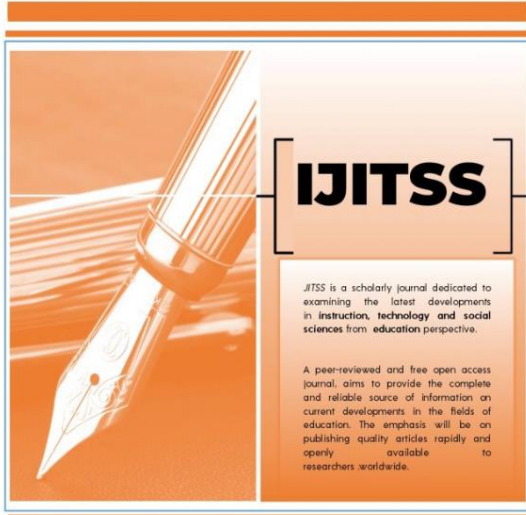


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### Applicability of RFID in Higher Education

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# Applicability of RFID in Higher Education

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## Abstract

The paper aims to identify the applicability of RFID in higher education. Being one of the most robust wireless communication technologies, RFID can be applied to wireless applications in different fields. In order for the higher education sector in Malaysia to improve the teaching system and administration of institutions, it should take advantage of the adoption of RFID to improve the quality of education in higher education. In order to ensure that students are best provided, educational sectors should be encouraged to invest more in the growth and advancement of RFID technology. Given the difficulties and obstacles of integrating RFID technology, refinements and enhancements to RFID technology should be the highlight of academic discussions among decision makers and stake holders in the higher education ministry. RFID is also viewed as an IOT precondition. If all everyday objects were fitted with radio tags, computers could recognise and inventory them. When the RFID readers are linked to the Internet terminal, they can identify, track and control objects attached to tags globally, automatically and in real time as necessary after they have been distributed around the globe. This is one of the many advantages of the Internet of Things in the future especially in the Industrial Revolution 4.0

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## Introduction

Radio frequency identification system (RFID) is a state-of-the-art automated technology and assists machines or computers classify objects, document metadata or track individual targets using radio waves ((Jia, Feng & Ma, 2010). Being one of the most robust wireless communication technologies, RFID can be applied to wireless applications in different fields. RFID recognizes items attached to RFID tags and is a passive, non-contact system (Sarma, Weis & Engels, 2002; Siiio & Hayasaka, 1999). Using RFID technology, universities have built digital campuses, given campus cards including access control and fire fighting systems, basic security alarms, information technology combined with the construction of campus facilities (Kalamani, Sowmiya, Dheivambigai & Sudhan, 2020).

Over the past decade, RFID has been used in airports, schools, libraries and recently it has even been introduced into educational environments. RFID use has evolved largely because of its many benefits. Widely utilized to identify tagged objects or humans in a unique way, RFID is a wireless communication technology. Industries and government agencies like higher education will benefit from latest RFID applications (Hunt, Puglia & Puglia 2007).

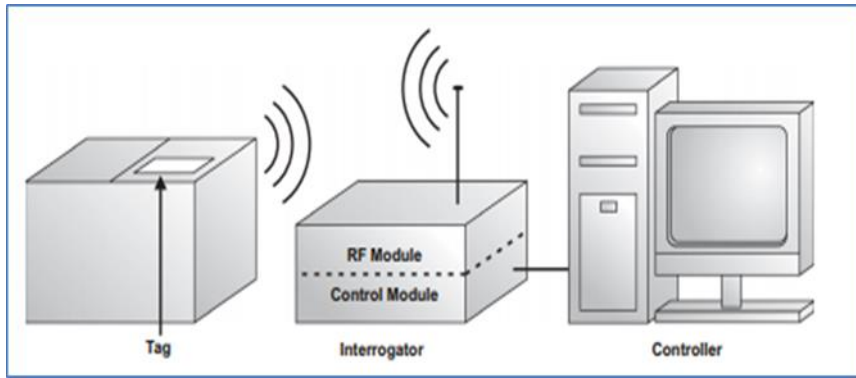


Figure 1. The Basic Building Blocks of an RFID System.

Source: LARAN RFID

As shown in Figure 1, a RFID system has three core components:

1. A tag (known as a transponder) consists of an antenna, a semiconductor chip and occasionally a battery.
2. An interrogator (referred to as a reader or a read / write appliance) composed of an antenna, a module for RF electronics, and a module for electronic controls.
3. A controller (also called a host) that usually consists of a desktop or workstation running database and control software (referred to as middleware).

Through radio wave transmission, the tag and questions connect with each other. When the interrogator receives the data from the tag, the data is transmitted through a normal network interface to the controller, like an ethernet LAN, or even to the internet. Such knowledge may then be used for a variety of purposes by the controller. The controller might, for example, only use the data to store a database object.

To save and forward data to the interrogator is the RFID tag's fundamental purpose. A tag is made up of an electronic chip and an antenna inserted in a package, for example a packing label secured to a box. Data can be saved and read from memory of a chip. The RFID interrogator functions as a link between the control unit and the RFID tag and has a few simple features:

- Read the RFID tag 's data material
- Write tag data (as in intelligent tags)
- Transmit data from / to the controller
- Reinforce the tag (for passive tags)

RFID interrogators mimic the functions of small computers. It also has three components: an antenna, an RF electronics module that communicates with the RFID tag, and a control module that communicates with the controller. Besides carrying out the four simple roles as stated above, sophisticated RFID interrogators can execute three more important tasks:

- Introduction of anti-collision steps to guarantee simultaneous radio wave communications with several tags,
- Authentication of fraud protection tags or unauthorized device entry,
- Encryption of data to safeguard data integrity.

The “brains” of any RFID system are RFID controllers. Various RFID interrogators are interconnected and information is processed centrally. A Personal Computer; a workstation; a running database; application software, or linkage of this equipment is the most common controller in any network. The data obtained by the interrogators in the field may be used by the controller to:

- Keep stock and notify providers when new stocks are needed,
- Monitor and probably even redirect movement of objects through a network
  - Check, identity and grant permission for keyless entry systems

RFID has often been referred to as an alternative to Bar Code Technology. As RFID prices are much higher, the comparison is not considered to be satisfactory by critics. RFID provides a range of advantages that bar-code systems cannot, such as reading and writing to Tags, the ability to operate with hundreds of tags concurrently, instead of one at a time, without clear sight line between Tag and Reader.

Internets of Things (IoT) applications are used in many fields such as smart transport, smart city, hospital and games as well as education. Previous interactive response systems used infrared or radio frequency (RF) wireless communication technologies for transmission of the students work to teacher administration system involving high cost, troublesome usage or challenging deployment. An important area in research which is gaining popularity is on the uses of RFID and IoT to improve the quality of higher education. RFID is one of the most important IoT technology applications in higher education, for example, many universities in China use the high-frequency (HF) card as student’s identification among other useful applications.

### **RFID Technology Applications in Higher Education**

Institutes implement a variety of solutions for improving overall monitoring of students, mainly through RFID devices. The RFID student includes features including web based attendance management systems, RFID technology intelligence library collection system; RFID use of secure authentication system and others

#### ***Web based attendance system using RFID based card***

The sporadic attendance of students is of interest to most educational institution administrators; therefore, higher education’s require a reliable student attendance record system. The RFID technology is another way to simplify the student’s attendance record system. RFID enables the processing of wireless data for identification and other uses for readers from electronic tags attached to or embedded in items. RFID systems include software modules, networks and databases, which enable the flow of information from tags to the information structure of the organization where it is processed and saved. In tandem with the RFID equipment, a real-time device is introduced to monitor the attendance of students. RFID is a technology that enables a tag on an identity card to wirelessly interact with a reader, to retrieve the tag information. Students only require to insert their ID card into the reader, and their time of attendance is automatically reported in real time as a database, more accurately than normal (Hodges & McFarlane, 2005).

Most colleges and universities in China have developed smart campus card systems that use HF RFID cards as identification devices for students. Once students reach the classroom before the course starts, they will be asked to swipe their RFID cards, the proposed program will then record the time which determines if they are late or absent. This program is built to enable students to follow course schedule as determined by the university (Tan, Li, Wu & Xu, 2018).

#### ***RFID Technology Intelligence Library Collection System***

The prospective path for library management advancement and reducing library maintenance systems costs to a minimum in HEs is with the usage of RFID technology. The HF and UHF were used in RFID technology. Since the HF standard is established, evolved early than UHF and used for more time, HF technology is thus more mature and reliable compared to UHF from the point of view of technological growth. High frequency technology is being used in RFI system libraries such as JIEI University Chengyi College, Shenzhen Library, the Xiamen Library, Hangzhou Library and the National Library. To store information on books, the library of the Cheng Du Sports University prefers the UHF RFID tag as it has many advantages. The advantages are: a wide range use, a reasonable coverage and a lower price in comparison with HF RFID. In summary, RFID technology can address various previously unsolvable library technology issues, increased performance and reduced the

required workforce. Besides, the efficiency of library management and consistency of resources and service extensions can easily be improved with RFI technology (Huang, 2012).

Furthermore, RFID technology definitely benefits libraries and the main advantages include optimizing operations, mechanical sorting and identification of library materials that have not been properly checked out. According to Amit (2017), without the help of librarians, users can manage the “check in” and “check-out” processes. It cannot be denied that it is a waste of student’s precious time to queue up to buy or return books. Nevertheless, by automating the procedure of borrowing and returning books, RFID’s self-services have actually solved this problem. The completely automated system therefore has no chance of any human errors happening and reading articles can be distributed within a short time, because more than one book can simultaneously be read (Habibur & Shiful, 2018).

The automated device consisting of conveyors and sorting equipment to return materials to the correct area of the library is another application of RFID technology. For example, Amit (2017) said handheld readers are used to scroll down the shelves and detect misclassified books. The monotonous role of librarians' inventory checking is thus removed. In fact, high number of items were commonly untraceable and theft was one of the key contributing factors. The RFID EAS Gates anti-theft component has the function of monitoring objects approximately 1 meter in distance and is used to activate the alarm system if a student has passed through with an unborrowed item (Annaraman et al., 2015).

#### ***Secure Authentication System using RFID***

To ensure data collection is completely secured and confidential, the RFID system has been developed and incorporated in some of the industry's latest systems. Presently, the RFID technology is becoming a very relevant authentication system (Abdulhadi & Abhari, 2016; Ahsan, Shah & Kingston, 2010). In order to protect students and staff from harmful or damaging situations, the security system is much needed in higher educations. In addition, it is most recommended to secure an individual and his personal information using RFID's better security systems. Only an approved individual who is responsible for caring for the ID's owner's information can access confidential information. The ID card issued by the IT-unit of UniKL MIIT can access lecture room doors and lecture attendance and also as a "Touch n Go" device which can be used on highways in Malaysia. The ID card can also be used for cashless transactions that are very useful during the Covid-19 pandemic. The implemented features can also ensure the safety of the ID card owner's information (Ahmad, Raziman, Baharum & Rahman, 2019).

#### ***Customized Distributed Security System***

RFID has been used to achieve a secure high-end communication network for the universities by means of a personalized distributed security system (Sengupta, Biswas, Sen, Ray, Roy & Sarkar, 2019). There are very serious issues with security breaches in universities. The data transfer process between administration, university administrators and students must be safe. Eventually, the customized distributed protection system would create a safer atmosphere for educational leakage including leakage of question paper, theft of important documents, etc. Distributed safety system for universities and experimental data using Low-Frequency RFID technology demonstrates that this system can be used widely at universities to efficiently keep the confidentiality.

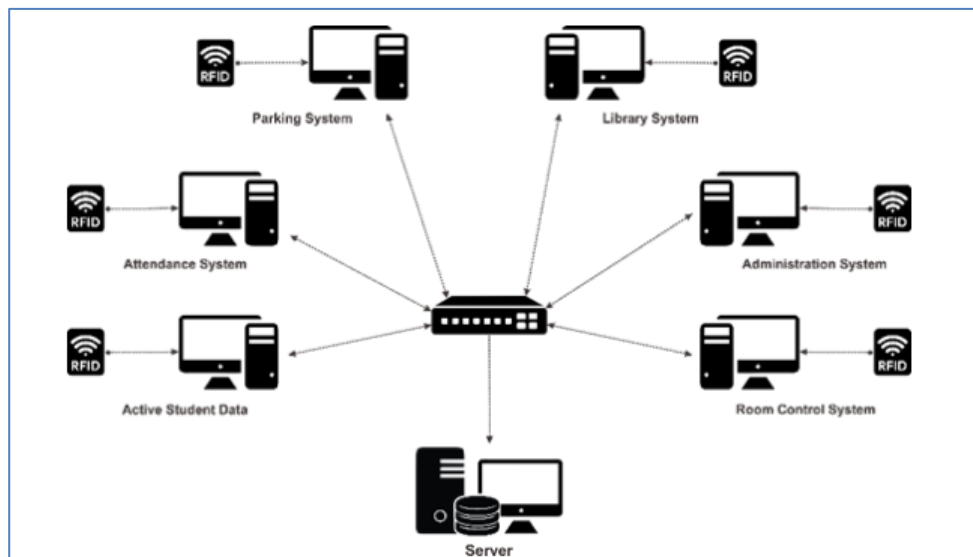
#### ***Attendance Management System based on Facial Recognition***

The application of face recognition technology is an attendance *management system* for education sectors. A Raspberry Pi designed for face detection and recognition is linked using an Open Command Visualization (OpenCV) library and a Raspberry Pi Camera module. (Open-CV) is an open source code library and useful in visual fields such as image processing. It can be accessed when the data is attached to the LCD display (i.e., a digital device or laptop) on a memory card attached with Raspberry Pi. The camera records the image for the students and transfers it to the Raspberry Pi, programmed with the OpenCV library to handle facial recognition. There are many advantages of this system: It saves the faces that are detected and automatically tags attendance; this device is user friendly and safe; it saves time and energy from the current situation and can also be used for safety purposes in organisations or secure zones.

### ***Integrated information network based on RFID***

RFID systems have been widely used in education environments, particularly in university environments. One of which is the use of the RFID system as an ID card for students with various functions ranging from lecture attendance, library lending access to automated room control. By using the RFID system, it is definitely important to include system information (software) that supports the RFID (hardware) system. However, RFID information systems are often separately developed so that data inconsistency between such systems can be created. Therefore, radio frequency identification information network may be integrated with higher education administration academic activities.

An integrated RFID information system for the management and monitoring of all data services is important with many RFID data from all services. That time the RFID is used in a transaction using the academic management and service system, the data used in the transaction will increase. RFID data provide many of the resources needed in order to monitor and track all data services, whether for absences, students, library services or parking services. This comprehensive information system is used for the RFID Project academic and administrative services. The information system would improve performance and effectiveness in data collection, education and administrative services. The integrated IT system can, in addition to data management, contribute to reporting and providing information to other systems that require clear strategic decisions in the administrative and academic sectors (Kurniawan, 2018) (Figure 1)



-Figure 2. The design of an integrated information system based on RFID

### ***Fixed assets tracking and management***

RFID assists administration not only in controlling students and teachers, but also facilitates tracking and control of fixed assets. Fixed assets in educational settings include computers, tablets, smart devices, books, furniture, equipment in laboratories and other university supplies. Because fixed asset tracking is particularly important in the case of large institutions like schools or universities, a robust, automated fixed asset tracking program is necessary for monitoring fixed assets in real time efficiently and accurately, thus minimizing sacking, expenses and workload. Combining passive and active RFIDs into a reliable system is the solution.

That's why implementing a fixed assets tracking software is incredibly necessary, ensuring enormous precision and reducing job costs. Since RFID readers simultaneously search many tags without the need for direct sight coordination, they can locate their fixed assets easily and precisely. The inventory method is in reality easy using RFID, reducing product conduct time and simultaneously improving performance and accuracy. Not to mention the swift location of solid assets, the physical inventory of fixed assets in real time, the improvement in productivity through monitoring of fixed assets or infrastructure, the provision of more convenient decision-making information and the prevention of assets leaving the organization. In addition, a highly accurate RFID

fixed assets monitoring program is required to enhance inventory accuracy, enhance the process efficiency and secure tagged fixed assets due to the quantity and variety of fixed assets available to higher education.

### ***Tracking and management of university equipment***

A university faces various problems in terms of its facilities just like any other institution that focuses on learning. The large number of lecture rooms, dining halls, classrooms, textbooks, shops, supplies, research facilities, computers and other electronic devices as well as sensitive library content in a university can be tracked by tracking these challenges. Maintenance is required for all campus equipment. An object needs to be tracked and/or replaced if stolen or lost. Tagging and monitoring useful RFID tags for businesses helps track products easily if they are missing. Through working together, a solution can be created that allows equipment to be tracked, controlled and maintained, ensuring that the equipment is safe and secure for businesses.

### ***Staff attendance and productivity management***

The foundation of the productivity of higher education is based on the efficiency of the workers. The RFID Personnel Tracking Program will also allow for the monitoring of the productivity of professors, administrative assistants, caretakers and ground maintenance staff (GAO, 2020).

### ***Campus and security systems access control***

Most lecture rooms, offices, gymnasiums, parking areas, doors, cafés and fields pose a number of specific challenges to ensure the safety of staff and students. To minimize possible risk of danger, management of the people entering campus is important. A higher education's security begins with the safety of staff, lecturers and students. The RFID Access Control System is a completely automated program by which certain areas on university are granted or restricted access to ensure that movement to all campus areas is controlled.

### ***Tracking unknown workers, students, lecturers and visitors***

In order to safeguard safety and welfare, it is important to identify and locate students and staff in an organisation. Administrative staff will be able to locate professors, students and support personnel in a short time when the need arises by using the RFID Personnel Tracking System. The protection of professors, staff and students in the event of danger from unknown sources can be ensured with a series of advanced RFID badges with integrated alarms. Upon activation, the tag will communicate the identity and location of the individual to the monitoring system to ensure that security and law enforcement reactions take as soon as possible.

### ***Integration of the higher education management system with of RFID Solutions***

A RFID or RFID identification device has the function of gathering the identification of objects, workers and all related data in real time. The problem comes when it is time to bring the information gathered into action, such as the incorporation of RFID data into educational applications in order to access, interpret, distribute and send important information to end users. Technology for expertise evaluation, payroll systems and policy support tools are used to improve the performance of other employment and education processes. The compatibility of an RFID solution with these systems is important. For easy integration and compatibility, RFID systems are designed. The Auto Id engine integrates middleware and basic RFID technologies, along with the hardware and software experience of RFID make it simple to integrate with all currently used educational systems. The data obtained by RFID systems are incorporated seamlessly with the IT infrastructure of an organization through a middleware and a proper API (GAO, 2020).

### **Challenges in of RFID technology in Higher Education**

While the future is bright for the RFID industry, before RFID technology can be widely used, many issues have to be solved. Since it has only been introduced over the past few decades, the RFID technology has not been thoroughly understood. RFID technology faces many challenges because of its high costs. The growing use of RFID technology has worried advocates concerning primarily the protection of privacy. The track ability RFID technology can provide, both for materials and individuals is a source of concern if this power is potentially abused.

The students in a university campus scenario are exposed to fraud and risk of monetary loss, due to the abuse of the system when RFID cards are used for the recordings of class attendance and the purchase of tickets in bars



and cafés. Any RFID card in the of RFID reader range can be cloned and this poses a threat to RFID card users. This means that any irresponsible person with a RFID reader can clone a RFID card and then use it to purchase tickets on the bar or canteen if they are in close proximity to a university RFID card. Many approaches can be followed to counter these attacks:

- 1) Modification of the authentication of the default hard-coded provided by a supplier;
- (2) Encryption algorithms can be used to protect the transmitted data to ensure that the ciphertext does not disclose any private information, even if the attacker wiretaps the communication;
- 3) To identify the owner of the RFID card, encrypted access token on data blocks can be used. This ensures that only the server has access the decryption key and guarantees that only the server can determine the identity of the user;
- 4) By extending card data structure format blocker card feature can be used to control a privacy bit, which can be abled or disabled, only when the reader has the exact access code,
- 5) By saving a large random number that acts as a card ID (using those bytes in a particular order), take advantage of randomization.
- 6) Consult with the universities cyber security office to implement the latest security standards for improving RFID device protection and data security (Pereira, Carreira, Pinto & Lopes, 2020).

In a university campus, the University ID card will incorporate an RFID chip that transmits a modulated radio frequency signal with digital data, after driven by a nearby reader, which is stored inside the RFID chip memory. The RFID physical protection device acts as a lock and key and is the key for the RFID chip. RFID chips have a code that can be read by the device, i.e. the reader, instead of having a specific pattern. Nonetheless, due to the higher cost, size and complexity of the card / tag and its reader, there are several still unregulated RFID chips in a collection of RFID chips, a good feature for door blocks and quick paying device. There are also significant security risks when using RFID chips in the sense of university campuses because any near-by reader can read RFID cards / tags: all readers in the correct frequency range can read card / tag data , making the tag/ reader one of the weakest things for RFID (Williamson, Tsay, Kateeb & Burton, 2013). The University ID Card is incorporated with the RFID chip to address this issue and has a huge effect on facilities such as access protection, student / attendance at a staff and canteen / bar payments (Pereira, Carreira, Pinto & Lopes, 2020)

### **Challenges for the management of RFID data**

High data-RFID systems volumes should be able to produce large amounts of raw data in relatively short time periods. RFID technology adopters need to ensure that their IT systems are correctly dimensioned. Besides, EM-RFID devices can easily be jammed, which causes confusion to students with growing use of an electromagnetic spectrum like Wi-Fi that requires a high energy frequency. Such circumstances thus dissuade the development of the world market for RFID student monitoring.

Furthermore, RFID devices face another problem from reader collisions in educational organizations. Such collisions occur if signals from several readers hit simultaneous RFID tags. It can lead to problems like signal interference and the reading of several tags that can overlap student data. In addition, a student's real-time location can be supplied by an RFID cards, which can be a classroom, a bathroom or outside the school / college building. This discourages university students from wearing such RFID card as it invades their privacy.

### **Future of RFID's in Higher Education**

RFID is also viewed as an IOT precondition. If all everyday objects were fitted with radio tags, computers could recognise and inventory them. When the RFID readers are linked to the Internet terminal, they can identify, track and control objects attached to tags globally, automatically and in real time as necessary after they have been distributed around the globe. This is one of the many advantages of the Internet of Things in the future especially in the Industrial Revolution 4.0 (Jia, Feng & Ma, 2010).

## Conclusion

In order for the higher education sector in Malaysia to improve the teaching system and administration of institutions, it should take advantage of the adoption of RFID to improve the quality of education in higher education. In order to ensure that students are best provided, educational sectors should be encouraged to invest more in the growth and advancement of RFID technology. Given the difficulties and obstacles of integrating RFID technology, refinements and enhancements to RFID technology should be the highlight of academic discussions among decision makers and stake holders in the higher education ministry.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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