Australian Journal of Basic and Applied Sciences, 4(11): 5584-5589, 2010
ISSN 1991-8178

Intelligent Campus Bus Identification and Monitoring System

[1]M.A. Hannan, [1]A.M. Mustapha, [2]H. Basri and [3]A. Hussain

[1]Department of Electrical, Electronics and Systems Engineering
[2]Department of Civil and Structural Engineering
[3]Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, Selangor, Malaysia

Abstract: RFID is an expanding technology and has a promising future in monitoring and identification system. This research is carried out to test the RFID and GIS system integration. The developed system is able to monitor the movement of the campus buses and their positions. Accordingly, we have developed a theoretical framework as well as the method and system for bus monitoring system. Experimental process has also been conducted. The result would display the location of buses and their positions in map form as well as timing of the bus travelling in each location. Initially, a GUI is developed to give an idea on how the actual system is going to work.

Key words: ITS; RFID; GIS; identification; monitoring

INTRODUCTION

The development of intelligent system in today's modern world is fascinating. Homes, vehicles and even appliances are preferred to be intelligent. Frankly, intelligent system is a system that acquires Artificial Intelligence (AI) of a device. AI is claimed to be able to recreate the capabilities of the human mind.

This research solely focuses on the transportation, so an Intelligent Transportation System (ITS) is implemented. ITS is a part of AI and was first introduced due to the traffic congestion problem that arose. The technologies applied in ITS are as wireless communications, computational technologies, floating cellular data, sensing technologies and video vehicle detection. The applications of ITS implemented worldwide are in electronic toll collection, emergency vehicle notification systems, cordon zones with congestion pricing, automatic road enforcement and collision avoidance systems. Based on the existing use of ITS, it is proven that ITS is a very crucial system in today's technologies.

Identification is the act of identifying while monitoring is the act of maintaining regular surveillance over. This study deals with RFID to provide information of the monitored vehicle. The information is then displayed in the GUI as in the map form as well as vehicle information such as number plate, ID of the driver and expected time of bus movement. This allows the identification and monitoring of UKM bus system.

RFID and GIS:

Radio-frequency identification (RFID) is a technology that applies radio waves and is one of the automatic identification technologies used to identify object of interest. Considered as the next stage in the barcode revolution, RFID is vastly developing in the identification market. Many big enterprises like Wal-Mart, Unilever, and Gillette have implemented RFID (Srivastava, 2004) even though there are still many unsolved problems from this complex technology. The fact that it holds a very promising future convinced those enterprises to take the risk of implementing it in their chain systems. Wal-Mart, especially, is fairly certain that RFID tags can dramatically improve its supply chain system efficiency. This results in the requirement of its top suppliers to tag their shipping crates and pallets in 2005.

Basically, RFID consists of two major components which are the reader and the tag. Tags which come in various forms are capable to store data and information. The size of information to be stored in a tag depends on the type of tag. In general, there are three types of tags: active, passive, and semi-passive. Besides the capacity of data storage, these three types of tags are also differentiated by their ability to communicate with the reader. Active RFID is able to interact with the reader at the farthest distance which is more than 100 meters, while passive RFID can only interrogate with the reader if both are in very close proximity; which is

Corresponding Author: M.A. Hannan, Department of Electrical, Electronics and Systems Engineering

at least three meters from each other. This is because a passive tag is not associated with any batteries to power it up, unlike an active tag. Therefore, it relies fully on the power sent by the reader to get activated. Table 1 represents the difference between active and passive tags. Semi-passive tags characteristics are intermediate between active and passive RFID tags.

Table 1: Summary of characteristics of active and passive RFID

Characteristics	Active RFID	Passive RFID
Tag power source	Internal to tag	Energy transferred from the reader via radio frequency
Tag battery	Yes	No
Availability of tag power	Continuous	Only within the field of the reader
Available signal strength from tag to reader	High	Low
Communication range	Long range (≥100m)	Short or very short (≤3m)
Data storage	Large (128kb)	Small (128b)

Geographical Information System (GIS) is a system that captures, stores, analyzes, manages, and presents data that are linked to a location. It can also be defined as a computer program that used for storing, retrieving, and analyzing geographical data. GIS for Transportation (GIS-T) is in urgent need nowadays as a result from the developing ITS (Hsieh *et al.,* 2008).

RFID and GIS are two technologies that are often associated with each other to realize many operations (Wang *et al.,* 2008) like in tourism (Abe *et al.,* 2007) and in managing street trees (Kim *et al.,* 2006). RFID has also been widely used in supply chain management (SCM) (Yuan and Huang, 2008; Beier *et al.,* 2006; Brewer *et al.,* 1999), including in the distribution system (Hu *et al.,* 2007) and Warehouse Management Systems (WMSs) (Poon *et al.,* 2009). Besides SCM, RFID has been proven to give good results in smart parking applications (Pala and Nihat, 2007), in healthcare (Nagy *et al.,* 2006; Wang *et al.,* 2006), for animal tracking (Kritzler *et al.,* 2008), and in a fire evacuation model (Daito and Tanida, 2008, 2009). From all the reviews of the previous papers, it is safe to say that RFID technology is widely implemented in various field of research. RFID is also often integrated with GIS, giving good results.

Scenario of UKM bus Campus System:

Figure 1 shows the layout of UKM campus and the bus stations in UKM. In Figure 1, the red dots in the map represent the bus stations in the campus. Based on the layout, there are 16 bus stations in the UKM campus area, not including the one at the UKM train station and the other at the UKM hostel located outside the campus. The buses pass all the stations, and in order for the bus system to operate efficiently, a schedule is fixed. All the buses move according to the schedule.

There are five different routes taken by the campus bus every day. The base station for all the campus buses is at the vehicle's unit. The bus moves from its base to its assigned route. In general, the routes are almost the same, only the final destination varies. The first route starts from the base and ends at Pendita Zaaba Hostel, the second route ends at the Law Faculty, the third route ends at the train station, the fourth route ends at the Islamic Learning Faculty, and the final destination for the fifth route is Idris Al-Marbawi Hostel located outside the UKM campus.

Aside from these five daily routes, other routes are also assigned occasionally. For example, during examination season, many buses are to follow the routes to the examination halls. The total number of the campus buses is 26. Aside from the campus bus owned by UKM, a total of 15 buses are also rented by the university with an outside company to support all the passengers. City buses which charge are also allowed to come in and out of campus to accommodate the students. The bus system and network in the campus is very crucial especially to those who commute using the bus around the campus. They depend on the bus schedule to plan their time and to estimate the time to get to the bus station so that no time is wasted just by waiting for the arrival of the bus. Nevertheless, though the schedules are set up to be followed, there are often times when the bus drivers fail to accurately follow them. This can cause the bus passengers who are mainly students to be late to class, not to mention their time is wasted unnecessarily. This situation leads them to pay for bus services in order not to be late. This occurrence proved that if the campus bus system is not sufficient enough, the passengers may have to waste either of these two; time or money.

To prevent any wastage, the bus monitoring system is proposed. With the implementation of this system, the whereabouts of the bus can be monitored and if the bus driver fails to follow the bus schedule, the authorities have the right to take appropriate actions. This monitoring system also enables all the assigned campus buses to satisfy the many routes and schedules that had been set up. Hence, the students will have no reason to opt for other services other than the efficient campus bus service and at the same time they are able to save their money on transportation.

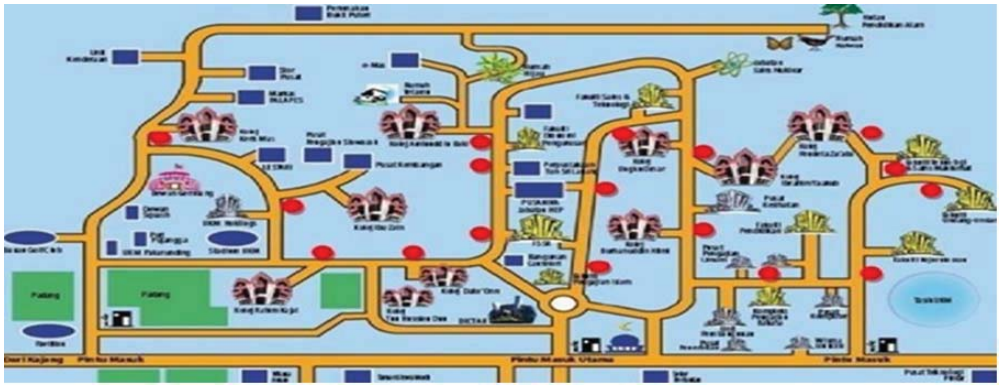

Fig. 1: UKM campus and location of bus stations layout

Intelligent System Framework:

An intelligent system is determined from the combination of a few systems building it. In this study, the monitoring and identification system is made up of RFID technology, GIS software, Global Positioning System (GPS), and Global System for Mobile Communications (GSM) systems. GPS is a system that depends on the satellite to give out the position of an object, while GSM is a system that enables messages to be sent globally. There are a few companies in Malaysia that handles the GSM networks, for example Maxis, CELCOM, and Digi. In order for this system to be efficient, the availability of GPS and the right choice of GSM network are crucial.

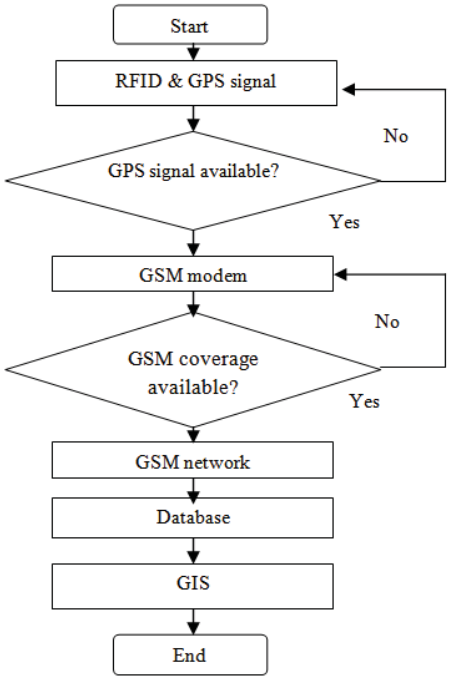

Fig. 2: System interface for bus monitoring

Figure 2 represents the flowchart of the system interface for bus monitoring applied in the research. RFID reader and tag will communicate to give a signal, and with the availability of GPS, the signal will be sent to the GIS software via internet through GSM modem. If GPS is not available, the loop will not continue on and the system will not be completed. If otherwise, the signal will be sent to the host computer via GSM. The same goes for GSM, if GSM coverage is available in a particular area, the signal will be able to enter the GSM network where the signal will be processed and the data will be stored before being interpreted by GIS software in the host computer. If it is not available, the loop will repeat itself and it will continue searching

for an available GSM network in the area. The position and information of the tracked object will be represented in the host computer in map form via GIS, indicating the system is able to act intelligently.

Methodology:

RFID technology is used as the identifier in this research. As discussed earlier, RFID technology requires some extent of cooperation between the RFID reader and RFID tag. There are three types of RFID tags. The type of RFID tag used in this research is the passive RFID which has no internal power source and rely on the energy transmitted by the reader to activate. This means that the two devices must be in the required proximity in order to operate. The distance between the reader and the tag depend on the frequency of the tag. There are four types of tag frequencies: Low Frequency (LF), High Frequency (HF), Ultra High Frequency (UHF) and Super High Frequency (SHF). For passive RFID, the farthest for the reader to be able to read the tag is approximately 3 to 5 meters, which is the UHF tag. This is the type of RFID tag to be used in this research.

The signal from the reader is sent to the host computer with the help of GSM. CELCOM is the chosen mobile network in this research. The network will determine how fast and how accurate the signal can be sent to the host computer.

RFID is integrated with GIS as the computer program. The integration between RFID and GIS has been used in many previous researches, thus it is decided to be integrated in this research as well. GIS enables the visualization of the items monitored in the form of map.

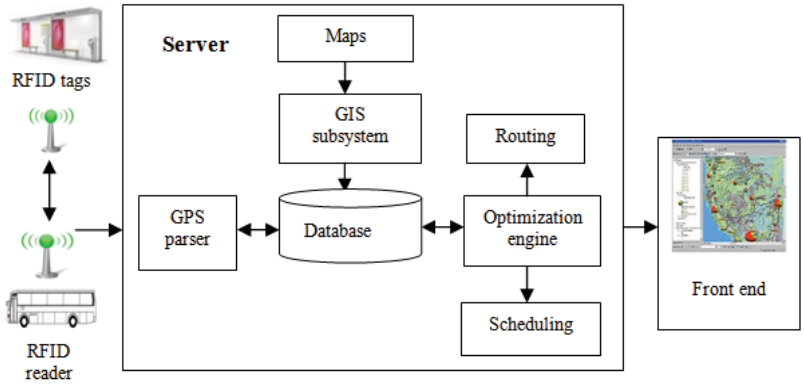

Fig. 3: Architecture of the proposed system

Figure 3 represents the monitoring system to be implemented in UKM bus system. The system works such that when the bus nears a bus station, the tag at the bus station will trigger the reader installed in the bus. Signals read by the reader will then be sent to the GPS parser inside the server. Parser is a computer program that divides code up into functional components. Once the signal has been interpreted into functional components, they will be saved in the database. The data from the GIS subsystem is then integrated with the data obtained from the RFID technology inside the database. From the database, both the data obtained from RFID and GIS will be optimized by the optimization engine for the best routing and scheduling plan. The users can view the location of the bus monitored in the form of map via the devices which support the system (computers, PDAs or cell phones) which are the front end of the system.

The flow of the research is according to the steps follows:

1. Installation of RFID reader in one campus bus
2. Installation of RFID tags at five selected bus stations:

a) Perpustakaan Tun Sri Lanang (campus' main library)
b) Health Center
c) Engineering and Built Environment Faculty
d) Pendita Zaaba College
e) Keris Mas College

3. Installation of GIS software in the host computer located at the Engineering and Built Environment Faculty UKM. GIS software to be installed is ArcGIS Software.

4. Developing mathematical equations and suitable programming language using MATLAB R2009.
5. Monitoring process: to validate whether the integration of RFID, GIS, and wireless communication works well or not.
6. Once the trial stage is announced to be a success, the system will be further implemented in the remaining campus buses and bus stations.

RESULTS AND DISCUSSION

Before realizing the actual system, a Graphical User Interface (GUI) has been developed using MATLAB to give an idea of how the possible system is going to work.

Fig. 4: GUI layout of the bus monitoring system in UKM

Figure 4 shows the GUI layout created. As an example, when button Bus 3 is clicked, the location of that bus is shown in map form. The information of that certain bus such as the plate number of the bus and the driver's ID is also available and can be assessed. This thus enables the authorities to easily identify the bus as well as the driver if any delay occurs.

This system is also meant to ease the users who are mainly students. By implementing this system, students can expect the time of arrival of a bus just by clicking at the location of the bus station they are getting on as shown in Figure 4. They can also know the location of the buses around the campus as well as the bus routes.

Conclusion:

An integrated system of RFID and GIS is developed to monitor and identify the campus buses. The system enables the administrator and the users to locate the position of the campus buses just by logging in the system via internet. The implementation of RFID technology in this research is able to integrate well with GIS software to monitor the campus bus in UKM. Initial work has been done and a GUI is created to represent the actual system. With the development of this system, an efficient bus system is expected to ease the students in the future, making UKM a university that cares and is aware of its students' welfare.

ACKNOWLEDGMENT

This work was supported under the research grant UKM- PTS-0017-2009.

REFERENCES

Abe, A., N. Maita, Y. Ooshida and T. Kano, 2007. "Proposal for a system based on the Universal Design approach for providing tourism information by linking RFID and GIS" in Magyar, G., Knapp, G., Wojtkowski, W. G. & Zupančič, J. (pnyt.). Advances in Information Systems Development, pp: 247-258. US: Springer.

Beier, S., T. Grandison, K. Kailing and R. Rantzau, 2006. "Discovery Services—Enabling RFID traceability in EPCglobal networks" International Conference on Management of Data.

Brewer, A., N. Sloan and T.L. Landers, 1999. "Intelligent tracking in manufacturing" Journal of Intelligent Manufacturing. 10(3-4): 245-250.

Daito, M. and N. Tanida, 2008. "A fire evacuation model of using active RFID in underground shopping mall" Research Center of Socionetwork Strategies (RCSS) Discussion Paper Series, 2(74): 1-21.

Daito, M. and N. Tanida, 2009. "Effectiveness of cellular phone with active RFID tag for evacuation-the case of evacuation from the underground shopping mall of Tenjin" International Journal of Humanities and Social Sciences, 3(1): 72-83.

Hu, H., Y. Wu, X. Hu, L. Liao and N. Xu, 2007. "Research on the application of radio frequency identification in cigarette-distribution system" IEEE International Conference on Automation and Logistics, pp: 2586-2591.

Hsieh, W.H., C.J. Ho and G.J. Jong, 2008. "Vehicle information communication safety combined with mobile RFID system" International Conference on Intelligent Information Hiding and Multimedia Signal Processing, pp: 1021-1024.

Kim, E.M., M.W. Pyeon, M.S. Kang and J.S. Park, 2006. "A management system of street trees by using RFID" Web and Wireless Geographical Information Systems (W2GIS) 2006, pp: 66-75.

Kritzler, M., S. Jabs, P. Kegel and A. Kruger, 2008. "Indoor tracking of laboratory mice via an RFID-tracking framework" Mobile Entity Localization and Tracking 2008 (MELT '08), pp: 25-30.

Nagy, P., I. George, W. Bernstein, J. Caban, R. Klein, R. Mezrich and A. Park, 2006. "Radio Frequency Identification systems technology in the surgical setting" Surgical Innovation, 13(1): 61-67.

Pala, Z. and I. Nihat, 2007. "Smart parking applications using RFID technology" RFID Eurasia, 2007 1st Annual, pp: 1-3.

Poon, T.C., K.L. Choy, K.H. Harry Chow, C.W. Henry Lau, T.S. Felix Chan and K.C. Ho, 2009. "A RFID case-based logistics resource management system for managing order-picking operations in warehouses" Expert Systems with Applications, 36(4): 8277-8301.

Srivastava, B., 2004. "Radio Frequency ID Technology: The next revolution in SCM" *Business Horizons* November-December, 60- 68.

Wang, S.W., W.H. Chen, C.S. Ong, L. Liu and Y.W. Chuang, 2006. "RFID applications in hospitals: a case study on a demonstration RFID project in a Taiwan hospital" in Proceedings of the 39th Hawaii International Conference on System Sciences, pp: 184a-184a.

Wang, Y., K.W. Oscar Ho, Q. George Huang, D. Li and H. Huang, 2008. "Study on RFID-enabled real-time vehicle management system in logistics" in Proceedings of the IEEE International Conference on Automation and Logistics, pp: 2234-2238.

Yuan, Z. and D. Huang, 2008. "A novel RFID-based shipping containers location and identification solution in multimodal transport" Canadian Conference on Electrical and Computer Engineering, pp: 267-271.