



RFID BASED INDOOR TRACKING SYSTEM

Prof Anand Chaudhari
Department of CSE
PRMITR, Amravati, India
aachaudhari@mitra.ac.in

Shreyash Bhojar
Department of CSE
PRMITR, Amravati, India
shreyash941@gmail.com

Kaushik Bhorjar
Department of CSE
PRMITR, Amravati, India
vbhorjar@gmail.com

Abstract-

The concept of RFID systems has been available for a long time, yet only recently has its potential been recognized in applications of ever-growing demand. The recent popularity of RFID technology is due to its fundamental properties that characterize the production, deployment, and functionality of RFID systems. Radio Frequency Identification (RFID) has been considered as a cost-effective alternative for indoor tracking. It gives the ability to track objects in a certain area specially in an indoor premise. RFID uses tags which uses a radio frequency to transmit its location to a RFID reader. The readers also have their own frequency which after interaction with the tag's radio frequency can read the data stored in the tags. RFID based Tracking System is designed to track a moving personnel in a indoor area, such as a office premises, college department or college campus. Existing positioning technologies such as GPS does not provide the feature of indoor tracking. The proposed system has hardware and software components. Challenge for detecting human beings in big institutions. Whenever we want to find someone in mobile prohibited area, it is difficult to find them within a short period. This kind of circumstances can be avoided by using RFID technology. This report proposes a method that enables indoor location tracking of personnel by utilizing RFID technology. RFID technology is often leveraged to realize location in a reasonable, power efficient and user friendly manner.

INTRODUCTION

RFID was first used over sixty years ago by the British Air Force to identify friend aircrafts in World War II. Though it is being used for decades, recently its cost effectiveness and fundamental capabilities are being realized. The commercial use of Radio Frequency Identification (RFID) technology extends historically to the 1970's. The introduction of this technology motivated future research that encouraged to integrate RFID into various applications such as inventory control/monitoring to human/animal tracking. However, the practical significance of this technology was not fully realized, until mass manufacturing of RFID tags and readers, at different scales and for different ranges, was made possible. Currently, RFID-based systems are being proposed as cost effective alternatives to previously established technologies Wi-Fi and GPS^[1].

RFID is an example of AIDC (Automatic Identification and Data Capture) technologies. As the name suggests AIDC technologies are those technologies that involve the capturing of data without human intervention. This automatic data transmission is initiated as well as terminated with no outside help whatsoever. All this is carried out while abiding to certain pre-defined system rules and parameter that are either specific to the use-case or to the architecture. RFID is a prime example of this technology as it does not require any human interaction whatsoever to function. Once set-up is done, the system functions automatically while following the pre-specified rules.

RFID uses electro-magnetic waves to power a smart tag that is fixed on an object. This uses no external energy source as the only devices interacting are the reader and the tag. This almost negligible energy requirement has made RFID a very lucrative solution for institutions which need to implement tracking solutions in places where they cannot put a power source.

MOTIVATION

The managers at any institute, be it an office or a school management or college department management needs to keep track of the employees to have a coordinated work environment. To keep track of the position of

the employees, whether they are present at their assigned position or not, a localized tracking system needs to be implemented. But the most used technologies like GPS, or Wi-Fi tracking use satellites or large routers and are more suitable for an outdoor environment and a large scale tracking where less obstacles are present like walls and rooms. RFID technology has a particular advantage in indoor tracking as it uses comparatively cost efficient hardware and has more accurate positioning inside any building.

COMPONENTS

A basic RFID system is comprised of three main elements RFID tags, RFID readers and a Processing unit. RFID tags are simple communication devices that are activated by incoming signal from the RFID reader, when it is in its operating range which is between 3m-10m. The tags usually contain small amount of memory, to store small details such as unique ID. RFID reader communicates with and accesses the RFID tags via an antenna. It is also connected with a Processing Unit which is responsible for filtering and processing the data acquired from the tags.

Processing unit can be either a PC or mobile platform. It integrates the reader-tag subsystem into a higher level application and is usually responsible for backend processing.

RFID Tags

The smart tags are the component that need to be physically attached to the object which is to be identified. They are usually small in size and are easy to attach to any given object. They do not have any inherent source of energy *but* they make use of the energy transmitted by the interrogator to power themselves. The size of the tag is essentially dependent on the size of the antenna as it occupies the most space.

RFID Readers

An RFID reader's function is to interrogate RFID tags. The means of interrogation is wireless and because the distance is relatively short; line of sight between the reader and tags is not necessary. The below figure shows the block diagram of a typical RFID reader.

Processing Unit

The backend Processing Unit in general consists of a database and a well-defined application interface. When the backend receives new information, it adds it to the database and if performs some computation on this data. The application retrieves data from the backend. In many cases, the application is collocated with the reader itself. When the reader scans the Tag, the application uses the derived identifier (RSSI) and scans the database for the same and then inserts the post processing information in the database again ^[2].

SYSTEM OVERVIEW

A reader and few tags in general are of very little use unless, it is connected with a powerful backend. Simply retrieving a serial number does not provide much information. A backend processing unit provides the additional information such as when and where the tag was scanned ^[4]. RFID readers scan tags, and then forward the retrieved information to the backend. The backend in general consists of a database and a well-defined application interface. When the backend receives new information, it adds it to the database and performs some computation on this data. The application retrieves data from the backend. In many cases, the application is collocated with the reader itself. When the reader scans the Tag, the application uses the derived identifier and scans the database for the same and then inserts the post processing information in the database again.

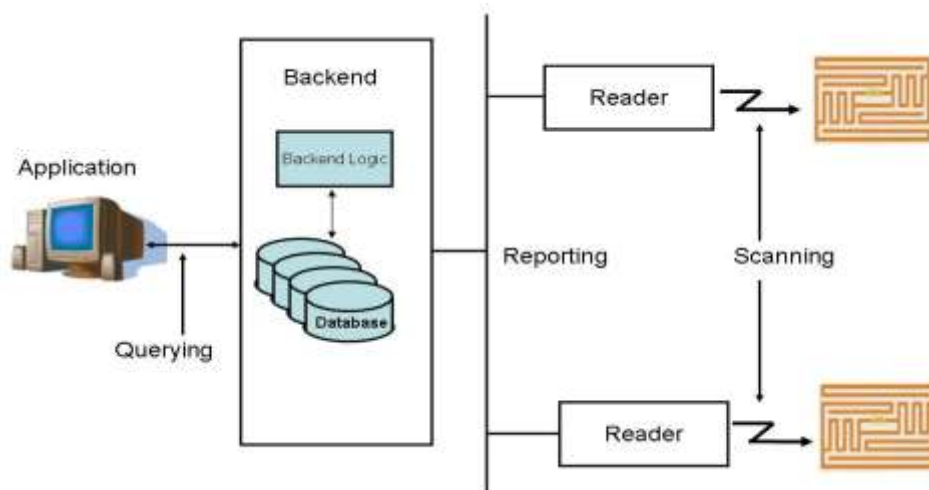


Fig.1 Complete view of the system

In the proposed system RFID tags are attached to an individual to be identified. Each tag has its own “read-only” internal memory depending on the type and application. This memory is to store personal information, of an individual such as unique Identification features^[4]. The real power of RFID comes in combination with a backend that stores additional information such as descriptions for products and where and when a certain tag was scanned^[3]. The RFID Readers are spread across the hallways and key locations in order to retrieve the contents of the specified tag, it generates magnetic fields that enable the RFID system to locate the individual (via the tags) that are within its range.

The area selected for the experiment will be equally divided into cells formed by the grid. The readers are located such that the Tag simultaneously comes in the range of more than 2 Readers. When the tags come in the range of the readers RSSI (Received Signal Strength Indicator) will automatically be detected and recorded in the database for those readers.

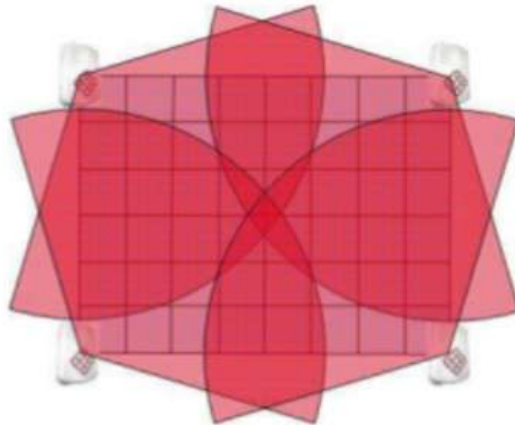


Figure 2: Area divided into Grid

RSSI(Received Signal Strength Indicator)

The RSSI value gives us a clue to the distance between an RFID reader and an RFID tag. The environment has a huge effect on the results, but as a rule of thumb, we can say that the higher the RSSI level, the closer the RFID tag is to the reader^[4]. The RSSI value can give us an indication of the distance to the tag, but only after we analyze the environment and take it into consideration, this is where the equally divided cells comes into play.

The RSSI value can also be used to determine the direction that a tag is moving. As the RFID tag moves closer to the RFID reader, the RSSI value increases. When the RFID tag moves away from the RFID reader, the signal gets weaker. The RSSI value only tells us the distance to the tag, not where it is going.

Several RFID readers are usually required to achieve reliable information about the direction. It is also usually recommended to use supporting techniques, such as “phase difference”, for more reliable results^[6].

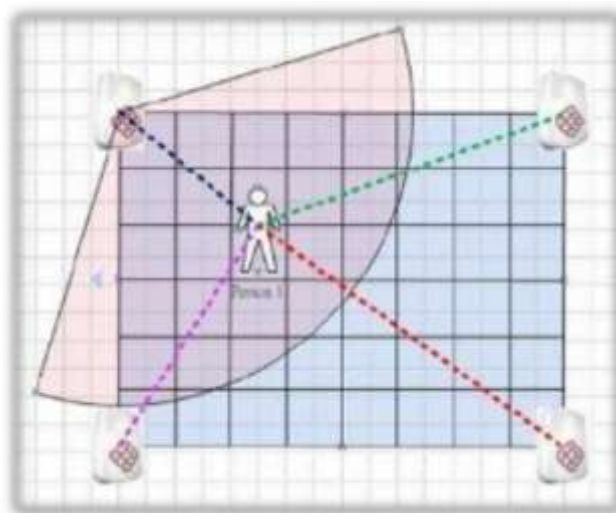


Figure 2.1.1: Locating the tag

There are various Equations that can be used to calculate the distance of the tag from the reader based on RSSI value. RSSI based Euclidean distance is one such equation used for calculating the distance of the transmitting signal from the reader.

$$d_{ij} = \sum_{k=1}^n (x_{ij} - x_{jk})^2$$

Figure 2.1.2: Euclidean Distance formula to calculate the distance between two nodes

Triangulation

Most wireless receiver modules available today have a received signal strength indicator (RSSI) that gives the signal strength measured at the receiver and which is associated with each received signal source. This information is usually part of a packet stream that gives the source identification and RSSI level in power levels of dBm. The RSSI signal is usually a nice diagnostic tool that shows the margin of the received signal compared to the sensitivity of the receiver^[5].

The strength of the signal from the tag to the receiver may also be used as a locator, especially when used with multiple locators to triangulate the position.

However, four networked transceivers arranged in a triangular pattern and equipped with omnidirectional antennas can determine both the transmitter's power level and the Cartesian coordinates (x, y, z) of the transmitter relative to the receivers when they share their RSSI information^[3].

Anti Collision Protocols

Tag collision occurs when a reader energizes multiple tags in its interrogation field and they all respond to it simultaneously. This confuses the reader as it is unable to differentiate between the tags. It confuses the reader.

Such a problem is bound to occur in the proposed system as it will deal with a large number of tags in close proximity of each other.

- *Aloha Protocols:*

The tags transmit their data in randomly selected slots in a frame to the reader to reduce the possibility of a collision. However, this does not guarantee that all the tags will be identified in the process. As a result, this protocol suffers from Tag-Starvation where a tag which is correctly read might not be identified by the reader because of the excessive number of collisions with that particular tag.

- *Tree Based Protocols:*

These protocols work on a query-response model where the reader provides the tags with a query and the tags whose id matches the query must respond to the reader with their whole id. The reader initially starts with a null string and if it detects a collision, adds a bit to the query. This process is repeated till each query gets a reply from only one tag.

- *Hybrid Protocols:*

Hybrid protocols combine both the Aloha-based protocols and the Tree-based protocols to avoid their problems and provide better tag identification. They implement a tree based structure for tag estimation to predict the number of tags. This combination of protocols increases the efficiency of these protocols while also increasing the complexity. Hybrid protocols can significantly increase performance as compared to the previously mentioned protocols^{[7][8]}.

A COMPARISON OF RFID PROTOCOLS

Parameters	Protocols		
	<i>Aloha Protocols</i>	<i>Tree Based Protocols</i>	<i>Hybrid Protocols</i>
Mechanism	Randomly slotted	Query based	A combination of query based tree strategy and Aloha based slots
Number of tag to reader commands	Low	High	Low
Usage	LF, HF and UHF RFID systems	HF, UHF RFID systems	Not implemented on any standard
Method	Probabilistic	Deterministic	Mixture (Aloha and Tree Based)
Tag Starvation	Yes	No	No

CONCLUSION

After studying and comparing the various Anti-Collision protocols, we have decided that the proposed RFID system will include Aloha and Tree based anti-collision protocols as they are easy to implement and have been used extensively in the past. The Euclidian Distance Formula and RSSI value will be used in combination to calculate the distance between two nodes. This will allow the system to get the accurate position of the subjects thus providing us an efficient way of managing personnel.

ACKNOWLEDGMENT

This research was supported by Prof. Ram Meghe Institute of Technology & Research. We thank Prof. A. A. Chaudhari Sir for assistance with RFID technology and comments that greatly improved the manuscript. We are also immensely grateful to Dr. G. R. Bamnote Sir, Head of Department of Computer Science & Engineering, Prof. Ram Meghe Institute of Technology & Research, for their comments on an earlier version of the manuscript, although any errors are our own and should not tarnish the reputations of these esteemed persons.

REFERENCES

- Bernard Ghanem , RFID Project Technical Report
 "RFID reader block diagram," http://ecee.colorado.edu/~liue/teaching/comm_standards/rfid/BlockDiagram.html
 Christoph Jechlitschek , A Survey Paper on Radio Frequency IDentification (RFID) Trends, <http://www.cse.wustl.edu/~jain/cse574-06/index.html>
 International Journal of Engineering Research and Reviews ISSN 2348-697X (Online) Vol. 3, Issue 1, pp: (73-80), Month: January - March 2015, Available at: <http://www.researchpublish.com>
 Applying RSSI filters for optimal RFID performance
<https://www.nordicid.com/resources/expert-article/applying-rssi-filters-for-optimal-rfid-performance>.
 Applying RSSI filters for optimal RFID performance
 A Comparison of RFID Anti-Collision Protocols for Tag Identification <https://www.mdpi.com/2076-3417/8/8/1282/htm>
 Erik F. Golen, Nirmala Shenoy, Xiaojun Cao, "A low latency scheme for bulk RFID tag reading"