Context and Location Aware Public/Personal Information Service based on RFID System Integration

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Abstract: - In this paper, a *Context and Location Aware Public/Personal Information Service based on RFID System Integration* (CLAPIS) that integrates the existed RFID systems is proposed. This system includes *Embedded Service Middleware Platform*, and *End User RFID Handheld Facilities*. The *Embedded Service Middleware Platform* which runs on the PC or PDA provides modulated API and can be substituted for any other similar system, hardware, and Internet service. The *End User RFID Handheld Facilities* gives and suits the three possible utilization conditions such as: *end user RFID tag*, *end user device with RFID System*, and *hybrid end user RFID handheld facilities*. The real test and verification prove that the proposed CLAPIS can certainly reduce the construction cost of local area public/personal service system. Users of three possible utilization conditions are all completely served. The recyclable RFID Device/Tag can further reduce the payment and is more environmental.

Key-Words: RFID, Information Service, Context Aware, Location Aware, System Integration.

1 Introduction

RFID today is the popular wireless induction system [5-7, 11-15,35,36]. Each RFID tag in RFID system is given a unique ID (UID). When an independent RFID tag approaches the RFID antenna, the induction between tag and antenna happens. The information and content recorded in the tag is transmitted to the RFID antenna and translated into the computational data. Following up the data translation, the tag recognition can be completed and related applications are provided.

Many local or small area wireless applications for monitor and control were proposed. The RFID systems were proposed to be used in hospital or health care [2-4,25]. A designed RFID tag is given to each patient that each patient should always wear every time and everywhere. Hence, all the patients' current location and conditions are monitored by the hospital. In other words, patients are under cared even an emergency state happens.

In addition, some entrance guard systems are also based on RFID system. The RFID ticket or RFID card [5-7, 12] is used to identify that a user is legal or not. According to the short-distance wireless signal, the RFID tag users can be monitored within the specific area.

Most of these applications are based on the indoor environments or be an on demand tiny area service [2-4,14,16]. The application is established without integrating the existing system or just with the assumptions of existing system integration.

Some applications focus on embedding RFID into a small device such as handheld host [1]. The handheld device users can be plugged in the SD or CF interface of RFID reader card. Hence, the users can scan and induct the RFID tag everywhere.

In opposition to creating new execution or service environment, there were many existed systems or applications about context-aware or location-aware deployed. These applications use the GPS to locate the user's location. Then, according the record of GPS, the service application server provides the location related information to the user. Although the GPS hardware can be plugged-in many handheld devices, to enable that every mobile device or user equips the GPS is not practicable. In addition, it also consumes the power of the mobile devices when GPS is used.

Furthermore, the users of context-aware or location-aware services exactly need the direction or information they required but not the exactly value of longitude and latitude in the world. Hence, to provide users with the fitting local information and the related direction of the required personal service without too much useless or unnecessary information gained is more important.

In this paper, a realistic application, *Context and Location Aware Public/Personal Information Service based on RFID System Integration* (CLAPIS), is proposed. By using the CLAPIS, the main contributions are :

1) users of *Context and Location Aware Public/Personal Information Service based on RFID System Integration* can communicate through the RFID tag or handheld devices with RFID reader to obtain the required or local information and services,
2) the efficiency of system management and service utilization can be improved,
3) the *Context and Location Aware Public/Personal Information Service based on RFID System Integration* can be embedded in other similar service systems and hardware,
4) the service object can be various,
5) the costs of the real construction for the public or personal service system by using our proposed system can be decreased and estimated.

Fig. 1 shows the service concept of *Context and Location Aware Public/Personal Information Service based on RFID System Integration*. People who locate in the different area may require the individual services. The services can be actively provided to the users via local area server. Or, the user can user the mobile handheld devices to actively access the services from local area server or CLAPIS server.

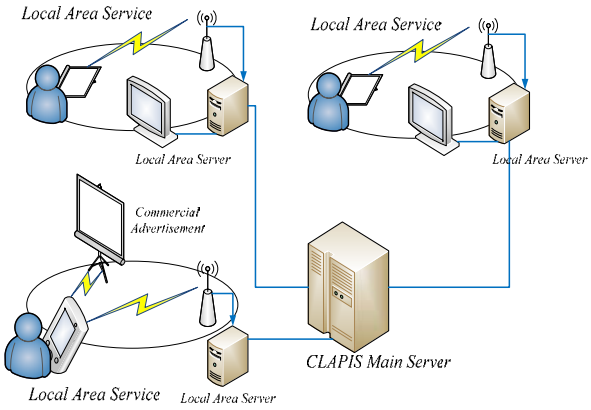

Fig. 1. The concept of *Context and Location Aware Public/Personal Information Service based on RFID System Integration*

The remainder of this paper is organized as follows. In Section 2, the proposed context-aware or location-aware researches were introduced. Section 3 presents the proposed *Context and Location Aware Public/Personal Information Service based on RFID System Integration*. The real states and implementations are shown in Section 4. At last, the conclusion is given in Section 5.

2 Related Work

Many researches proposed before presented the importance of providing information and services related the user's location to each person.

Some researches assume that there are GPS devices or module included in the users' mobile devices. Then, according to the information of GPS (GIS) [18,21-23], the location aware or related information or services are provided to the mobile user trough the wireless network.

In addition to GPS, according to the orientation made by the station of wireless cellular system[19], the related information according to the user's location can be given to the user via cellular system.

Not only supply the public services but also give the personal services, the context aware researches [20,24,25] were also proposed.

Research in [17] was proposed that considering the user's related location. The services and information of user-location-related public places such as

the museum [16] are provided. According to the requirement of users, different services are given through wireless network or cellular system to different users even they are in the same places.

Since the RFID system is popular and generally implemented, many researches [26-32] tried to integrate the RFID to and applied RFID technology to context-aware systems. However, in [33], what kind of the context, the corresponding context services, and the context-aware RFID system are important to be provided for user is still an issue of the existing system. In addition, there is no standard of operation modes of the RFID systems implemented for the context-aware services.

Hence, in this paper, to suit the RFID system to the context/location aware services, the system structure and three possible conditions of RFID utilization are proposed.

3 Context and Location Aware Public/Personal Information Service based on RFID System Integration

The mobile devices are assumed that there are many extra functions or facilities equipped and integrated such as GPS, WiMAX, WiFi, and Bluetooth, etc. However, a device with too many extra facilities equipped indicates that the power consumption is increased. Since the power of each handheld device is limited, identifying different users in different areas or locations with less power consumption is an important issue.

Due to induction characteristics of RFID, the power supply to a RFID tag is needless. The power to drive the IC of RFID tag relies upon the induction made by the RFID antenna. In addition, each RFID tag is given an unique ID (UID) and can be use to communicate with the RFID system. Hence, in this paper, *Context and Location Aware Public/Personal Information Service based on RFID System Integration* is proposed to integrate the RFID system for context and location aware information service.

In this section, the proposed *Context and Location Aware Public/Personal Information Service based on RFID System Integration* which includes:

1) *Embedded Service Middleware Platform*
2) *End User RFID Handheld Facilities*

are introduced. The system structure is shown as Fig. 2. The *Embedded Service Middleware Platform* is the main system to manage the internal and external system connections. The RFID API and parser are included and provided to communicate with the third party RFID system. The *Embedded Service Middleware Platform* also makes the information connection to other business management system or database via software API. In addition, the related information to the RFID tag inducted is presented by user interface.

For the end users, *End User RFID Handheld Facilities* consists of two appliances: *end user RFID tag* and *end user device with RFID System*. A user can use a given readable and re-writable RFID tag or a handheld device such as PDA which equipped a RFID system to gain the required public/personal services. In Fig. 2, the user handheld device also equips the RFID system, RFID API, and parser to scan ad induct the commercial RFID tag. The communication and the data transmission between the handheld device and server can be established via 1) Internet, 2) server-client socket, 3) a user RFID tag, or 4) a readable and re-writable RFID tag. A user can view the information or obtain the services via user interface (UI) presented by server or the user handheld device.

The other business management systems in the framework can be the third party developments and independent of the whole CLAPIS.

When the user approaches the RFID system at the specified area, the induction and communication between end user RFID tag and antenna of *RFID System* is automatically established. A RFID reader will parse the signal into the digital and computing content. Then, the *RFID System* transmits the information obtained from the tag to the *Embedded Service Middleware Platform* via Internet. According to the RFID information, the *Embedded Service Middleware Platform* searches for and

provides the specific personal service recorded in local area server according to the on demand conditions of the user. Moreover, the information or services can be updated or provided from the CLAPIS main database via Internet connection. Then, the user can obtain the public/personal information from the user interface.

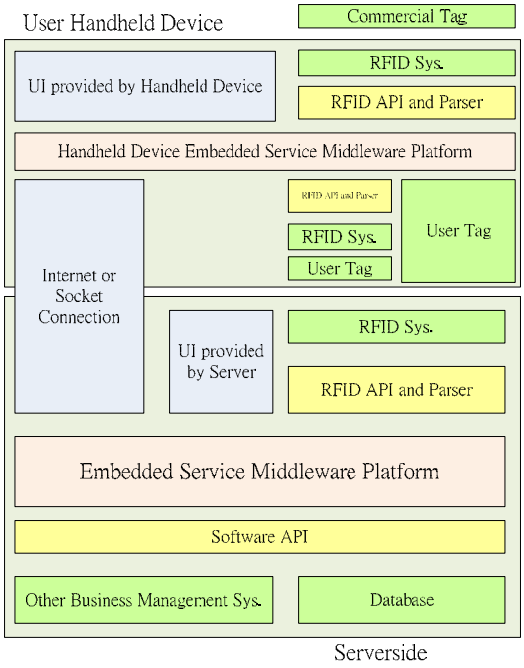

Fig. 2. The whole framework of *Context and Location Aware Public / Personal Information Service based on RFID System Integration*

In the proposed CLAPIS, the RFID antennas and reader are deployed 1) at the specific area or location such as the entrance of the rapid transit system shown as Fig. 3 or the information service machine, or

Fig. 3. The RFID system infrastructure of information service machine in the entrance of the rapid transit system

2) within the handheld devices such as PDA or mobile phone shown as Fig. 4.

Fig. 4. The real implementation of CLAPIS within a handheld device.

In addition, the RFID tags are 1) used by an end user, or 2) put in the commercial advertisement in public.

When a user served by CLAPIS, there are three possible conditions:

1) an *end user RFID tag* is used,

2) an end user scans an existed commercial RFID tag via *end user device with RFID System*, and

3) an end user without network utilizes *hybrid end user RFID handheld facilities*.

3.1 End User RFID Handheld Facilities

The *End User RFID Handheld Facilities* mainly consists of *end user RFID tag* and *end user device with RFID System*. These two facilities can be utilized individually or be an integral RFID system. These three possible applications are presented as follows.

3.1.1 End User RFID tag

Since not all the mobile handheld devices equip the wireless network module or RFID system, a user can only use the RFID tag without power consumption for location-aware services.

When a user is given an only readable RFID tag, the related information or the user's on demand service conditions about the user is given by himself and on demand recorded in the CLAPIS database.

When the user requires the local area public or personal services, the user should

be at the tiny induction area such as a local area information center or a service station. Then, the RFID system placed in the specific area inducts the RFID tag and gain the information such as UID from the RFID tag. The reader of RFID system then sends the information to the local area server via Internet.

After receiving the information, the local area server responses the on demand required services corresponding to the specific local area that the on demand required services were recorded in the CLAPIS database before. At last, the user can gain the location-aware information or services via user interface. Fig. shows the flowchart of the user who uses the *end user RFID tag*.

In addition, the CLAPIS database can record the history of the user's requirements. The statistic user requirements can be used to classify that what kind of the service the user requests most. Next time the CLAPIS can provide the personal services according to the classified results. In other words, the users can be served with the services they most pay attention to. Fig 5 indicates the flowchart of End User RFID tag utilization.

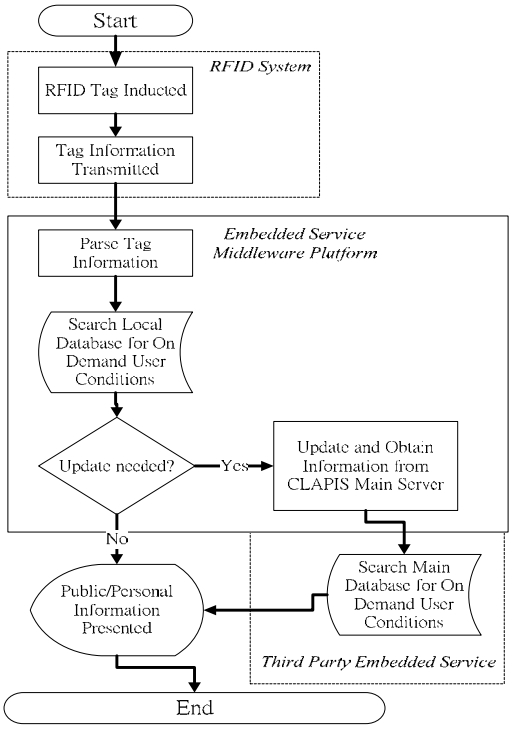

Fig 5. The flowchart of *end user RFID tag* utilization

3.1.2 End User Device with RFID System

Considering the popularity of handheld devices such as PDA and mobile phone, the devices which powered by battery with portable ability can be used as the service devices. There are many handheld devices that capable of plugging in the SD or CF type of appliances. These handheld devices can also access the Internet and communicate with other service applications. In addition, there are RFID systems that sized as a SD card. Hence, a handheld device can be the RFID system.

As the only readable RFID tag is used on the commercial advertisement, an individual and unique ID, and business related information are recorded in each commercial advertisement RFID tag. When the advertisements with the commercial RFID tags are placed in public, an *end user device with RFID System* user can actively read the commercial RFID tag information of the advertisement interesting in. Then, through the Internet, the requested service or detail of the advertisement according to the read commercial RFID tag information can be obtained.

After obtaining the RFID information of the commercial advertisement, the handheld device can 1) present the requested services according to the information scanned from the RFID tag via on demand defined data format such as XML, or 2) present the requested services according to the database that built in the handheld device, or 3) access the Internet for the further services searching and presentation.

If the requested services can not provided directly by the handheld device (such as that the RFID tag without XML format or no related service recorded in the database of handheld device), the communication between the handheld device and local area server via wireless network is established. Then, the local area server provides the requested location-aware services or business of the related sent RFID tag on the commercial advertisement are presented in the user's mobile device. The flowchart of *end user device with RFID System* is shown as follows.

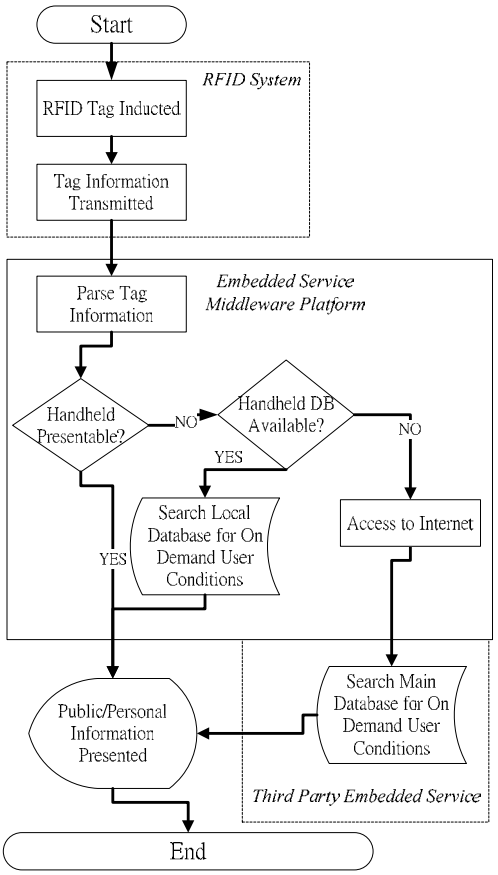

Fig 6. The flowchart of *end user device with RFID System* utilization

3.1.3 Hybrid End User RFID Handheld Facilities

However, the handheld device users may not always connect to the Internet via wireless network or the mobile phone network. In other words, a user may not obtain the required services or information via Internet at time. If a user wants to keep the services without Internet and can re-use the required services, how to maintain, record, and re-use the information content of scanned RFID tag becomes an important issue.

In this paper, the hybrid end user RFID handheld facilities method is proposed. Each handheld device user is assumed that the handheld device used equips two facilities: a re-writable RFID tag and the antenna and reader of the RFID system.

When a user is interesting in the specific commercial advertisement such as the coupon of a shopping store, the handheld device can be used to scan the RFID tag of the advertisement. Then, if the wireless network or mobile phone cellular network is available, the related or further information and services can be provided to the user. If the network connection is not available, the handheld device records the content of the RFID tag of this advertisement. In other words, there may be many contents of different RFID tags recorded in this device.

Then, as the users go for shopping in the store, the recorded coupon is required. However, the user does not connect to the network for corresponding information updating yet. The database of CLAPIS cannot provide the information about the handheld device users to the store. It means that the users have to provide the related information such as the coupon themselves. Fortunately, the RFID tag content of the advertisement is recorded in the handheld device. Therefore, the user can select the required content and re-write the user's RFID tag as the RFID tag content of the advertisement. At last, the store can scan the user's RFID tag and identify that a user can give the required tag content or not. The following flowchart presents the procedure of a user obtaining the RFID tag content and served by the hybrid end user RFID handheld facilities.

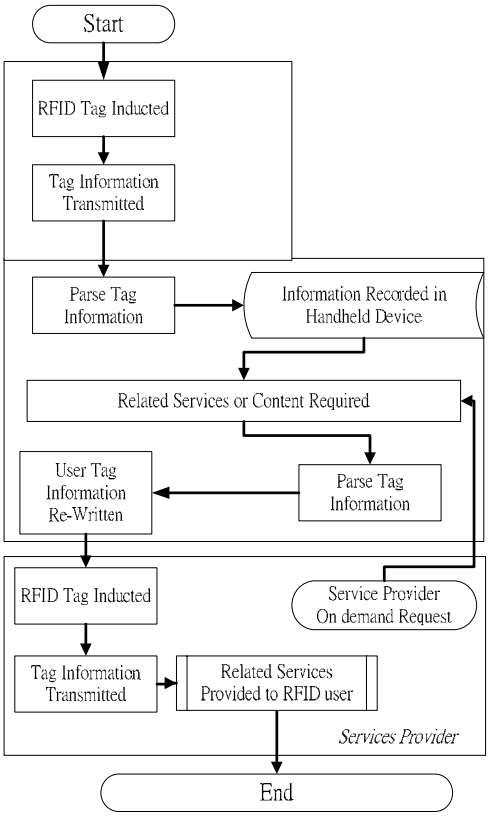

Fig 7. The flowchart of *hybrid end user RFID handheld facilities* utilization

Considering the practicability and to increase the usability of the proposed system, the HF type of RFID tag in this paper is selected for integrating other existed business applications.

3.2 Embedded Service Middleware Platform

To enhance the *End User RFID Handheld Facilities*, the *Embedded Service Middleware Platform* is proposed to deal with the information content from the RFID tag and provide the related or required services. To be feasible of the three types of *End User RFID Handheld Facilities*, the *Embedded Service Middleware Platform* includes the *handheld device middleware application* and *embedded server service middleware*.

In *Context and Location Aware Public/Personal Information Service based on RFID System Integration*, there are two existed service applications included: RFID system and other business management system which are independent of the CLAPIS. Due to that there are many types of RFID systems, the proposed *handheld device middleware application* and *embedded server service middleware* contain the RFID API assisted with RFID parser. An RFID API is used to communicate with a reader of the RFID system. Since there may be different types of messages from different RFID system, the implemented RFID parser can parse the analog message from the RFID antenna as the digital content.

3.2.1 Embedded Server Service Middleware

After parsing the message from RFID system, the content of RFID tag can be identified. If *end user RFID tag* is used, the *embedded server service middleware* can search and present the local information such as local area shopping information, traffic information, or the customization information, recorded in local database that match the on demand conditions of the RFID tag user. In other words, the RFID user can be directly served with sufficient local area related information. If other further information needed, the *embedded server service middleware* can send the user's request to the CLAPIS main server to obtain the requested service or to the other business applications via Internet for extra service obtaining.

Considering reducing the cost of construction and embedded in existed application, the Software API is proposed to communicate with the existed business applications. In other words, the requested services can be provided directly from the other businesses (local or wide area) without all applications integrated. Hence, the users only need the *end user RFID tag* to obtain the services at the specific area or place with RFID system assisted. The end users are served passively by the local area CLAPIS.

In opposition to *end user RFID tag*, when a user of *end user device with RFID System* actively scans the RFID tag of the commercial advertisement, the handheld device can send the scanned RFID tag information via wireless network or cellular mobile system to the local area server with *embedded server service middleware* embedded. Then, as the procedure of *end user RFID tag*, the *embedded server service middleware* searches for the requested services and transmits these services to the user's handheld device by wireless network or cellular mobile system. The structure of the *embedded server service middleware* is shown as follows.

3.2.2 Handheld Device Middleware Application

However, not all the *end user device with RFID System* can connect to the *embedded server service middleware* via wireless network or cellular mobile system. Hence, *handheld device middleware application* is proposed for a handheld device that may need to manage the RFID tag information or content and provide the services itself.

According to *hybrid end user RFID handheld facilities* described in section 3.1.3, a user equips a re-writable RFID tag and the antenna and reader of the RFID system. Therefore, the *handheld device middleware application* also provides the RFID API assisted with RFID parser to control the RFID system embedded in the handheld device.

When a user scans the RFID tag of the

advertisement, RFID API of *handheld device middleware application* parses the message from RFID system. The content of RFID tag can be identified. Then handheld device records the content of the RFID tag in the database of the handheld device. In other words, there may be many contents of different RFID tags recorded in this device.

Therefore, the users can use *handheld device middleware application* to select the tag content recorded in handheld device database if needed. Then, the RFID API controls the RFID system embedded in the handheld device to re-write the content (such as UID) of the tag of the handheld device. At last, the RFID content requirement from other business applications or systems can be provided through the RFID tag of the handheld device. In other words, the *hybrid end user RFID handheld facilities* user needs a tag which can be re-written the content as any commercial advertisement RFID tag by the handheld device.

4 Implementation

To real test and verify the proposed *Context and Location Aware Public/Personal Information Service based on RFID System Integration*, we develop the *Embedded Service Middleware Platform* in Java language. IC Brains[8] and ThingmMagic [9] RFID reader and antenna are selected for the RIFD system real implementation. The tag product of International Semiconductor Technology Ltd. (IST) [10] is used for *End* User RFID Tag and commercial advertisement RFID tag.

4.1 RIFD System

There are two types of RFID systems implemented in the real verification environment. ThingmMagic is implemented with the local are servers and CLAPIS main server. The readers and antennas are placed in the specific limited public area as Fig. 3. Fig. 8 shows the readers and antennas of IC Brains which are used as the portable devices for PDA. To guarantee the stability and accuracy of RFID tag detection and identification within the finite time, the power of ThingmMagic antenna is set as 30 dBm and the state of antenna and reader are always on.

Fig.8. The handheld device, PDA, and the RFID reader (SD type of interface).

Considering the performance of RFID tag, the IST's tag with size 2"X3.5" for PVC and label are used. Fig. 9 shows the example tag used in CLAPIS. In addition to the type of RFID card, the various IST's patent embedded RFID 3D toy is also selected for real verification.

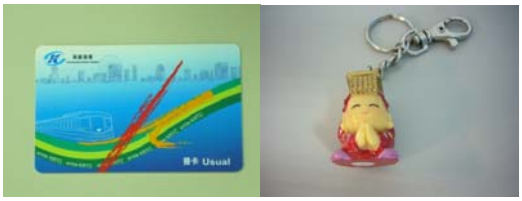

Fig. 9. The RFID tag and 3D toy of IST used in CLAPIS.

4.2 Embedded Service Middleware Platform

The *Embedded Service Middleware Platform* of server PC based on Java language is independent of operation system. For PDA, *Embedded Service Middleware Platform* is programmed by eVB language.

The RFID API uses server-client socket to communicate with the ThingmMagic RFID reader. To manage the real time events from the RFID reader, the *Embedded Service Middleware Platform* runs thread environment. In this paper, the proposed platform runs based on the PC and PDA. The related parameters are shown in Table 1. For reducing the cost of system construction, each local area server is connected to at least two screens and present individual service at the same time.

Table 1. The related parameters of PC and PDA for CLAPIS.

PC	
CPU	Core 2 Dual 1.66GHz
Memory	1 G DDRII RAM
HDD.	At least 200MB
O.S.	Microsoft Windows XP
PDA	
CPU	ARM920T PXA270
Memory	512MB
Network	Wi-Fi
O.S.	Microsoft Windows Mobile Version 5.0 for Pocket Pc

According to the user interface in the *Embedded Service Middleware Platform*, the end user can obtain the real-time and local services of local area or neighborhood. The related or requested information according to the on demand user's conditions, such as shopping news, real-time traffic and weather, and destination direction instruction are presented. The presentation of CLAPIS is based on video instruction, menu lists, or graphic interactive user interface. Fig. 10 is an example that is a shuttle bus transportation instruction based on video.

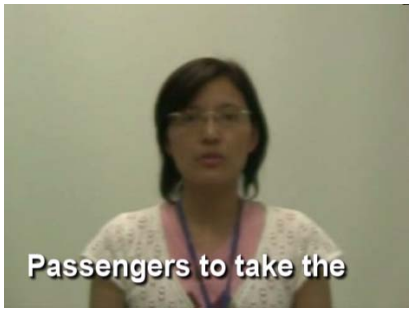

Fig. 10. The presentation of CLAPIS (Ex. Shuttle Bus Transportation).

4.3 Real Presentation and Result

The real test and verification is implemented in IST. The *end user RFID tag* type verification is tested. Fig. 11 shows one shoot of the verification. When the user approaches the on demand placed RFID system, the *Embedded Service Middleware Platform* automatically presents the information corresponding the content or user's related information recorded in the RFID tag. For example, if a Taiwanese uses the RFID tag, the presentation of local area server will be based on traditional Chinese. But the local area server will provide English when a native English speaker user his own RFID tag respectively.

Fig. 11. The environment of test and verification for *end user RFID tag* of CLAPIS.

If the end user uses the *end user device with RFID System*, the user can actively scan the RFID tag within the commercial advertisement or the instruction in public. Then, the requested service or information will be presented by the h *embedded server service middleware*. The connection between handheld device and local area server can be automatically established if needed. Fig. 12 shows one shoot of the verification.

Fig. 12. The environment of test and verification for *end user device with RFID System* of CLAPIS.

According to the verification, the results are presented in the web: http://www.wretch.cc/video/jianms&func=single&vid=4361207&o=time_d&p=0.

5 Conclusion

In this paper, an embedded application, *Context and Location Aware Public/Personal Information Service based on RFID System Integration*, is proposed to integrate the existed service systems, devices, and business database. The proposed integration system provides the RFID API module and related parser that can easily embed other RFID systems in. In addition, the three possible conditions of *End User RFID Handheld Facilities* which correspond to a user served by CLAPIS can provide the corresponding services to each user. The verification shows that the proposed system is realistic and can provide the public and personal services automatically. The total cost of infrastructure establishment for these services can be reduced.

Reference

[1] Hoboken RFID-enables Its Parking Permits, *RFID Journal*, June 2006, http://www.rfidjournal.com/article/articleview/2421/1/1/

[2] Hospital Uses RFID for Surgical Patients, *RFID Journal*, July 2005, http://www.rfidjournal.com/article/articleview/1714/1/1/

[3] RFID Hospital: Columbus Children's Hospital To Install RFID System From Mobile Aspects, *RFID Solution Online*, March 2007, http://www.rfidsolutionsonline.com/content/news/article.asp?DocID={26FD8444-A98C-4062-911F-41F26031E4B9}&Bucket=Current+Headlines&VNETCOOKIE=NO

[4] RFID trial tracks hospital equipment, http://www.computing.co.uk/computing/news/2168717/rfid-trial-tracks-hospital

[5] RFID Takes a Swing at Ticket Fraud, *RFID Journal*, December 2005, http://www.rfidjournal.com/article/articleview/2060/1/1/

[6] Moscow Metro Tries RFID-Enabled Ticketing, *RFID Journal*, February 2007, http://www.rfidjournal.com/article/view/3049/

[7] Beijing Olympic Games Prompts RFID Development in China, http://www.rfidglobal.org/news/2007_9/200709031653253861.html

[8] IC Brains Hong Kong Limited http://www.icbrains-asia.com/eng/product.htm

[9] http://www.thingmagic.com/

[10] http://www.ist.com.tw/

[11] M. S. Jian, C.L. Lee, K. S. Yang, and N. Y. Huang, "Embedded Automatic Parking Management System based on RFID and Existed Gate System Integration," *Proc. of WSEAS Inter. Conf. on Sys.*, July 2008.

[12] Z. Pala and N. Inanc, "Smart Parking Applications Using RFID Technology," *Proc. of 1st Annual RFID Eurasia*, pp. 1 – 3, September 2007.

[13] M. F. Lu, S. Y. Chang, C. M. Ni, J.-S. Deng, and C. Y. Chung, "Low Frequency Passive RFID Transponder with Non-revivable Privacy Protection Circuit," *Proc. of WSEAS Inter. Conf. on Instrumentation, Measurement, Circuits, and Sys.*, pp. 166-169, Hangzhou, China, April 2006.

[14] M.vilammi, L.vSydänheimo, P. Salonen, and M. Kivikoski, "Read Range Analysis of Passive RFID Systems for Manufacturing Control Systems," *Proc. of WSEAS Inter. Conf.*, pp. 2081-2085, May 2002.

[15] M. S. Jian, C.L. Lee, K. S. Yang, and N. Y. Huang, "Embedded Local Area Public/Personal Service System based on RFID System Integration," *Proc. of WSEAS Inter. Conf. on Sys.*, July 2008.

[16] R. Tesoriero, J. A. Gallud, M. Lozano, and V. M. R. Penichet, "A Location-aware System using RFID and Mobile Devices for Art Museums," *Proc. of 4th Inter. Conf. on Autonomic and Autonomous Sys.*, pp.76-82, 2008.

[17] C. Ciavarella and F. Paternò, F., "The design of a handheld, location-aware guide for in-door environments." *Springer Verlag Personal and Ubiquitous Computing*, pp.82-91, 2004.

[18] C.S. Baptista, C.P. Nunes, A.G. de Sousa, E.R. da Silva, F.L. Leite, and A.C. de Paiva., "On Performance Evaluation of Web GIS Applications," *Proc. of the IEEE 16th Inter. Workshop on Database and Expert Sys. App.*, pp. 497-501, 2005.

[19] P. Bahl and V.N. Padmanabhan, "RADAR: An inbuilding RF-based

user location and tracking system", *Proc. of Infocom*, pp.775-784, 2000.

[20] L. Han, S. Jyri, J. Ma, K. Yu, "Research on Context-Aware Mobile Computing," *Proc. of 22nd Inter.Conf. on Adv. Infor. Net.g and App. – Workshops*, pp.24-31, 2008.

[21] M. Marmasse and C. Schmandt, "Locationaware information delivery with commotion", *Proc. of 2nd Inter. Symposium in Handheld and Ubiq. Comp.*, 2000.

[22] D. Ashbrook and T. Starner, "Learning significant locations and predicting user movement with GPS", *Proc. of Inter. Symposium on Wearable Comp.*, 2002.

[23] D. J.Patterson, L. Liao, D. Fox, and H. Kautz, "Inferring High-Level Behavior from Low-Level Sensors", *Proc. of 5th Inter. Conf. on Ubiqutious Comp.*, 2003

[24] L. Buriano, "Exploiting Social Context Information in Context-Aware Mobile Tourism Guides", *Proc. of Mobile Guide 2006*, 2006.

[25] M. A. Munoz, M. Rodriguez, J. F. Center, A. I. Martinez-Garcia and V. M. Gonzalez. "Context-Aware Mobile Communication in Hospitals", *IEEE Computer*, pp.38-46, 2003.

[26]K. Romer, T. Schoch, F. Mattern, and T. Dubendorfer, "Smart Identification Frameworks for Ubiquitous Computing Applications", *Wireless Networks*, pp. 689-700, 2004.

[27] S. Willis and S. Helal, "A Passive RFID Information Grid for Location and Proximity Sensing for the Blind User," *TR04-009*, 2004.

[28] G. Chen and D. Kotz, "A Survey of Context-Aware Mobile Computing Research," *Dartmouth College Technical Report TR2000-381*, 2000.

[29] J. E. Bardram, R. E. Kjar, and M. O. Pedersen, "Context-Aware User Authentication - Supporting Proximity-based Login in Pervasive Computing", *Proc. of Ubicomp*, pp. 107-123, 2003.

[30] C. Floerkemeier and M. Lampe, "Issues with RFID usage in ubiquitous computing applications", *Proc. of Pervasive Comp.*, pp. 188-193, 2004.

[31] M. Crawford, et. al., "RFID Enabled Awareness of Participant's Context in eMeetings", *Proc. of Pervasive Tech. Applied Real-World Experiences with RFID and Sensor Net.*, 2006.

[32] J. Bravo, R. Hervas, G. Chavira, and S. Nava, "Modeling Contexts by RFID-Sensor Fusion", *Proc. of Pervasive Comp. and Comm. Workshops*, pp. 30-34, 2006.

[33] J. Choi and E. Kim, "Using of the Context in RFID Systems", *Comm. of the Korea Information Science Society*, pp. 64-70, 2006.

[34] RFID Public and Personal location / context aware services, http://www.wretch.cc/video/jianms&func=single&vid=4361207&o=time_d&p=0

[35] RFID Parking Demo, http://www.wretch.cc/video/jianms&func=single&vid=4167314&o=time_d&p=1&cid=56540