
Theoretical Framework on Applications of RFID Technology in Healthcare, Education and Agricultural Sector

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ABSTRACT

This paper presents the application of Radio Frequency Identification Technology in some key sectors of the economy in order to clearly show its applications and benefits in addressing problems that regularly occur due to human error and lack of appropriate Technology. Healthcare, agriculture and education are amongst the key sectors of every economy that requires adequate attention. The application of RFID technology in addressing problems such as medical error and safety, checkmating counterfeit drugs, improper patient records, poor diagnosis, improper animal identification and genetic improvement, poor library management system and theft control, inefficient attendance system mired by overcrowding is paramount. In this paper, the researchers succinctly explained how the adaptation of RFID technology in healthcare, agriculture, and education sectors helps in improving healthcare services, proper animal identification for genetic improvement, better attendance system, and efficient management of Library system in higher institutions of learning.

Key words: RFID, Tags, Readers, Healthcare, Agriculture, and Education

INTRODUCTION

Radio Frequency Identification (RFID) is a fast growing technology that is receiving significant attention in many sectors of the economy. RFID is a new technology that uses radio waves to send data from an electronic tag attached to an object through a reader for the purpose of identifying, locating, and tracking the object (Abhang, 2016). RFID find applications in many areas like automated health care services, agriculture, toll collection, personnel surveillance, vehicles, paper

currency, transportation, airline luggage, supply chain: in manufacturing, distribution and retails which include smart-shelves, in offices and schools during time for attendance marking, pharmaceutical industry, waste management, in school's library system, etc. (Pawar 2016). The technology uses radio waves for the collection and transfer of data and it can receive data automatically without any human intervention (Yao et al. 2010). RFID technology is similar to the bar code identification system mostly used in retail

stores only that RFID does not rely on the line-of-sight reading and scanning of goods. Also, RFID scanning can be done at greater distances than bar code scanning. Just like barcode, RFID technology also finds application in the retail industry for product tracking, control, and management of products flow. It is also used in healthcare for tracking patient’s location, surgical instrument, monitoring patient’s drugs, identification of hospital personnel, tracking of blood bags, counterfeit drugs detection, etc (Kaur et al, 2011). In agriculture, monitoring of honey bee colonies, cold chain of perishable goods, livestock management for traceability and identification of animals, supply chain management of agricultural products, selection of genetic improvement in livestock breeds, seed management system, laying hen individual behavior monitoring system, automatic crop monitoring using embedded system, and many other applications so numerous to mention (Meikle and Holst, 2014; Salleh *et al.*, 2015; Yoa and Lihua 2017; Saleem and Rao, 2017); Gwaza and Gambo, 2017.

In this paper, the application of RFID technology in healthcare, agriculture and education with emphasis on higher institutions of learning is presented in order to highlight its significance and challenges. Apart from section one which covers the introduction, section two deals with the components of RFID technology. Section three covers its applications and significance in smart healthcare. In section four, the deployment of RFID in smart agriculture and education were discussed. Section five covers the summary and conclusion of this research.

RFID Technology

RFID is a technology that consists of a tag, reader antenna and a central control unit (Ahson and Ilyas 2017). The tag is used for encoding information or data whereas the reader which consists of digital and Radio Frequency (RF) unit is used for extraction of the encoded data from the tag (Singh et al, 2009). Figure 1 shows simplified RFID system with two readers and tags.

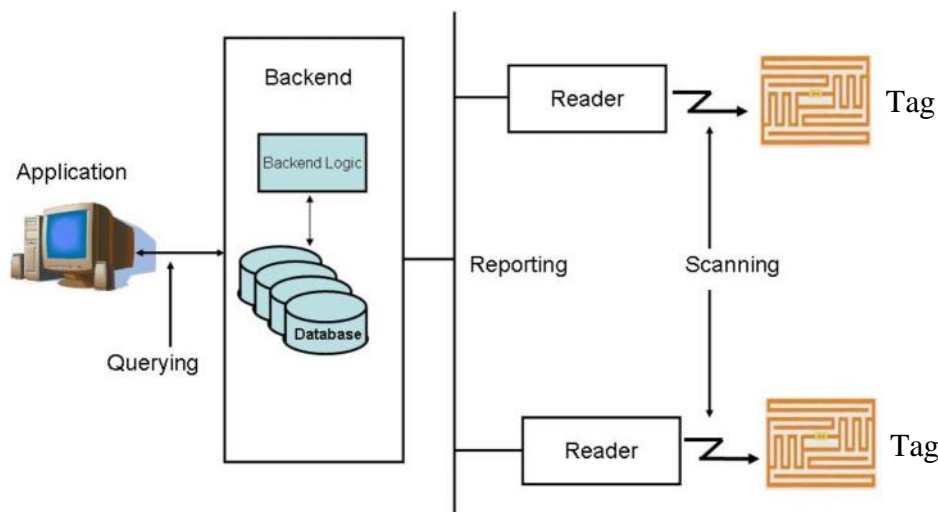


Figure 1: Architecture of RFID Technology with Multiple Readers and Tags (Christop Jechhlitschek, 2006)

As shown in Figure 1, the RFID technology consist of three different layers namely the control unit, readers and tags. RFID tags can further be subdivided into passive, active and semi-active tags.

A passive tag obtains energy through RF signal from the reader while the active tag is powered by battery embedded in the tag and it permits large memory. The semi-active tag also communicates with the RFID reader but it has additional modules that can be supported through an internal battery (Chen et al. 2010). RFID systems can be read only meaning that data is transferred only in one direction from the tag to the reader. It can also be read-write which is a two-way communication. An example of an active tag is the transponder that is fixed to an aircraft that helps in identifying its origin. Another example is a device attached to a car that uses Global Positioning System (GPS) to locate the car if stolen or heading to unauthorized destination (Wat Roy, 2006).

RFID technology has numerous advantages which include, its high speed, it does not require any line of sight, has read and write capability, it requires less human intervention, has less operating cost, it is capable of holding large information amongst others (Pawar R.G 2016). RFID tags fall into three different frequency bands namely, Low Frequency (LF) within the range of 30 kHz - 500 kHz, High Frequency (HF) ranging from 10MHz - 15MHz and Ultra High Frequency (UHF) ranges from 850 - 950MHz, 2.4 - 2.5GHz, 5.8GHz (Christop Jechhlitschek 2006). In a secured RFID system, tags responds only to authenticated readers, thus solving the problem of unauthorized access.

Further authentication of the system can be achieved by employing the readers which use random frequencies so that unauthorized attacker cannot get access to the information on tag.

RFID Technology in healthcare services

Deployment of RFID technology in healthcare services has great benefits of improving patient safety, avoiding medical error, and counterfeit drugs, which is the main responsibility of healthcare services. In the health-care space, the technology can aid automated identification of patients and staff, facilitate security and reduce medical errors (Ma and Wand 2016). In most developing countries like Nigeria, misidentification of patients and medical error is a common problem that many hospitals encounter on a daily basis. RFID systems can be employed in hospital to address these problems. Counterfeit drugs can be avoided by affixing tags on each of their drugs from the manufacturing company to their respective destination to avoid counterfeits. The application and benefits of RFID technology in addressing the aforementioned problems is itemized and discuss hereunder.

a. Improving Medical Error and Patient's Safety:

RFID technology is one of the revolving technologies that is receiving great attention in the health sector because of the way the technology has been used over the years to significantly address the increasing health challenge. Due to the increasing cases of medical error and patient safety, the technology has been used to enhance patient safety and to reduce medical error. Prior to

the introduction of RFID systems, Hospital Management System (HMS) always finds it difficult to track patient's record and information immediately whenever there is an emergency case and this often leads to death as a result of improper record of patient and medical error. Many researches show that the application of RFID in healthcare is a welcomed development because it helps in patient identification and monitoring, prevention of wrong usage of drugs, warehouse management of drugs and devices, and prevention of the fake drugs.

In the works of Wu and Liu, (2005), the researchers designed and developed a prototype to tackle medical errors in Taiwan hospitals using RFID technology. The design was prompted by the introduction of Electronic Medical Record (EMR) that helped in providing the medical staff with easy access to patient's data and information. The EMR enhanced correct information when needed and the system structure consisted mainly of drug and patient safety. The RFID system performed its basic task by printing tag setup and drug data input setup in order to manage the medicines tag subsystem. The savant management subsystem setup helped in monitoring drugs, patients, and other equipment in the hospital. The medicine comparison subsystem took records of patients, medication records, and responses to medication administered to patients. On the other hand, the medicine entry and the existing control subsystem took proper control of drug position setup, detection, and the movement of drugs within limited areas. And finally, the entry and the existing control subsystem took note of patient position setup, position detection, and limited patients movement within the limited areas. The prototype yielded promising results and

if integrated into health information system with RFID system would go a long way to improve medical error and patient safety.

b. Improving Pharmaceutical Supply Chains to Checkmate Counterfeit Drugs:

RFID is one of the fastest growing technologies in the pharmaceutical sector and in the field of supply chain management that is gaining significant attention by researchers.

Bollampally and Dzever, (2015) closely studied the impact of RFID on Pharmaceutical Supply focusing particularly on India, China, France, and the UK. The study was aimed at reducing the risk of counterfeit drugs that were becoming more easily available in the market place. The research provided an overview of how RFID technology was yielding results globally in pharmaceutical supply chains. Even though the application of RFID technology in this industry was new, the researchers showed that integrating RFID system in Pharmaceutical supply chains would yield significant result in checkmating fake and counterfeit drugs in those selected countries.

c. RFID-based Real-time Hospital Patient Management System:

Most hospitals find it difficult to adopt information and communication technology. And usually, nurses play a vital role in capturing patient information manually during registration and handling emergency cases. Most often, nurses spend much time in keeping record and updating patient's record which may sometimes be subjected to human error. In order to enhance automation and efficiency of record keeping, RFID technology is integrated in hospital for better management system. Chowdhury and Khosla, (2007)

worked on RFID based real time patient management system in the healthcare sector. The technology offers a way of transmitting and receiving data from a patient to hospitals without human intervention by means of wireless communication. The technology captured data automatically which can be used to identify, trace, track and store patient information electronically on a tag. Staff within the hospital can access and update patient's record through (WiFi) connection with the help of mobile devices such as Personal Digital Assistant (PDA). In this scenario, the hospital management system uses the unique ID of patients transmitted by RFID tags saved in databases. An RFID tag attached to a patient with patient's information embedded in a tag can be used to retrieve patient record stored in the hospital database using graphical user interface based hospital management system developed by Agile system development methodology using C#. It is run in Microsoft visual studio.net 2003 environment. When a RFID reader reads multiple patients' embedded RFID tags, the application lists and displays all identities of patients in the information area. Clicking on a particular ID, displays the patient's information and this makes it easy for the health service provider to manage patient's case information in of emergency unit.

RFID in Smart Agriculture and Education

Animal identification by means of marking has been an old method that existed in developing continent like Africa. In Africa, different methods of identification are used by nomadic for identifying animals. Today the deployment of RFID Technology addresses the entire aforementioned problem in agriculture sector. In the educational sector,

most especially in higher institutions of learning, student's attendance and library management are better managed through RFID technology. The aim of implementing RFID in most libraries is to provide a more robust, effective, and efficient library services such as automatic cataloging, self-check-in and check-out of library materials, provision of security of library books against theft, well-organized tracking of books and other materials within the library (Dhingra, 2017). In library management, RFID technology works through thin flexible paper tags usually place inside the cover of each book to monitor its movement. In this chapter, the application of RFID technology in agriculture and education are discussed.

In the research conducted by Gadzama and Gambo, (2017), the researchers deployed RFID technology to select animals for genetic improvement and it helped herdsman to identify unproductive breeders to cull from the herd with less human effort. The RFID technology uses ultra-high frequency and Global Positioning System (GPS) to track the animal's movement in order to identify their feeding and the health statue so that they can be used for good breed by improving their genetic. The deployment of this technology yielded positive results by improving and selecting good breeds of animals

Monitoring laying hens' behavior using RFID technology was carried by Yao and Lihua, (2017). The RFID technology could detect individual behavior of breeding hens by attaching unique tags to the feet of the breeding hens. An antenna was attached on the roof of the cage and it helps in monitoring hens' movement by means of unique tags through the reader. The antenna through the reader helped in automatic recognition of

tags attached to the breeding hens within the cage. The information of each hen was transmitted for monitoring. The reader uploaded the information of the breeding hens to the processing module. The relevant information about the hens was captured in the database for effective monitoring. The system had the ability to detect, capture and monitor individual breeding hen in real time. In higher institution of learning, Singh and Mahajan, (2017) employed RFID technology in library management system to avoid theft of books and other relevant materials. This was achieved by capturing all relevant information about each book into the library management system database. Whenever a user borrowed or brought a book, the RFID reader from the tag read the information about the particular book and transmitted the data into the database and the book was issued or returned. In a situation where the user wanted to exit the library, the antenna that was usually attached at the exit door would automatically read the information contained on the RFID tag attached to the book to verify whether the book was genuinely issued or not. If it was not properly issued to the user, the antenna would send a signal to the alarm to sound an instant alert to notify any library staff. This significantly helped in reducing book theft.

Kassim *et al.*, 2012 designed and implemented web-based student attendance using RFID technology to solve the problem of improper attendance taken due to over population in UiTM University Malaysia. The proposed system consisted of three different modules, namely: reader, data reporter, and web server. Those modules were integrated together in order to allow friendly interaction with the user. Students and staff of the university were assigned unique

identification tags. The attendance system can only grant access to only three different category of users namely the administrators, lecturers and students. The prototype of the system designed was tested and it was working successfully. Implementing the research in real time would go a long way to address the problems of inefficient attendance taking in higher institutions as a result of overcrowding.

SUMMARY AND CONCLUSION

RFID technology has numerous advantages over other technologies such as barcode. Some of these advantages include, less human intervention for tag detection. RFID technology does not require any line-of-sight and can have a longer range. Tags can have read/write memory capability and can store large amounts of data. It has the ability to identify items individually and can also read items simultaneously. RFID tags can be combined with other devices such as sensors and actuators to achieve effective and efficient operation.

The tag collision remains a major drawback in Radio frequency identification systems and can cause malfunctioning of both tags and readers. There is need for a reliable and efficient collision avoidance protocols for identification of multi-tags communication. Also, high cost of RFID system integration is also a setback. Privacy and security issues of RFID tags are aspects among the major challenge. Unprotected tags are more prone to eavesdropping and DoS attack (Aman Ullah, 2018). There is need to encrypt the tags to avoid unauthorized readers from having access to vital information. Interference as a result of wireless transmission between RFID devices and other wireless technologies

deployed in workplace and data center is another great challenge.

In conclusion, this paper gave an insight of the current state and trend of the application of RFID technology in agriculture, healthcare, and educational sectors. The technology at the initial stage is faced with numerous challenges and unresolved pertinent issues hindering its full implementation and application. However,

despite these challenges RFID technology continues to gain significant attention in all aspect of the economy for identification, control, traceability and authentication of object. Other key areas of application include, toll collection, supply chain, inventory control, traffic management, water level monitoring, electricity theft control, commercial stores among others.

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