REMOTE CONTROL FACILITIES OF WEB-BASED SURVEILLANCE SYSTEM FOR ELECTRIC POWER APPLIANCE AND NETWORK CAMERA

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Abstract: We have been improving our monitoring system, which had been organized with network cameras, an integrated web/mail server, web-based clients and remote control devices. Several kinds of devices can be used as our clients including, for example, high-performance cellular phone, which are equipped with Java virtual machine and web-browsing facilities.
Our integrated server is designed to play intensive roles of web and e-mail services. It can obtain JPEG images from network cameras, process them, accumulate them into its database. It can also receive some types of requests from clients, analyze them and perform registered services for monitoring and/or controlling. Almost all software of our monitoring system have been written in Java programming language, because of easy and powerful description of GUI as well as network programming.

1 INTRODUCTION

People need higher performance monitoring system with lower cost. Security cameras and sensors are widely employed in the several area and public environment. So we want to utilize them and obtain an useful information including images for our determination as well as our risk aversion. We have developed a monitoring system in order to perform remote monitoring and remote controlling services for system reliability and maintenance. The previous version of our monitoring system was realized with well-known technologies, such as server-client computing model, security camera with network facility, Java technology for several computing environment, HTTP(Hyper Text Transfer Protocol)-based network programming style and Linux-based computing environment with several kinds of open-source software.

2 SYSTEM CONFIGURATION

2.1 Monitoring Facilities

An integrated server of our monitoring system can periodically obtain images from some network cameras through the private network. Such images are transmitted from camera to server by means of HTTP-based communication procedure. They are accumulated as JPEG images temporally into the internal buffer of the server, reduced into a fourth and a ninth resized image data and finally stored into image database. Reduction of image must be done, because some mobile devices allow only restricted amount of packet size between the server and themselves.

In order to realize remote monitoring, it is absolutely necessary to obtain several kinds of images. Although animated (moving) pictures would be much more effective to make a suitable decision about the target situation than stationary ones, our system can only deal with continuously stationary pictures still now. Integrated Server requires network camera to transmit JPEG images at a sampling rate, receives such images as monitoring view, reduces size of images and then accumulates a series of them in the storage. The server also prepares Java Applet on its homepage through its Web service, begins to run the process of http daemon (Apache), waits for clients' access from global network and then delivers such an Applet to the target client. Figure 1 shows a scheme of our remote monitoring procedure.

At the side of client, Java Applet downloaded from the server provides a GUI which communicate server

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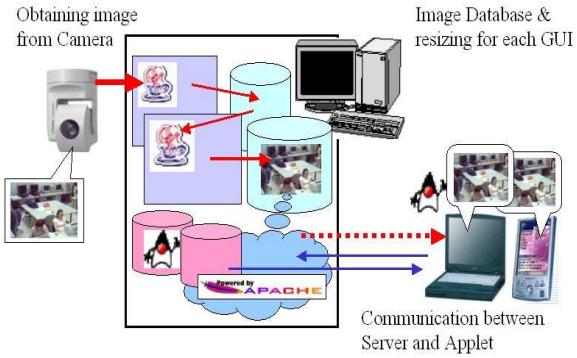

Figure 1: Schema of Obtaining Image from Network Camera and Processing it for the several types of Client of Monitoring System

to requests transmitting JPEG image by means of HTTP connection and display received JPEG data file on the browser in the mode of stationary image or continuously alternating images like as slide show. In the case of later mode, Applet prefetches JPEG data from server, stores and preload in the double-buffering style, and realize quasi-moving picture on the display of PC's browser.

2.2 Control Facilities

Remote control service seems to be essential for supplementing remote monitoring service and enlarging it into wide application. Various control mechanisms have been proposed for several application. This time, we have employed power switching facility as remote control function. It is based on the OpenPLANET technology, which has been developed by the Shikoku Electric Power Company Ltd. It has some excellent characteristics, one of which is to transmit digital information from node to node through electric power line.

OpenPLANET control server is connected to Integrated Server in the private network. It works as sub-server in our monitoring system. It has a dedicated interface to connect serially with the Electric Power Line Router (EPLR). It is the special-purpose microcomputer-based device, which can translate digital information into analog signal and mix it along electric power line. With EPLR, digital information of OpenPLANET server can be carried to another computer only by means of electric power line within single electric power distribution board. So we need not to equip additional cable to transmit digital information between controller and the target node to be controlled.

Power Control Adaptor (PCA) is the special-purpose power outlet based on OpenPLANET technology, which can turn on or off electric power according to analog control signal from remote controller via electric power line. The Open PLANET server provides remote control facilities to perform electric power switching by means of transmitting control signal for digital information into PCA with EPLR.

Our Integrated Server has a connection with such an OpenPLANET server, sends and receives socket-based messages to/from such a server, and performs remote control service for electric power switching through private networking. Communication between our server and OpenPLANET server is carried out based on TCP/IP protocol and software for their communication is realized with Java programming. Java codes can be executed not only on our Integrated Server but also on the OpenPLANET server. And frankly speaking almost software of our server is written with Java programming language.

The merits of employing the OpenPLANET technology are summarized as follows:

- No additional cabling is necessary to realize remote power switching, because control signal can be transmitted via electric power line with EPLR.
- No additional remodeling of target device to be controlled is necessary, because PCA is equipped between such a target device and according conventional power outlet.

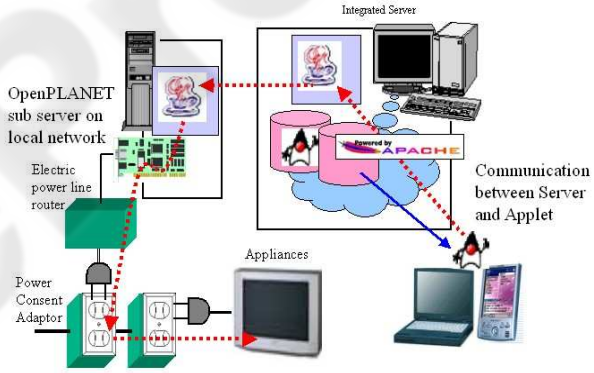

Figure 2: Schema of Controlling Appiance with OpenPLANET in our Monitoring System

Client users can enjoy remote control service from Integrated Server if they request Java applet download from the server to do power switching. Such a Java applet communicates with its Server to allow OpenPLANET control sub-server to perform the above control mechanism. Figure 2 shows a scheme of our remote control procedure.

2.3 GUI Services for Cellular Phone

Figure 3 shows a sample view of monitoring image on a cellular phone, which is delivered from Integrated Server. It is a view of a display image from CLDC-based Java application emulator for a certain cellular

phone. In order to reduce useless traffic cost between cellular phone and Integrated Server, client of cellular phone must make sure to push the bottom for obtaining the next image from Integrated Server.

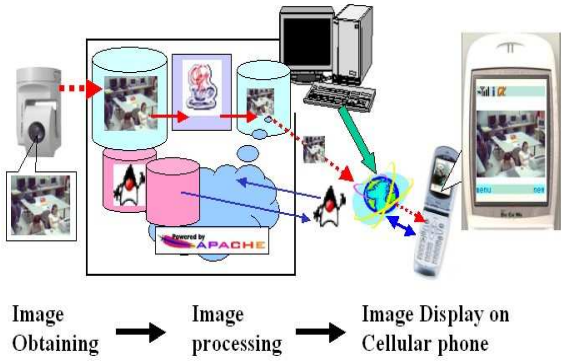

Figure 3: Schema of communication between server and CDLC-based Cellular Phone for Obtaining Image from Network camera

With Java applet, clients can browse monitoring quasi-moving image obtained from network camera on their browser of PC through Integrated Server. But it has seemed to be more effective and convenient for clients to browse such images with their cellular phones, because almost all people of Japan always carry their cellular phones together with them. One of various Java technologies, for example CLDC (Connected Limited Device Configuration) of Java 2 Micro Edition(YuFeng and Zhu, 2001), allows us to utilize relatively small sizes of Java program (or Java application) on the specific cellular phones, and then it can be downloaded from a certain Web server and perform a mobile communication based on HTTP connection between server and cellular phones.

Integrated Server has prepared such a Java applet on its homepage, deliver it into clients' cellular phone according their requests, and communicate it in order to transmit monitoring images and allow cellular phones to browse them. As there are some constraints on the image data size, which cellular phones can accept at the one time, for both of transmission and display of it, then our Server must reduce JPEG images from network camera into a suitable size for cellular phones and accumulate these images in its storage for request of image delivery from cellular phones.

3 SYSTEM EVALUATION

3.1 Image Processing and E-mail service

Users whose e-mail addresses have been entered in our Integrated Server can receive e-mails about some kinds of message from the server, when monitoring system recognizes whether a situation of target system needs sending message, such as emergency contact or not. Our message mailing service covers the following two cases, namely,

- Normal e-mail transmission service, which includes sending message to such personal computers connected to wired / wireless LAN.
- Mobile e-mail transmission service, which deals with cellular phone and/or PHS through global communication network.

In the former case, generally speaking, e-mail is one of the most usual message transmission methods between computer's users of LAN and the Internet. And the message to be sent may contain description of a special URL, which tells users to get information about image, control scheme and Java applet. With such information, clients can access a suitable resource for them to steer the monitoring system efficiently.

On the other hand, clients sometimes leave their seats where they sit down and work with computers. They will carry cellular phones or PHS's with them, however, even at such a situation. In the later case, cellular phone including PHS provides wide area of e-mail service to clients, so that message from server can be delivered to the target clients no matter where they are.

It is very much useful for emergency message to be sent to clients when monitoring system and clients decide to utilize e-mail service of cellular phone and PHS. With such message mailing service, some emergency call can be realized as follows; Integrated Server periodically obtains a series of images from network cameras. When a new image is partially different from the previous one, image recognition procedure, which has been already invoked, investigates whether the target two images have a certain difference on a fourth or a ninth of whole image or not.

If such a procedure proves some difference between two images, Integrated Server recognizes that some change of images happens at the monitoring point, decides to send the suitable clients e-mail by means of the above message mailing service. Integrated Server has been customized to be a mail server. When image recognition procedure points out the difference between target images, Integrated Server has sent e-mail to the previously entered clients with e-mail sending facilities. Especially, sending e-mail to cellular phone client is effectively because users almost always carry around such cellular phones.

3.2 Image Processing with Database for Camera Homing

Some cameras have special platforms to be controlled by external signal, so that they can perform smooth homing to seize and hold the dynamic changes of target view. Some direction information for controlling such a platform can be calculated effectively with image database and image processing. Image database has been realized with freeware database engine named PostgreSQL and its image data can be obtained from network camera periodically. Image processing has been done with the following procedures; two target images extracted from database are divided into fourth or ninth pieces of sub image, corresponding two pieces of sub image are compared with pixel-wise operations, and detection of dynamic changes can be performed based on the result whether compared two sub images are different or not. Figure4 shows a scheme of image processing with database for camera homing.

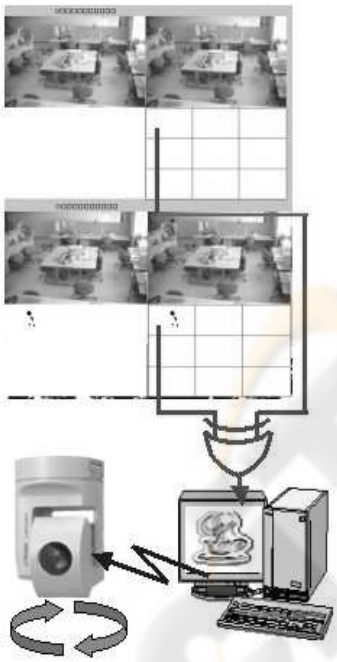

Figure 4: Schema of Image Processing with Database for Camera Homing

According to the detection and position of dynamic changes, direction of controlling camera platform can be computed in order to realize automatic homing. And then the event concerned with start of automatic homing can be informed into the specific client as emergency contact by means of e-mail services as described in the previous subsesction. The information of such a situation for clients are sent with a warning message including the URL expression which contains Java Applets for PC browser and/or a special CLDC-based Java applications for some kinds of cellular phone.

The clients which have received the above information can download the suitable Java Applets or CLDC-base Java applications through wide area network so that they can enjoy personalized (or privacy-based) remote monitoring by means of the location-independent way. Enhancement of our monitoring system can be realized and supported with the above structure and method.

4 CONCLUSION

We have described design and tentative implementation of a distributed monitoring prototype system. This prototype has been available to obtain image from network camera, perform power switching for electrical device and appliance and so that it can ensure reliable use of electric and/or mechanical systems. Our monitoring system contains several kinds of servers: Integrated Server is designed to play an intensive role to instruct and integrate its subsystems by means of network connectivity.

In our work, Web service mechanism and Java technology are essential keys to al-low our system to be much useful to describe several server programs and smart GUI's, and network-oriented applications efficiently. Instead of Integrated Server, many subsystems are organized, for example, network camera, remote sensors, remote switches and remote control devices. They can cooperatively work together to realize distributed monitoring system. Mobile computing devices, especially, wireless portable PC's and/or cellular are useful for client users to communicate with monitoring and database server at any place as well as at any time.

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