World Applied Sciences Journal 12 (Special Issue on Computer Applications & Knowledge Management): 01-06, 2011
ISSN 1818-4952

RFID-Enabled Presence Aware System (RPAS)

[1]Nazleeni Samiha Haron, [1]Mohd Hilmi Hasan, [1]Mazeyanti Mohd Ariffin,
[1] P.A. Emelia Akashah [1]Syadia Arina and [2]Kamaruzaman Jusoff

[1]Department Computer and Information Sciences, Universiti Teknologi PETRONAS,
Bandar Seri Iskandar, 31750 Tronoh, Perak, Malaysia
[2]Faculty of Forestry, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

Abstract: Presence is a person's availability and willingness for communication at the time responses were sought from him or her. This piece of information is vital to people in need of immediate communication. By knowing one's presence, the person can explore on meeting opportunities and perform decision making instantaneously. SMS, e-mail, shared calendar or instant messaging (IM) are the common methods to seek presence, but they impose some limitations that do not remedy the situation completely. As such, RFID-enabled Presence Aware System (RPAS) was proposed. The objective of the paper is to design and implement RPAS to enable automatic presence detection using RFID and make presence information sharable via web application. The study was conducted using six-phased structural development method. The user acceptance testing and the formal tests carried out revealed that the system was easy to use and useful. This study implies that automatic presence detection and shareable presence status will contribute to effective time management for personnel that indirectly gain the competitive strength for an organization. Future work includes integrating context-aware computing in RPAS for more intelligent presence detection system.

Key words: Presence · Presence-awareness · Radio Frequency Identification (RFID)

INTRODUCTION

Presence is a person's availability for communication at the time responses were sought from him or her. This piece of information is vital to people in need of immediate communication. For example, it would be more convenient if X can confirm in advance whether Y is available for a meet up or a phone call, chat session, video conference, etc. Through this capability, X will be able to proceed with other tasks without having to wait around for Y. This too saves X the trouble of asking other people if Y really is around.

SMS, e-mail, shared calendar or instant messaging (IM) are the common methods to resolve this issue, but it does not remedy the situation completely. As of current, meetings involving two or more parties require the setting of an appointment using e-mails. Under certain circumstances, either might be forced to cancel the appointment due to unforeseen events. It would help if both parties have each other's mobile number and are able to immediately propose a last minute rescheduling. However, this is not always the case as mobile numbers are personal in nature and are not extensively shared. After all, e-mails have a relatively long propagation time as there is a considerable delay between a message being sent and a message being read. Shared calendar offers the interface for viewing someone's schedule and the ability for the meeting requestor to pick any suitable date and time for a meeting. However it may be restricted to certain group of people and sometimes does not indicate the latest status of the requested person. IM offers the user the flexibility to advertise their presence status but updating this status should be automatic. The current method requires users to state their status manually and this could be troublesome and error prone. Sometimes, unplanned visits had to be made to other party's office in case of emergencies. It would help if one can verify whether the intended person to meet is really there prior the meeting.

To alleviate the abovementioned problems, RFID-Enabled Presence Aware System (RPAS) was proposed. The main idea behind the system is to have a mechanism for sharing the presence information for each personnel in the organization. Its RFID component eliminates the need

Corresponding Author: N.S. Haron, Department of Computer and Information Sciences, Universiti Teknologi PETRONAS, Bandar Seri Iskandar, 31750 Tronoh, Perak, Malaysia, E-mail: nazleeni@petronas.com.my.

for users to change their availability status manually, simultaneously giving the system a higher degree of effectiveness. In addition the system tries to give users the ability to instantly check a person's availability without having to manually prompt him or her for confirmation. They can simply check from an application that displays the availability statuses of each personnel. The indirect contribution of the system is to make people aware of meeting opportunities and subsequently their time can be managed effectively. By being more time-efficient, more tasks can be accomplished within the same time frame, making the importance of presence-information more obvious to the organizational setting today. From a more general view; the project demonstrates how presence-information enables productive communication between diverse members of an organization. It tackles the time management issues in getting multiple parties to exchange information instantaneously.

The objective of the paper is to design and implement RPAS to enable automatic presence detection using RFID and make presence information sharable via web application.

Related Work: Presence, when viewed as a piece of information, is the availability and willingness for communication [1]. The information will then be used to decide whether it is the proper time to initiate a communication. A pre-knowledge of the corresponding party's presence is essential and can improve the situation [2]. This implies that interaction cannot take place unless both parties are physically or virtually present and are able to communicate voluntarily. Consequently, presence is particularly important when someone needs to initiate communication instantly.

As presence information plays an increasingly huge role to our community today, businesses has started to make use of them by deploying Instant Messaging (IM) tool to gain competitive strength [3]. In addition, IM was not only used as a replacement for other communication media but as an additional method for reaching others [4]. These prove presence information is essential in any organization.

However, an application must be able to provide a bridge between virtual presence and physical presence [5]. While it may be true that IM sets a person's status to away if the mouse and keyboard are idle for a certain range of time, the information will no longer be accurate if that person had manually set his away status earlier and had forgotten to change it to available the moment he/she returns. Such situation suggests inconsistency and incorrect user's situation [2].

Furthermore, presence awareness is a must feature for any presence system to be meaningful. Presence awareness was defined as the information like the location, identity, activities and the neighbors of someone or something who or which is present somewhere [6]. By knowing these information, others can decide accordingly when, how and where to reach the intended person. This will aid in efficient communication among the staff in the organization.

It is best that the presence awareness information is automatically retrieved with minimal human intervention. Researchers have demonstrated that RFID technology can be used in capturing and providing information such as identity, location and activity automatically [7-14]. An automated attendance system was developed where RFID was used as the technology to identify people automatically [8]. In [9], a smart environment was created where all objects are associated with an RFID tag and sensors. The smart environment reacts to a presence by returning personalized services according to the preferences associated with the RFID tag. RFID has also been used to capture presence and location information for situational awareness for army enterprises [10]. Another system was developed using the same technology and concept but for campus setting [11] attest that RFID can be used as an input device to capture presence awareness information. In addition, RFID was proposed in [12] as the technology of choice for efficient monitoring of items in a library as alternative solution to geospatial information system (GIS). One example of how RFID can be used to capture activity information can be found in [13].

MATERIALS AND METHODS

The study has been conducted using six-phased structural development method.

Preliminary Investigation: In this phase, interviews and observations were conducted as to gather information on how meetings take place in a typical organizational setting. 30 personnel from both large and small organizations were chosen as respondents. In this study, current methods of meeting arrangement and communication style were discovered. In addition, limitations and weaknesses with regards to those methods were also identified. Respondents were also asked on their willingness to share presence information.

Requirement Analysis: Based on the investigation conducted, key functional requirements for RPAS were analyzed. The requirements were divided into two categories: non-functional and functional requirements. Non-functional requirements entail how the system is supposed to be. It is critical to determine these requirements as it will influence the choice of system design and architecture. Functional requirements describe how the system is required to perform. Hardware and software requirements were also ascertained in this stage.

System Architecture: In this stage, the architectural framework was developed. The framework served as the road-map for the system-building process. System components in form of subsystems were identified based on the requirements gathered in the previous stage. Subsequently, the functionalities for each component were derived. Lastly the communication and interaction operations among the components were determined.

System Design: System design involves an understanding of domain being studied, the application of various alternatives and the synthesis and valuation of a proposed solution. In this stage, detailed subsystem designs were carried out. Unified Modeling Language was used to model both structural and behavioral elements of RPAS. Structural diagrams aid in visualizing the things that must be present in the system being modeled. Behavioral diagrams were used to depict the interaction and the flow of the system. The resulting design served as the blueprint for the system that was used in the subsequent phase.

System Implementation: In this stage, a prototype was developed according to the deliverables from the previous phases. Each subcomponent was implemented using different software. The rationale was different components provide different functionalities and require distinct capabilities that can be derived from certain software.

System Testing: A set of formal tests were carried out in order to ensure the system worked according to the requirements and design specified. The tests include module testing, integration testing and functionality testing. In addition, user acceptance test was conducted with 30 respondents to solicit user's perception on usefulness and usability of the system. The respondents were given an RFID tag each and were asked to experience with the system as both requester and requested type of users. Their feedbacks were sought via a questionnaire. The questionnaire was designed based on Technology Acceptance Model (TAM). The results were then analyzed to discover the viability of proposed system.

System Requirements: The requirements have been categorized into two namely functional and non-functional. They were gathered during the second phase of the study.

Functional Requirements: The functional requirements were determined for the entire system as well as for the specific RFID tag holder and presence information requestor.

As for the entire system, the requirements were set as follows: a) RFID readers must be placed at the entrance of personal offices, a point that any employee must pass through to get to his or her workstation. b) Tags must be distinguishable to provide unique identification. c) One floor will have at least 2 transceivers to afford wide coverage. d) Users may request for notification of a certain RFID tag holder. e) Admin can change the ownership of an RFID tag.

As for the requirements for RFID tag holder include: a) One RFID tag per person. b) Tag holder's profile must be registered into the system. c) Tag holder can manually provide additional description to their status such as location, activity and absence duration. d) Status reset is done at 12:00am daily to avoid inconsistent record of availability statuses. e) Names appearing on the list of tag holders are accompanied with tag holder's particulars such as office location, room number, e-mail and extension. f) The system must be accompanied with a link where users can report errors. This is particularly important to increase the system's reliability.

Finally the sole requirement for presence information requestor is to search for presence status and location of the RFID tag holder.

Non-Functional Requirements: The list of non-functional requirements was quite extensive and some were summarized as follows : a) There will be a daily reset of statuses to avoid inconsistency of information if an RFID tag holder chooses to set his/her status manually. b) The RFID reader must be able to detect several RFID tags simultaneously as it is possible for more than 1 employee to enter or exit a facility at the same time.

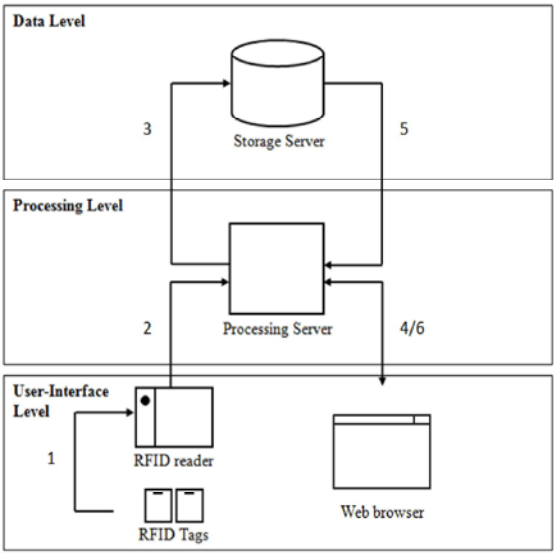

Fig. 1: System Architecture

c) The system must be able to match an RFID tag with its holder's profile correctly. d) Status updates must come with accurate time stamps. e) If a person decides to subscribe to service notification, the system must be able to send out an alert the first time a target enters the office. f) Back up operations for the database is done weekly so as to support system recovery in case of disasters.

System Architecture: The architectural overview of RPAS is as shown in Fig. 1.It was designed based on three-tier system architecture.

The General Steps Involved in the Process Were Labeled in Fig. 1 and Summarized as Follows:

- RFID reader detects RFID tags.
- Information associated with the tag number is sent to the processing server
- Storage server updates presence record
- Website user sends a request for the availability of an RFID tag holder.
- Processing server performs SQL query and retrieves a matching record
- Result is then returned to the website for display

The first tier is the user interface Level through which users can interact with the system. This level also acts as the front end for capturing input provided by the users and for displaying output as per requested by the users. There are two types of users for this system: Requested and Requester. Requested is the person whose presence status is sought for and requester is the person who request for other people's presence status. In this level, requested users will be interacting with the RFID component of the system and the web services in order to advertise their presence status. The RFID component comprised of three sub components: transponder, reader and antenna. The transponder or the RFID tag was embedded in the user's identification card (normally provided by the organization as a means to enter and exit a building and carried by the user). Each tag contains user information and the tag id. Reader runs software that is used to read information from the RFID tag. Antenna is attached to the reader and has its own identification information (antenna id) that determines their location. Whenever the requested user passed by any reader, the RFID tag will be automatically detected by the reader and it will generate a tag-read event with the schema (tag ID, antenna ID, time). This information will be sent to the processing server for further transaction and storage. Requested user can further modify their status setting by using the web browser user interface. Requester can access the application via any web browser software as to check on the requested user's status.

The middle tier is the Processing level that acts as the middle person between the user interface and the database. Components in this tier receive requests coming from the user interface tier. Subsequently, the components interpret the requests into apposite actions controlled by the defined work flow in accordance with certain pre-defined rules. This tier comprised of few core components such as Presence Management Service, Personalization service, Repository and Retrieval service.

Presence Management service offers functionality of processing captured RFID data to be consumed by other services. This is how the system obtains time-stamped record of entrance-and-exit activities of every tag owner.

Personalization service enables the user to manage their information according to their preferences. The information is structured into several categories such as general information about the user, presence information (status, location) and security settings (for authentication purpose).

The third service which is dubbed as Repository and Retrieval service, offers users or other services to store, retrieve and query the information stored in the database.

The final tier is the data level. The data level is responsible for modeling and storing information needed for the system and for optimizing the data access. Data needed by the processing level are retrieved from the database. The computational results produced by the processing level are stored back in the database.

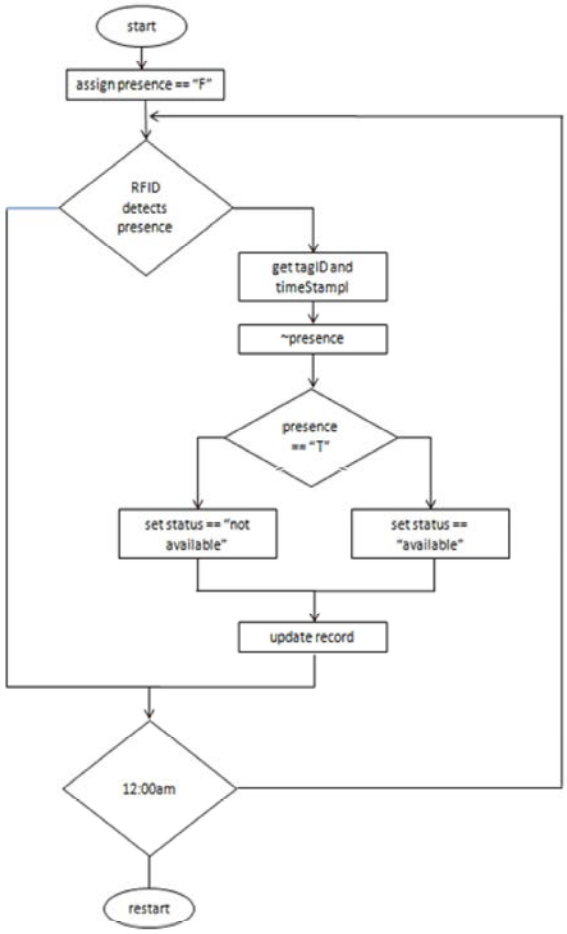

Fig. 2: Flow of Presence Management Service

Fig. 2 depicts the application logic for presence management module in order to ensure accurate labeling of statuses. At 12:00 am daily, the statuses will be reset to "F", which is an indicator for absence, in order to eliminate faulty of status record.

Prototype Implementation: The prototype was developed according the specified architectural framework and system design. The Presence Management Service has two distinct components namely RFID client application and RFID Web service. The role of RFID client application is to continuously monitor the RFID antenna and capture the entrance-exit behaviors for each detected RFID tag. Whenever any tag is detected, it will notify the Web service. The client application was developed using .NET language and runs on Windows operating system. . NET was chosen as it has extensive object reference and library for com port interactions. In addition, it is compatible with Apache's PHP and MySQL services. The Web service was developed using PHP. In addition, the rest of the services in the processing level can be accessed by client via an HTML user interface and were also developed using PHP. To enable the operation between processing level and data level, open database connectivity (ODBC) was selected as the connectivity protocol. Furthermore, structured query language (SQL) was used for writing statements and queries in the rational database management systems (RDBMS).

RESULTS AND DISCUSSION

User acceptance testing was carried out with 30 participants to solicit feedbacks on the usefulness and usability of the RPAS. All participants were asked to experience with the system as both types of users. Their behaviors while using the system were observed and their feedbacks were sought via questionnaire.

First of all, the study revealed that users could use the system easily, understand the functionality of the system and comprehend the presented information. In addition, the users found the interface design neat and clear.

Most importantly, the users found the system useful and helpful as their presence information were shared automatically without requiring their interventions. Furthermore, they were satisfied with the ability to control their privacy and profile in the system.

In conclusion, the users expressed positivity towards accepting the system.

CONCLUSION

The RFID-Enabled Presence Aware System has been designed to promote productive communication among members of an organization. RFID technology helps automate the recording of its occupant entrance-and-exit activities. Through the enablement of a self-updating system, organizations achieve better resource management because they are able to prepare communication plans more effectively. As a result, an organization saves valuable time and gets to complete greater amount of tasks in a short period of time. Because extensive sharing of presence information helps in overcoming ad hoc communications problems, organizations actually gets more control over the interactions that take place between its member. By improving internal communication flows, an organization gets to operate at a higher level of efficiency, giving it an advantage over its competitors. The system can either be expanded or be fused with identity management systems already in use by an organization. In addition, the system

can be added with more intelligent capabilities. Contexts can be sensed by the system via the device of the personnel. The context information can be automatically retrieved from user's calendar, tasks, notes which are stored in their devices such as laptop, mobile phone or any hand h eld devices. Examples of context include time, location, entity and identity of the user. This information (with granted permission) can also be shared to the requestor before exploring meeting opportunities. Furthermore, the system can propose a suitable meeting time for all parties involved after considering all the contexts detected. These intelligent capabilities will definitely contribute to more effective decision making and thus will aid in speeding up the efficiency of an organization.

REFERENCES

1. Singh, V.K. and H. Schulzrine, 2007. Presence Aware Location-Based Service For Managing Mobile Communications. 2007 Consumer Communications and Networking Conference, Las Vegas, USA, 11-13 January 2007, pp: 514-519.
2. Xiaolei, Z., C. Law, C. Wang and F.C.M. Lau, 2009. Towards pervasive instant messaging and presence awareness. International Journal of Pervasive Computing and Communications, 5(1): 42-60.
3. Cameron, A.F. and J. Webster, 2005. Unintended consequences of emerging communication technologies: Instant Messaging in the workplace. Computers in Human Behavior, 21(1): 85-103.
4. Fogarty, J., J. Lai and J. Christensen, 2004. Presence versus availability: the design and evaluation of a context-aware communication client. International J. Human Computer Studies, 61(3): 299-317.
5. Kikuchi, H. and Y. Nakamura, 2007. Online and Offline Presence Information Integrated with RFID and Instant Messaging Agent. The Advanced Information Networking and Applications Workshop, Niagara Falls, Canada, 21-23 May 2007, pp: 199-202.
6. Christein, H. and P. Schulthess, 2002. General Purpose Model of Presence Awareness. Lecture Notes in Computer Sci., 2468: 345-392.
7. Lieckfeldt, D., J. You and D. Timmermann, 2009. Characterizing the Influence of Human Presence on Bistatic Passive RFID-System. Wireless and Mobile Computing, Networking and Communications, Marrakech, Morocco, 12-14 October 2009, pp: 338-343.
8. Lim, T.S., S.C. Sim and M.M. Mansor, 2009. RFID Based Attendance System. The IEEE Symposium Industrial Electronics and Applications, Kuala Lumpur, Malaysia, 4-6 October 2009, pp: 778-782.
9. Lopez, T.S., D. Kim and T. Park, 2006. A Service Framework for Mobile Ubiquitous Sensor Networks and RFID. 1st International Symposium of Wireless Pervasive Computing, Phuket, Thailand, 16-18 January 2006, pp: 1-6.
10. Lucenius, J., 2008. Use of Presence and Location Information for Situational Awareness. The International Digital Telecommunications, ICDT08, Bucharest, Romania, 29 June-5 July 2008, pp: 117-125.
11. Haron, N.S., N.S. Saleem, M.H. Hasan, M.M. Ariffin and I.A. Aziz, 2010. A RFID-based Campus Context-Aware Notification System. J. Computing, 2(3): 122-129.
12. Pournaghi, R. and L. Pournaghi, 2008. Applying Geospatial Information System in Space Management of Academic Libraries. World Applied Sciences J., 3(1): 155-160.
13. Bravo, J., R. Hervás, I. Sánchez and G. Chavira. 2006. Visualization Services in a Conference Context: An Approach by RFID Technology. J. Universal Computer Sci., 12(3): 270-283.