Demonstration of a Loosely Coupled M2M System using Arduino, Android and Wiki Software

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***Abstract*—A Machine-to-Machine (M2M) system, in which terminals are loosely coupled with Wiki software, is proposed. This system acquires sensor data from remote terminals, processes the data by remote terminals and controls actuators at remote terminals according to the processed data. The data is passed between terminals using wiki pages. Each terminal consists of an Android terminal and an Arduino board. The mobile terminal can be controlled by a series of commands which is written on a wiki page. The mobile terminal has a data processor and the series of commands may have a program which controls the processor. The mobile terminal can read data from not only the sensors of the terminal but also wiki pages on the Internet. The input data may be processed by the data processor of the terminal. The processed data may be sent to a wiki page. The mobile terminal can control the actuators of the terminal by reading commands on the wiki page or by running the program on the wiki page. This system realizes an open communication forum for not only people but also for machines.**

Keywords- Sensor Network, Social Network, Wiki, Java, API, Message Oriented Middleware

I. SCOPE AND SIGNIFICANCE OF THE DEMO

A wiki is a web site that allows the easy creation and editing of any number of interlinked web pages via a web browser and can be used as a means of effective collaboration and information sharing.

If a wiki is friendly to people, it also must be friendly to machines. If a machine can read and write data on a wiki page automatically, people can obtain much more beneficial information. People also can easily control machines through the wiki page. Not only machine-to-people or people-to-machine, but also machine-to-machine communication, must be achieved easily. If such communication can be achieved, the wiki can be much more useful. For example, if a well-known wiki can be used to connect sensors in a sensor network, building one's own sensor network becomes easier.

To confirm the above presumption regarding the usefulness of wikis, we are developing a machine-to-machine (M2M) system using wiki software. This system consists of mobile terminals and web sites with wiki software. A mobile terminal of the system consists of an Android[6] terminal and an Arduino[8] board with sensors and actuators. The mobile terminal has been extended by adding a data processor to the mobile terminals of [4]. This processor is controlled by the program which is written on a wiki page. The mobile terminal can read data from not only the sensors in the Arduino board but also wiki pages on the Internet. The input data may be processed by the data processor of the terminal. The processed data may be sent to a wiki page. The mobile terminal can control the actuators of the Arduino board by reading commands on the wiki page or by running the program on the wiki page. This feature makes this M2M system flexible.

The user of an application, which uses this M2M system, can modify and improve the application easily using the editor of the wiki software anywhere without going to the physical place of the mobile terminal if the user can access the Internet and the user can use a web browser, according to the changes of demand, environment, and others. A group of people also can construct their own application of this M2M system easily just like a group of people collaborates using a wiki software.

This M2M system can be viewed as a parallel computing system in which nodes are the mobile terminals, and they are loosely coupled using wiki software.

A mobile terminal can be placed anywhere, that is, at an Internet-accessible place as well as a place where a mobile phone can be used, if the terminal uses an Android terminal for communication between the terminal and the wiki page. Using Arduino enables many users to make their own sensors and actuators easily because Arduino is open source hardware and its programming environment is easy to use. We are developing a remote room sensor system using this M2M system.

II. BASIC IDEA

Figure 1 shows an overview of the system. The system consists of mobile terminals and wiki sites. PukiWiki is used for the wiki software[1][2][3][5]. A mobile terminal consists of an Android terminal and an Arduino board with sensors (or an Arduino board with actuators)[4]. ADK is used to control the Arduino board. A mobile terminal of the M2M system also includes the data processor. A mobile terminal

reads a series of commands on a wiki page of a PukiWiki site and interprets these commands. The mobile terminal reads sensor data, write acquired data on the wiki page or controls actuators according to these commands. A program may be embedded in the series of commands. The program is interpreted by the data processor. The data processor can read data from sensors or wiki pages and it can process such data. The data processor also can write the processed data to a wiki page or can control actuators. The data on the wiki page, which is acquired by a mobile terminal, can be processed by a program with PJC at the PukiWiki site and can be transformed into another data format such as a graph.

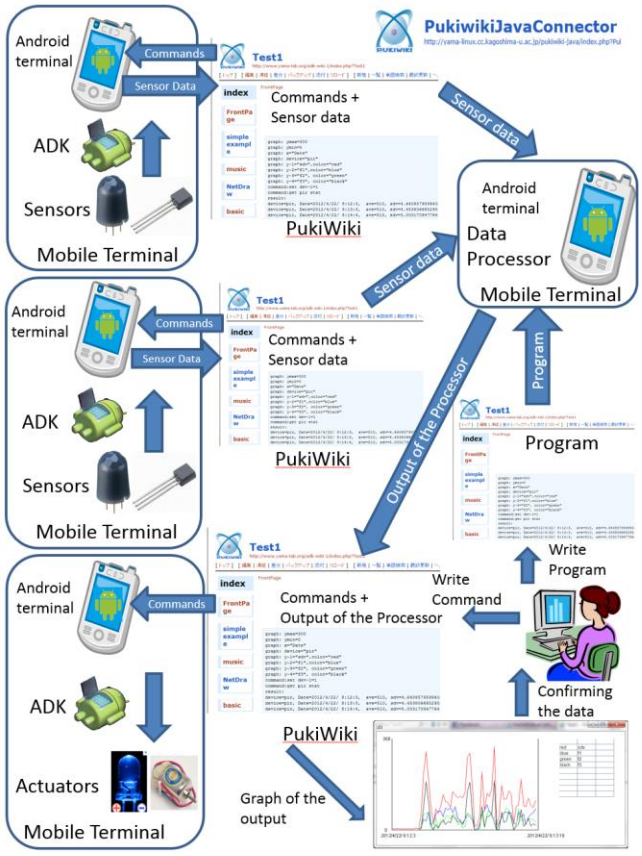

Figure 1. Outline of this system

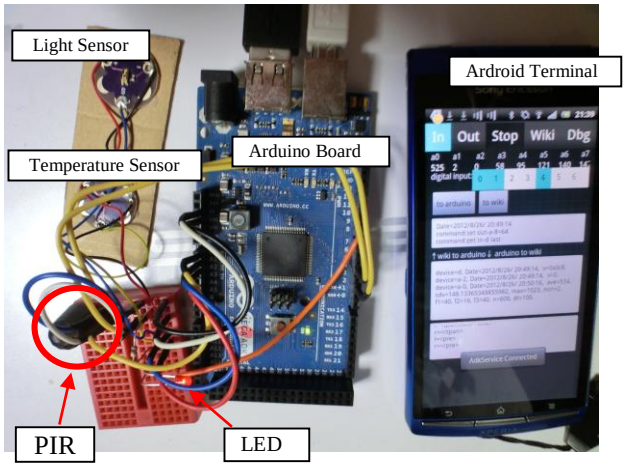

Figure 2. Mobile Terminal

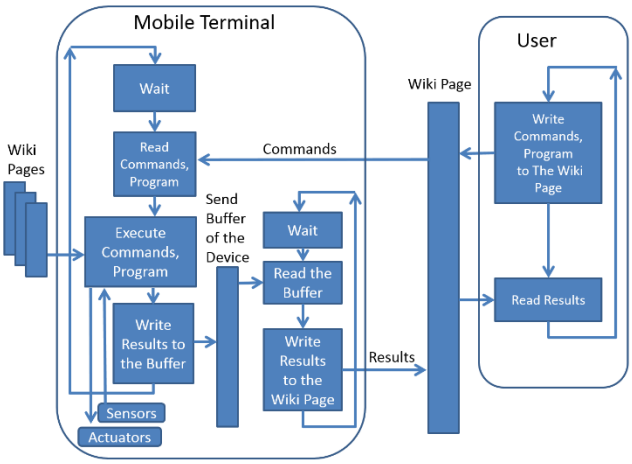

Figure 3. Behavior of a Mobile Terminal

Figure 2 shows the picture of a mobile terminal. The terminal consists of an Arduino board with sensors and actuators, and an Android terminal. The Arduino board and the Android terminal are connected with a USB cable.

Figure 3 shows behavior of the mobile terminal. The mobile terminal polls the wiki page regularly to read the source text of the wiki page. The URL of the wiki page was previously given by the GUI or a command. The wiki page includes a series of commands for the mobile terminal by parsing the page. The series of commands may include a program. The program can input data from other wiki pages. Some results of commands and some results of the program are written on the send buffer. The mobile terminal also repeats to write the contents of the send buffer to the wiki page.

[Edit | Freeze | Diff | Backup | Upload | Reload] [New | List of

wiki-basic-ex1

```
# example.
command: set readInterval=300000
command: set sendInterval=600000
command: set out-a-8=127
command: get in-a-1 last
command: program ex
program:   in0=ex("service","get in-a-2")
program:   in2=stoi(in0)
program:   ex("service","println in-a-2="+in2)
program:   if in2>150 then ex("service","set out-a-8=50")
program:   if in2<80 then ex("service","set out-a-8=100")
command: end ex
command: run ex
command: set pageName="wiki-basic-ex2"
result:
device=a-1, Date=2013/5/21/ 17:38:28,  v=0.
device=a-1, Date=2013/5/21/ 17:43:20,  v=0.
device=a-1, Date=2013/5/21/ 17:48:20,  v=0.
device=a-1, Date=2013/5/21/ 17:53:20,  v=0.
device=a-1, Date=2013/5/21/ 17:58:20,  v=0.
```

Figure 4. Example of a wiki page which has the series of commands and saved results.

Figure 4 shows an example of a wiki page which has the series of commands and saved results. The programming language of this processor is a kind of BASIC programming language. The processor has the ability of reading a kind of CSV (Comma Separated Values) format data into a table and the ability to manipulate the table like a macro program of a spreadsheet. From the user's point of view, the program on a wiki page is directly executed when the mobile terminal read the page, just like a Java Script is executed at a web browser when the page was opened by the browser. Usually, a program in a web page, such like a Java Script or a Java Applet, can read data from or write data to the server of the web page only, whereas this processor can read data from any web servers and can write data to any server of the wiki software if the servers allow it.

III. EQUIPMENT

In this demonstration, we will use three mobile terminals (Three Android terminals, three arduino boards and sensors), two PCs, one switch and one Wi-fi access point.

IV. SPACE AND SETUP TIME

We need about 0.7m x 1.8m area for placing the equipment. We would like to have a vertical space for the poster of this presentation if it is possible. We need about fifteen minutes for the setup.

V. ADDITIONA FACILITIES

We need about 500W. We would like to have Internet access. We would like have Wi-fi access for connecting mobile terminals and PCs. If it is difficult, we would like to use our own Wi-fi access point.

VI. COMPARISONS WITH RELATED WORK

A. IEEE 1888

IEEE 1888[9] is a HTTP-based SOAP/XML over IP communication protocol among facilities, databases and information system for facility information management and control. Both of our system and IEEE 1888 use web servers for data storage. A mobile terminal of our M2M system corresponding to the combination of the GW and the APP of IEEE 1888 system architecture. A Pukiwiki site of our M2M system is corresponding to the Storage of IEEE 1888 system architecture. Our M2M system does not have the Registry of IEEE 1888 system architecture. The program of a data processor of our M2M system is written on the wiki page of a wiki site whereas IEEE 1888 does not define where is the program of an APP.

B. Xively

Xively[10] is a real-time open data web service for the Internet of Things. As one of the most popular sensor data sharing services. Xively has open APIs for uploading and manipulating data, and so it is easy to enable a sensor device to upload data to Xively and also easy to write a program for processing the uploaded data. Many devices and applications can read and write data on Xively, and many users are currently using Pachube.

Our M2M system has functions similar to those of Xively. However, the APIs of Xively are used for the Xively site only. In contrast, our system can be used for any PukiWiki site, not only a specific site. Our M2M system can also be used for building one's own sensor/actuator network.

VII. CONCLUDING REMARKS

We have shown that a wiki site can be used for not only people-to-people collaboration but also people-to-machine, machine-to-people, and machine-to-machine collaboration using the proposed our M2M system. We successfully collected remote room data and uploaded the data to a wiki page using the M2M system. We also successfully controlled a device at a remote place, writing a command on a wiki page using the M2M system. We are improving this system to be more general purpose and to be easier to use. Reliability and security of this M2M system were not discussed in this paper. We will show them in later reports. We welcome the help of others who would like one to participate in improving and making his or her own sensor/actuator network.

REFERENCES

[1] PukiWiki-Java Connector, a Simple API for Saving Data of Java Programs on a Wiki, ACM WikiSym '11, Proceedings of the 2011 international symposium on Wikis, Mountain View, CA, USA, 3-5 Oct., 2011.

[2] Takashi Yamanoue, Kentaro Oda, Koichi Shimozono: A Simple Application Program Interface for Saving Java Program Data on a Wiki , Advances in Software Engineering, Hindawi Publishing Corporation, 2012 .

[3] Takashi Yamanoue, Kentaro Oda and Koichi Shimozono: A Casual Network Security Using a Portable Sensor Device and Wiki Software, 12th IEEE/IPSJ International Symposium on Applications and the Internet – C3NET workshop, 2012.

[4] Takashi Yamanoue, Kentaro Oda and Koichi Shimozono: A M2M system using Arduino, Android and Wiki Software, Proceedings of the 3rd IIAI International Conference on e-Services and Knowledge Managerment (IIAI ESKM 2012), pp.123-128, Fukuoka, Japan, 20-22 Sep. 2012.

[5] Takashi Yamanoue, Kentaro Oda, Koichi Shimozono: A Malicious Bot Capturing System using a Beneficial Bot and Wiki, Journal of Information Processing(JIP), vol.21, No.2, pp.237-245, 2013.

[6] Android: http://www.android.com/ as of May 23, 2013.

[7] Android Open Accessory Development Kit: http://developer.android.com/guide/topics/usb/adk.html as of May 23, 2013.

[8] Arduino: http://www.Arduino.cc/ as of May 23, 2013.

[9] IEEE 1888: http://standardsinsight.com/engineering_ standard_development/ieee1888 as of May 23, 2013.

[10] Xively: https://xively.com/ as of May 23, 2013.

[11] PukiWiki: http://pukiwiki.sourceforge.jp/ as of as of May 23, 2013.