P2P Sensor Data Mining System for School Temperature Measurement System

Ayahiko Niimi Hiroshi Shimada Rika Goto
Masaaki Wada Kei Ito Osamu Konishi
Department of Media Architecture
Future University-Hakodate
116-2 Kamedanakano-cho, Hakodate-shi, Hokkaido 041-8655, JAPAN

Abstract

In this paper, we propose the technique of the sensor data mining by the P2P (Peer-to-Peer) network. The mechanism that it is possible to share on the P2P network is considered by receiving information from the sensor by the P2P application. Searching request for sensor unit and mining the sensor data does on the P2P application. We consider that the proposed technique is applied to the school environment measurement system. In its system, sensor units are arranged on campus, user can measure room's temperature and humidity. The temperature sensor and the humidity sensor are implemented in a microcomputer board that can connect to the Internet, and we define the microcomputer board as a sensor unit. We construct the P2P sensor network on which a PC accesses the sensor unit and P2P application on its PC uploads on the P2P network. The P2P network becomes possible disclosing sensor information after more advanced processing is given by thinking as P2P application not the sensor unit but on the sensor unit and PC.

Keyword:

Sensor Data Mining System, P2P, JXTA, School Temperature Measurement System

1 Introduction

Recently, we can obtain various data easily by a high performance of computer and the Internet. Data mining that extracted significant knowledge from a large amount of data become popular. The technique for applying data mining to text information such as Web page is developed recently though the data stored in databases was targeted in normal data mining. In the Internet, various time series data can be obtained. For instance, the image data of the weather satellite and the data of various sensors can be obtained. The feature of these data is continuous data in the time series. The techniques which applied data mining from databases are used for time series data, but some techniques were improved for time series data.

The digital measurements of the temperature and humidity, etc. become possible, and connecting the system that acquired the measured data on the network becomes possible. However, there are many measurement systems which are rich systems that are used sensors on PC or which are cheap microcomputer systems that need to construct a special network for the sensor network. We propose the sensor network system using the microcomputer board that can connect to the Internet. This proposed system can acquire information from the sensor of the microcomputer group arranged on the network, and can view collected information on Web browser.

In KES2006 [1], it was shown to be able to construct easily the microcomputer's sensor network which was combined microcomputer modules (Micro Cube) and the database server and the Web application server. The system that measured the room temperature in school campus was constructed, it has run for four months, and the effectiveness is verified.

In this paper, we propose the technique of the sensor data mining by the P2P (Peer-to-Peer) network. The mechanism that it is possible to share on the P2P network is considered by receiving information from the sensor by the P2P application. Searching request for sensor unit and mining the sensor data does on the P2P application. The advantage of P2P system is scalability of the number of sensors. It becomes to be able to correspond to the change in the number of sensors easily by constructing the sensor network on the P2P network.

Chapter 2 describes the sensor module using Micro Cube. Chapter 3 describes the composition of the sensor network as server-client system. We describe the installation of Micro Cube, the server and the client and the technique of collecting and viewing

data. Chapter 4 describes the P2P sensor data mining system. In chapter 5, we describe construction of our proposed system, and discuss about the problem when constructing sensor network. Section 6 describes conclusion and enhancing in a future.

2 Sensor Module

In this section, we describe proposed sensor module.

2.1 Outline of Micro Cube

The Micro Cube is a board computer and is composed of several stackable boards [2, 3]. Fig. 1 is a photo showing one of the combinations of stacked Micro Cube. It has a CPU board with a RENESAS H8 CPU and a TCP/IP Protocol stack. Stackable boards can vary as follows: Ethernet LAN board, compact flash board, PCMCIA board, serial board (RS232C and RS422) and so on. Since the different combinations of stackable boards make a seamless connection with the sensors, users can structure an ad hoc sensor network very easily. To get sensor information through the Internet, HTTP is also employed so that user can get data via a standard Web browser.

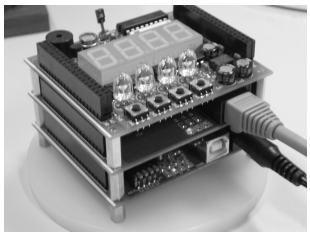

Figure 1: Photo of a Stacked Micro Cube

2.2 Instrumentation of the present system

The Micro Cube used in the system to get the information of room condition is composed of the H8/3069 CPU board, LAN board, and special sensor board. The special sensor board is utilized the board used of the programming practice class in Future University-Hakodate. (The sensor board is shown in Fig. 1) Future University-Hakodate has the programming practice class with the microcomputer and assembler language as “Media Architecture Practice II”. The special board for Micro Cube was designed for its practice class. The push switch, the thermally sensitive resistor (temperature sensor), and CdS sensor (optical sensor) were attached on this board as an input. Moreover, four digits seven-segments LED and four two-color LED were attached as an output. Because an accurate temperature measurement using the thermally sensitive resistor is difficult, a digital sensor is added in this board for our experiment. Humidity can be also measured in this digital sensor. Only the temperature data is acquired this experiment though some sensors are attached on the board. The exchange and the addition of the sensor can be easily done by exchanging the sensor boards.

To confirm the measurement data easily, the measured temperature was displayed in seven-segments LED. Moreover, data can be got by HTTP though the network. When only one sensor module runs, the user can display a present temperature when the user accesses it using Web browser.

3 Network Configuration

The sensor network was constructed by using the microcomputer that explained in Chapter 2. Fig. 2 shows the composition of the constructed sensor network system. First of all, we constructed proposed sensor network system as server-client system.

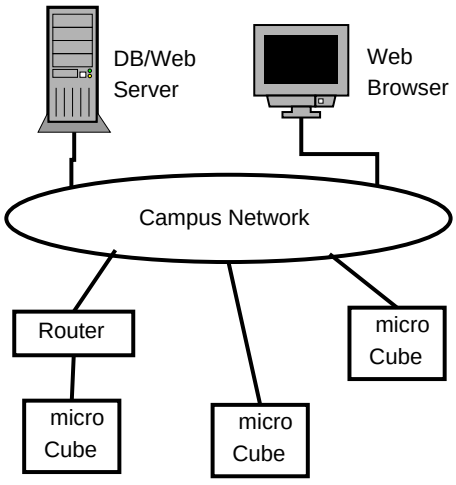

Figure 2: Network Configuration

The used software is shown below (see table 1). The data store part is implemented by Perl, and the data display part is implemented by JSP.

The following steps shows the steps of the collection of data and the display stored data.

1. Data storage

Table 1: Software used in the web database server

System	Software
OS	Red Hat Linux release 9
HTTP	Apache 2.0.40
Database	PostgreSQL 7.3.2
Software codes	Tomcat 5.0.28 and Perl 5.8.0

(a) The Perl script accesses to URL of Micro Cube.

(b) Micro Cube returns the measurement result by HTML format.

(c) HTML is parsed, and necessary data is preserved in the database.

2. Data browse

(a) URL of the server is opened from a Web browser.

(b) JSP accesses the database.

(c) Necessary data is acquired from the database.

(d) The result is processed to the graph and displayed it on a browser.

The micro cube arranged in school is connected with campus network (LAN). The data of each sensor module is acquired with the server set up on the campus network at regular intervals, and stores in the database. In this experiment, data is acquired from the sensor module every ten minutes. The acquired data is processed with the Web application server set up on the same server, and can be displayed from Web browser of PC on the campus network.

At first, Micro Cube connected to campus network by arranging it in the router because the router had not been exceeded in LAN of the micro cube. Afterwards, connecting Micro Cube to the campus network even if we modified the program, and the router is not set up became possible so that the router was exceeded.

4 P2P Data Mining System

In this paper, we propose the technique of the sensor data mining by the P2P (Peer-to-Peer) network. The mechanism that it is possible to share on the P2P network is considered by receiving information from the sensor by the P2P application. Searching request for sensor unit and mining the sensor data does on the P2P application. The advantage of P2P system is scalability of the number of sensors. It becomes to be able to correspond to the change in the number of sensors easily by constructing the sensor network on the P2P network.

We consider that the proposed technique is applied to the school environment measurement system. In its system, sensor units are arranged on campus, user can measure room's temperature and humidity. The temperature sensor and the humidity sensor are implemented in a microcomputer board that can connect to the Internet, and we define the microcomputer board as a sensor unit. We construct the P2P sensor network on which a PC accesses the sensor unit and P2P application on its PC uploads on the P2P network. The P2P network becomes possible disclosing sensor information after more advanced processing is given by thinking as P2P application not the sensor unit but on the sensor unit and PC. Moreover, even if one-sensor unit-one peer is not allocated, it is also possible to arrange peer that integrates some sensor units on the network. We construct P2P sensor data mining system used Micro Cube as sensor units and JXTA as P2P platform.

The sensor data constructs the system that can flexibly correspond also to the different kind sensor data by using the XML form. The advantage of the proposal approach is that it is easy to correspond to the change in the number of data sources. The change of the system is not to hard even when the composition of the sensor changes. Moreover, the data acquisition system from the sensor in the remote place can be easily constructed by constructing the system on the Internet.

5 Experimental Results

The system that explained in Chapter 3 was actually constructed. The system is constructed in December, 2005, and it is running at November, 2006. Because a lot of modules were able to be reused, the time that had constructed to development was about one week.

Some data display examples are shown as follows. (See Fig. 3) The displayed data can be switched to all or a part of room. The displayed range can be switched to a day, a week, a month, or all. Fig. 3 shows all data in one chart, and Fig.

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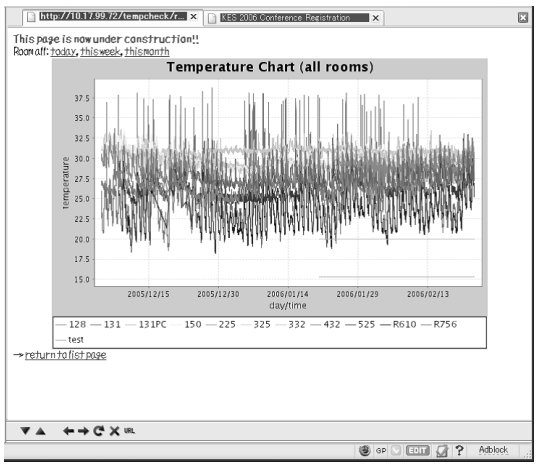

Figure 3: All Data in One Chart

not been exceeded in LAN of the micro cube. However, data might not be able to be acquired normally when some router's passing. Then, connecting Micro Cube to the campus network even if we modified the program, and the router is not set up became possible so that the router was exceeded.

It took time to divide the problem when data was not able to be acquired normally because Micro Cube connected to the campus network. Then, the problem was considered in cooperation with SE that resided in school. For the exceeding router problem, we constructed some environment, such as the dummy server with the PC-UNIX server, passing the router setting, bypassing the router setting, and it undertook the resolution of a problem while capturing the packet that flowed in the network.

Because data began to collect, temperature data is scheduled to be analyzed in the future.

6 Conclusion

We proposed the technique of the sensor data mining by the P2P for the sensor network system using the microcomputer board that can connect to the Internet. This proposed system can acquire information from the sensor of the microcomputer group arranged on the network, and can view collected information on Web browser. It was shown to be able to construct easily the microcomputer's sensor network which is combined microcomputer modules (Micro Cube) and the database server and the Web application server. The system that measured the room temperature in school campus was constructed, it has run for about one year, and the effectiveness was verified. We also proposed P2P sensor data mining system. Because data began to collect, temperature data is scheduled to be analyzed in the future. In the analysis of data, it is thought that it is possible to refer to a technique of the multiagent base [4, 5] and an analytical technique of the analysis of the fixed point observation data [6]. We descussed P2P sensor data mining system with microcomputers and JXTA.

The system that expands acquired more different type of sensor information will be constructed, and then, obtained data is scheduled to be analyzed in the future. In addition, we want to attach the IR I/O module on the microcomputer board, and to do the research for the ubiquitous computing of the indoor environment controlling.

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