RFID-Based Human Tracking System in Tertiary Institution

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Abstract: Tracking frameworks has been conveyed widely as web applications and standalone frameworks with a specific goal of monitoring and locating assets or people. It is basic to investigate a more recent and advanced technology that can be utilized in accomplishing the task of tracking. Radio Frequency Identification Technology (RFID) demonstrates good and effective process in this application area it is however, a seemingly much hyped phenomenon in the technological sphere. This research exploit the benefit this application offers as it enables software applications to be used as an interface to the hardware devices that is composed of the RFID. These eras of rigid use of information technology platforms, we find it necessary for tracking systems to be implemented on platforms that can be easily accessible. Thus, we present a web based tracking solution that enable a higher citadel of learning or organization to adequately manage their human resources and enhance productivity. We developed a web based human tracking system that leverages on the Microsoft ASP. NET MVC 5 framework and a desktop application to interact with the RFID reader using C#Form application.

Key words: RFID, tracking, lecturer, passive tag, reader, Microsoft ASPs

INTRODUCTION

Tracking can be defined as the act of following something or someone. It is hunting after or searching or locating something or someone. Personnel tracking can be defined as the act of locating or following someone in a particular environment. The problem of tracking is defined as having an object of interest and attention in a large search space or environment where people would have difficulties in doing the job of tracking themselves.

One of the challenges that confronts persons at Covenant University includes locating personnel's, i.e., faculty, staff or students, going through the normal procedures of asking people about the personnel in question can be stressful and frustrating, especially when not getting productive answers, this challenge can be solved using radio frequency identifier strategy.

RFID is an upcoming emerging technology deployed for object tracking within a large or small search space. It uses electromagnetic fields as its medium of data transfer and wirelessly from a tag to reader source, this is meant to serve purposes like identifying and tracking objects that are attached the radio tags. Other benefits of RFID include innovations because of variables like its ease and light weight, diminished size and reasonable cost of upkeep. Now a day's security, power preservation and versatility are among the top issues that are in thoughts when designing a project of this nature. The major components of RFID system are its tag which usually stores a unique serial number and RFID reader which the device uses in reading these tags.

In recent times, some cheap devices were employed worldwide in the industry, corporate organization and even academic institutions (Abdul Kadir *et al.*, 2010). This is due to the basic advantage of time efficiency which the technology is robust in.

Mario Cardullo's was the first true ancestor of modern RFID. The system is made up of electronic tags which can also be called transponders and a tag reader. There are 2 types of RFID tags that are commonly used in the recent days. The active tag contains an internal battery that sources power for the tag's chip while passive tags are ones that do not have an internal power source but are powered by the electromagnetic field from the reader. RFID arrangements tend to utilize unlicensed frequencies for their undeniable money saving advantages. RFID systems operate on 5 different frequencies, some frequencies available for RFID in the market are:

- 125 kHz (LF-Low Frequency)
- 134.2 kHz (LF-Low Frequency)

- 13.56 MHz (HF-High Frequency)
- 2.45 GHz (Microwave frequency)
- 5.8 GHz (Microwave frequency) (Abbasi and Shaikh, 2008)

The cost and benefits of tracking people with RFID have been debated ever since, RFID technology became commercially feasible. In 2003, Consumers Against Supermarket Privacy Invasion and Numbering (CASPIAN) and Privacy Rights Clearinghouse (PRCh) published a "Position statement on the use of RFID Chips on consumer products" this was supported by over 40 of the world's leading privacy and civil liberties organizations. The position statement declared that RFID system used for human tracking, both direct and indirect is never appropriate. It further argued that RFID should be limited to the tracking of material goods and items containing toxic substances, this was implemented by use of RFID Chips at John Jay High School, San Antonio, Texas, 12 December 2012. However, as the technology spreads it became more acceptable by the society and the recommendation was been left by the wayside.

In 2004 the technology was employed to track school children. A primary school in Osaka, Japan installed RFID readers in school gates and embedded RFID chips in children's schoolbags, nametags or clothing (Jo, 2012). In the same year, this practice migrated to the United States as 13 campuses near Houston, TX recorded when and where students got on and off a school bus. Police officials and school administrators carefully monitored the information in an attempt to prevent truancy and child abductions were carried out during this use at John Jay High School, San Antonio, Texas in December 2012).

With RFID tracking implemented in Covenant University students can be able to locate lecturers easily within the academic premises and buildings; faculty may also use the same means to locate colleagues, pears and even students within the campus with ease.

Literature review: Over the years, depths of research have been invested into the use of RFID in the subject of asset and or human tracking. Various systems were developed to find ways of using RFID. By CASPIAN and PRCh researchers wanted to solve the problem encountered on visits to public or official buildings like hospitals or public administrative buildings. They realized that without information people can easily be misguided. Their proposed system was called Sistema Intelligente de GUiado para Entornos Multiusuario Extensos they made use of programming and equipment components: RFID

passive technology for the client recognition and an AI planning and scheduling technique for the introduction and the directing of the patients. Abraham *et al.* (2002) were working towards building a smart campus with RFID technology involved. Their first step was to tag several actors and assets of smart employee identification card, students were likewise tagged and each student was given a unique ID, office items were also tagged. They continued by installing RFID readers in vital locations such as entrances to classrooms, university cafeteria, laboratories, walk ways and common rooms. The radio frequency identification technology was used for the following:

- Employee and student identification
- Monitoring of person and equipment
- Room automation
- Smart attendance maintenance
- Avoiding loss/stealing of costly equipment

The purpose of this system is the identification and locating a person or valuable object at any given time and position. This system combined with the actuation mechanism gives advantages such as object/personnel tracking, rigid security, power conservation and automatic record keeping. Abdul Kadir *et al.* (2010) investigated the use of RFID Incorporated into a Circuit (IC) within a building which elucidated the critical role this technology played in stock exchange issues. Such role includes significant reduction in work force, work cost, man-made and or workers blunder. While by RFID, the student wolf pack club tracking system was implemented, so as to easily minimize time invested in the process of ticket distribution during sports and athletics event. Jo (2012) made use of RFID as a means of taking students attendance instead of having the lecturer announce the roll call at the beginning or when the class is concluded. We proposed a simple interactive, resource effective model for personnel (faculty, staff, students) tracking system that deploys the use of passive tags attached to personnel's ID card and some additional hardware devices such as the RFID reader and a simple GUI website to display results of the search.

MATERIALS AND METHODS

RFID system in this application serves the distinct purpose of identifying the last known object's (faculty, staff and students) location within a particular search space (academic arena). A mobile device, thus, transmits this information through its wireless medium or a tag which is encapsulated for processing the RFID reader.
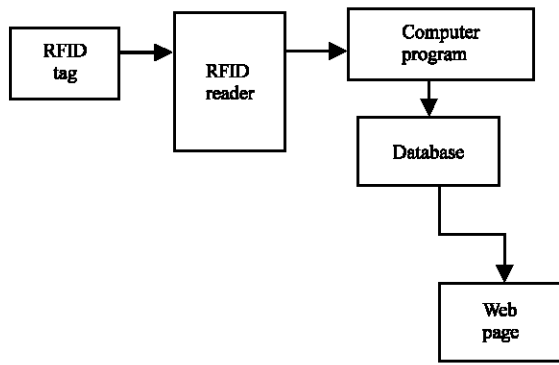
Fig. 1: CU RFID-based lecturer tracking system architecture

Fig. 2: RFID components used

This research dwells on the advantage of easy usability, opened and adaptable infrastructure offered by RFID technology is deployed to manage the database hosting, middle ware program hosting, resources for information gathering analysis and examining and process of the RFID information. The various components of an RFID system includes:

- RFID tag
- RFID reader

RFID tags are object that are so small that they can be embedded to any object and makes use of a unique sequence of characters which in most cases is a unique serial number to identify it. It is made up of a chip and the antenna. The RFID reader on the other hand is the source of the radio frequency energy used to fuel or activate the passive RFID tags, so, they transmit signals and is also responsible for reading the signal transmitted by the RFID tag this signal contain bits of information which is unique to each RFID tag, this information is assigned to lecturers in the school along with a tag which is known as the staff ID card. This system provides solution to lecturer tracking problem through facilitated use of hardware and software designs, data sent from the tag to the reader is managed by an application which sends this data to the database which in turn updates this data on a website as shown in Fig. 1.

Hardware components design methodology: In RFID frameworks is an object labelled with a mini silicon chip and an antenna which is usually referred to as a tag. This tag may be designed to be compact mobile or static and can be respectively scanned or mapped to an immobile or mobile readers via. a wireless radio waves. It is allocated a unique identifier for every object, enabling tagged objects to be personalized and identifiable by the reader.

When the reader is scans the tag, the details of the database contents is captured, the data is decoded and interpreted, other search and analysis required with the decoded information can be concluded. The components of the RFID framework are composed of the tag, reader and database. In this application, we designed electronic tags to be incorporated into every object's standardized means of identification, this means their ID cards (Abdul Kadir *et al.*, 2008; Anonymous, 2009; Liu and Chen, 2009; Longe, 2009; R-moreno *et al.*, 2009; Qaiser and Khan, 2006; Victor *et al.*, 2003).

These tags are accessible in any states, objects or users may be in motion, static position or even sleeping or unconscious as long as the ID card is with or around him/her. No charging or batteries needed, neither is line of sight between readers and tags needed for proper functionality of the card nor device. Tags cannot be easily destroyed and can be read under the presence of dirt's, they have encrypted irreplaceable serial code that cannot be altered.

The RFID framework made use of a RFID reader (USB) developed by parallax, the model of the reader is #28340. The hardware components of this reader have its information in at www.scribd.com/document/195. These details are also shown in Fig. 2.

The tags used for this project are passive tags, this are type of tags that do not use batteries but get powered when they are around an active RF magnetic field, generated by a reader, therefore, passive tags do not constantly produce signals unless if it comes in contact with an RF magnetic field, this helps solve issues relating to privacy intrusion. The tags would only release signal in major areas where the readers have been placed in the academic environment.

Software design methodology: The program is a desktop application that was developed with Microsoft Visual C#

which offers a lot of benefits to users. Its adaptability and scalability made us stick to it for our front end design. C# provides Rapid Application Development (RAD) which was deployed for a user friendly and robust graphics user interface which was also created to help user enter their search and have their results displayed.

Visual C# was developed from 2 programming language which are C and C++, access to the database is made possible with its accompanying functional handles such as DAO, RDO, ADO and the active X controls and objects. Programming in visual C# brings a lot of benefits such as a combination of visually arranged components or controls on a form, specifying attributes and actions of those components and writing additional lines of code for more functionality. Microsoft SQL Server management studio 2012 hosted the back end and was used to create and manage the database of this project. Microsoft SQL Server is an intense and solid free information administration framework that conveys a rich and dependable information store for lightweight web sites. The website was created using the ASP.NET MVC framework, this framework permits programming designers to manufacture a web application as a synthesis of 3 parts: model, view and controller. The MVC Model characterizes web applications with 3 rationale layers. The MVC Model defines web applications with 3 logic layers. A model speaks to the condition of a specific part of the application. A controller handles cooperation's and redesigns the model to mirror a change in condition of the application and after that passes data to the perspective. A perspective acknowledges vital data from the controller and renders a UI to show that data (Al-Ali *et al.*, 2008; Kassem *et al.*, 2010).

RESULTS AND DISCUSSION

A study of the pattern of how RFID tags are used gave an insight to how it may be used to monitor or even locate people's movement in an educational institution. For instance when every faculty, staff and students who are supposed users has been allocated an RFID tag (during registration as a new employee) walks by a location in the school where an RFID reader has been installed, a unique serial number which is equivalent to each lecturer's staff ID number which is already printed on the ID card and has been linked to such field. So, whenever is with his/her ID card and walks close to a reader, the reader picks the signal and transfers the information stored in the signal to the computer program, the data from the tag is pushed into the database, the location captured in the data is subsequently used as the object's new found

The tag is activated when it goes through a radio recurrence (RF) field (125 kHz for this situation) which is created by the reception apparatus installed inside the reader board. This is a distance or search space of about 12 cm within the vicinity of the reader. The system checks whether the tag is valid or not if that the tag is valid it will continue to the database and update the lecturer's location field in the database entry. The application program records the lecturer's location. The profile page location. This will be displayed in the lecturers profile on the website that the users will use to locate the objects/lecturers. of lecturers on the website gives the following details as output: lecturers name (First name, Last name), staff ID number, tag serial number, department, college, gender, e-Mail, program, office location, visiting hours, schedule, phone number.

An Administrator, who is also a privileged user is the only one with access right and permission to alter objects (faculty) and user's details and information. Just in case of resignation, change of location and otherwise such tags can be made opened to be re-assigned to a new user, if need be as shown in the web page in figures. The desktop application user interface that controls the RFID reader is shown in Fig. 3-11.
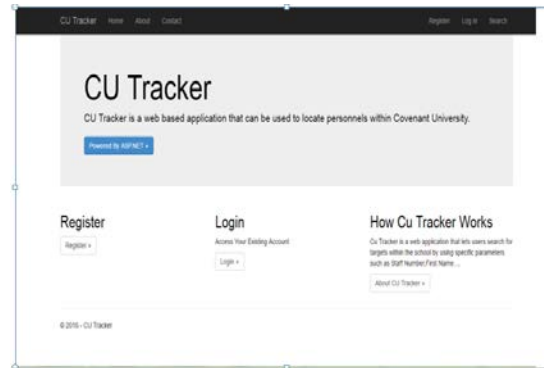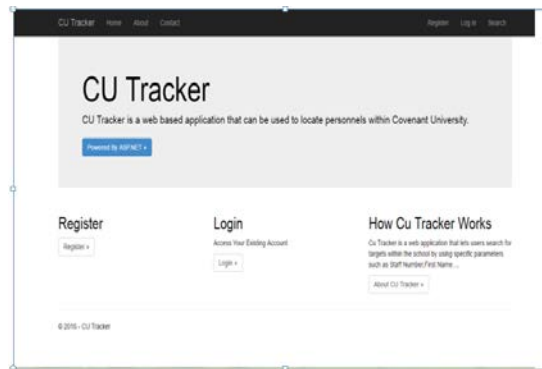

Fig. 3: Landing page (home page)
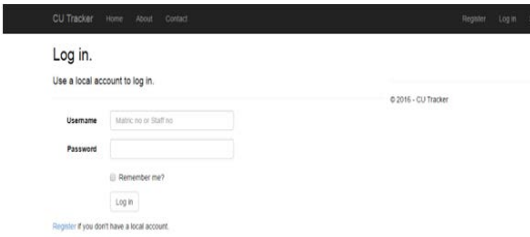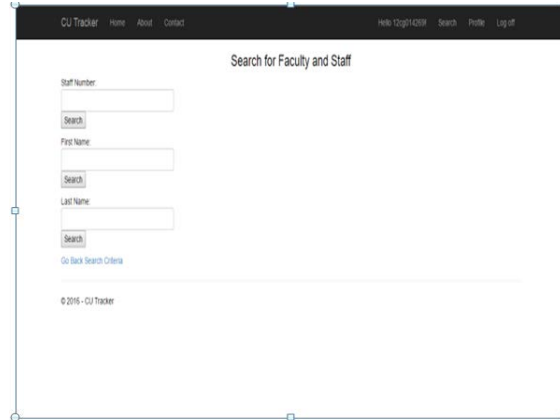

Fig. 4: Lecturer registration page

Fig. 5: Login page

Fig. 6: Create a profile page for lecturers

Fig. 7: Lecturer profile page

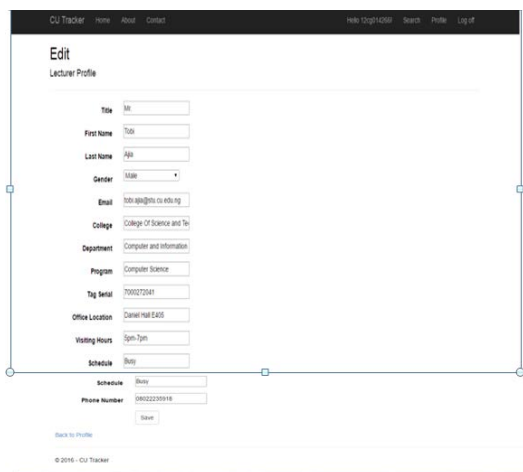Fig. 8: Edit lecturer profile page

Fig. 9: Lecturer search page
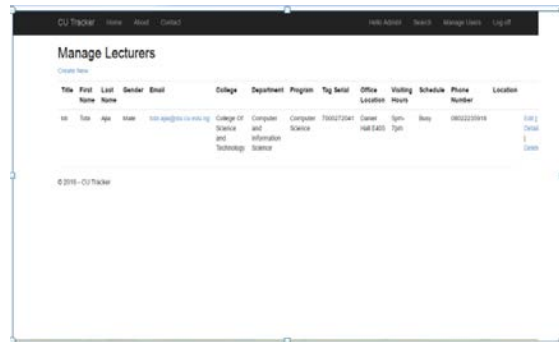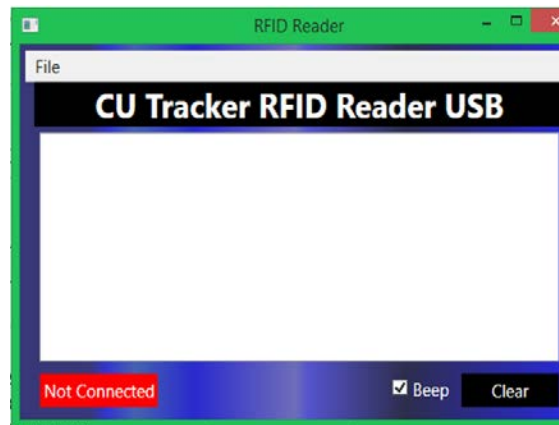

Fig. 10: Manage lecturers page

Fig. 11: Desktop application for the RFID reader

CONCLUSION

In this study, the radio frequency identification approach was adopted and implemented to track

lecturers within the academic area/building. This offers massive benefits to the school in locating personnel's within the school environment. It helps to overcome lack of necessary information needed to locate personnel within the school environment as long as he/she has his ID card lanyard on. Also, the students could easily locate lecturer's offices and their phone numbers without going through stressful activities. Providing relevant information like office location and lecturer's weekly schedule on user profile also helps to narrow down the search space of the personnel. The Model-View-Controller (MVC) framework made this application scalable and well-modulated. Bootstrapping was employed solve the problem of cross compatibility and sizes of devices and browsers used by the various members of the community.

Finally the application can be used as a portal for staff/student information. Although, radio frequency identification technology has several merits, one issue that is of concern is integrity of information. Another issue is pinpointing the exact location of the target and this has been greatly reduced in this study by providing a schedule text box in and other personal information such as phone number which can be used to locate the target.

RECOMMENDATIONS

For the further improvement of this project include: the use of a better radio frequency identification reader and tags that can cover a wider distance than the one used in this research. The existence of a social community in the university should be advised, so, the project can be integrated into the community for purposes such as external login and seeing location of friends without searching for them. Improving the intervals at which the reader reads a single tag. Compulsory use of staff/lecturer's and student's ID cards at the academic buildings.

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