interfaces from module to customers' boards apart from the RF antenna interface [9].

TABLE 1
WEATHER RESULTS

On	*Temp.(°C)*	*Pressure (mmHg)*	*Humidity (%)*	*Wind Spd. (km/s)*	*Rainfall (mm)*	*Alarm*
1	24.5	550	84.5	20	20	✓
2	21	550	51	30	40	
3	21	570	40	20	70	✓
4	23	520	60	20	25	
5	22	550	54	20	30	
6	26	550	73	20	10	✓

TABLE 2
DATA BOUNDARIES

On	*To*	*T1*	*Ho*	*H1*	*P0*	*P1*	*R0*	*R1*	*W0*	*W1*
1	20	21	30	60	500	600	0	40	0	30
2	20	23	30	60	500	600	0	40	0	30
3	20	27	30	60	500	600	0	40	0	30
4	20	27	30	60	500	600	0	40	0	30
5	20	27	30	60	500	600	0	40	0	30

T is temperature, H is humidity, P is pressure, R is rainfall rate, W is wind.

The Transmission Control Protocol (***TCP)*** is a connection-based protocol that provides a reliable flow of data between two computers. TCP provides a point-to-point channel for applications that require reliable communication. The Hypertext Transfer Protocol (HTTP), File Transfer Protocol (FTP), and Telnet are all examples of applications that require a reliable communication channel [5]. The decision tree was used to process input parameter to alert when a recorded parameter matches predefined conditions.

4 RESULTS

The weather data extracted for temperature (^{0}C), pressure (mmHg), humidity (%), wind speed (km/s), rainfall (mm) and the corresponding alarmable data is as shown in Table 1. The data is taken from the logs of result in the database available for a particular node. The data boundary is shown in Table 2.

5 CONCLUSION

The Focus of this design is to develop a system that can monitor the weather record and transmit disaster alert to a remote user at any location around the globe. The system can cover a long distance having combined the two widely used modes of communication, the GPRS and the Internet. The developed system is flexible and accurate and it has core competencies to display weather information, alert when weather conditions match using decision tree technique and keep weather information statistics.

Though the system's performance is based on the availability of the aforementioned channels of communication, recent efforts by communication network providers is however aimed at widening their coverage. Hence, the system is not limited by distance and can be easily monitored in any part of the globe.

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