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RFID Based Personnel Location Tracking and Monitoring

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ABSTRACT: RFID is a growing technology that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency (RF) portion of the electromagnetic spectrum to uniquely identify an object, animal, or a person. RFID is coming into increasing use in industries as an alternative to the bar code. The advantage of RFID is that it does not require direct contact or line-of-sight scanning. An RFID system consists of three components: an antenna and transceiver (often combined into one reader) and a transponder (the tag). The antenna uses radio frequency waves to transmit a signal that activates the transponder. When activated, the tag transmits data back to the antenna. The data is used to notify a programmable logic controller that an action should occur. The action could be as simple as raising an access gate or as complicated as interfacing with a database to carry out a monetary transaction. Low-frequency RFID systems (30 KHz to 500 KHz) have short transmission ranges (generally less than six feet). High-frequency RFID systems (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) offer longer transmission ranges (more than 90 feet). In general, the higher the frequency, the more expensive the system.

KEYWORDS: RFID, RFID tag, Personnel tracking, Radio frequency identification**.**

I. INTRODUCTION

People access control; monitoring and attendance tracking belong to most demanded RFID applications[2]. Many obvious characteristics of RFID make it more appealing than before and promoting its substitution to a barcode system[1]. RFID based access control & monitoring systems are typically used for granting access or control the people's attendance to the office, enterprise, car parking, school, library, hotels, events & exhibitions as well as for tracking employee time for payroll, safety, production and maintenance needs.

II. RFID AND ITS ADVANTAGES OVER OTHERS

A. RFID

Like smart card systems, data is stored on an electronic data-carrying device – the transponder. However, unlike the smart cards, the power supply to the data-carrying device and the data exchange between the data-carrying device and the reader are achieved without the use of galvanic contacts, using instant magnetic or electromagnetic fields[3]. The underlying technical procedure is drawn from the fields of radio and radar engineering. The abbreviation 'RFID' stands for radio frequency identification, i.e. information carried by radio waves. Due to the numerous advantages of RFID systems compared with other identification systems, RFID systems are now beginning to conquer new mass markets. One example is the use of contactless smart cards as tickets for short-distance public transport.

A significant advantage of RFID devices over the bar code or a magnetic strip on the back of a credit card or ATM card is that the RFID device does not need to be positioned precisely relative to the scanner[4]. We're all familiar with the difficulty that store checkout clerks sometimes have in making sure that a barcodes can be read. And obviously, credit cards and ATM cards must be swiped through a special reader.

In contrast, RFID devices will work within a few feet (up to 20 feet for high-frequency devices) of the scanner. For example, you could just put all of your groceries or purchases in a bag, and set the bag on the scanner. It would be able to query all of the RFID devices and total your purchase immediately.

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B. RFID SOLUTION BENEFITS

- Short proximity & long range automatic NLOS wireless identification.
- Reduce costly payroll errors.
- Increases employee transparency.
- Reduces the time required to process the data[2]

III. COMPONENTS OF RFID MODULE

RFID Tags

Figure 1 RFID tags [5]

An RFID tag is comprised of an integrated circuit (called an IC or chip) attached to an antenna that has been printed, etched, stamped or vapor-deposited onto a mount which is often a paper substrate or Polyethylene Terephthalate (PET). The chip and antenna combo, called an inlay, is then converted or sandwiched between a printed label and its adhesive backing or inserted into a more durable structure.

- Tag Chip

Figure 2 Tag chip used the RFID[5]

The tag's chip or integrated circuit (IC) delivers performance, memory and extended features to the tag. The chip is pre-programmed with a tag identifier (TID), a unique serial number assigned by the chip manufacturer and includes a memory bank to store the item's unique tracking identifier (called an electronic product code or EPC).

- Electronic Product Code (EPC)

Figure 3 Electronic product code[5]

The electronic product code (EPC) stored in the tag chip's memory is written to the tag by an RFID printer and takes the form of a 96-bit string of data. The first eight bits are a header which identifies the version of the protocol. The next 28 bits identify the organization that manages the data for this tag; the organization number is assigned by the EPCglobal consortium. The next 24 bits are an object class, identifying the kind of product; the last 36 bits are a unique serial number for a particular tag. These last two fields are set by the organization that issued the tag. The total electronic product code number can be used as a key into a global database to uniquely identify that particular product.

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RFID Readers

Figure 4 Different types of RFID readers[5]

An RFID reader, also known as an interrogator, is a device that provides the connection between the tag data and the enterprise system software that needs the information. The reader communicates with tags that are within its field of operation, performing any number of tasks including simple continuous inventorying, filtering (searching for tags that meet certain criteria), writing (or encoding) to selected tags, etc.

The reader uses an attached antenna to capture data from tags. It then passes the data to a computer for processing. Just like RFID tags, there are many different sizes and types of RFID readers. Readers can be affixed in a stationary position in a store or factory, or integrated into a mobile device such as a portable, handheld scanner. Readers can also be embedded in electronic equipments and in vehicles.

- Reader Antennas

RFID readers and reader antennas work together to read tags. Reader antennas convert electrical current into electromagnetic waves that are then radiated into space where they can be received by a tag antenna and converted back to electrical current. Just like tag antennas, there is a large variety of reader antennas and optimal antenna selection varies according to the solution specific application and environment.

The two most common antenna types are linear- and circular-polarized antennas. Antennas that radiate linear electric fields have long ranges, and high levels of power that enable their signals to penetrate through different materials to read tags. Linear antennas are sensitive to tag orientation; depending on the tag angle or placement, linear antennas can have a difficult time reading tags. Conversely, antennas that radiate circular fields are less sensitive to orientation, but are not able to deliver as much power as linear antennas.

Choice of antenna is also determined by the distance between the RFID reader and the tags that it needs to read. This distance is called read range. Reader antennas operate in either a "near-field" (short range) or "far-field" (long range). In near-field applications, the read range is less than 30 cm and the antenna uses magnetic coupling so that the reader and tag can transfer power. In near-field systems, the readability of the tags is not affected by the presence of dielectrics such as water and metal in the field.

In far-field applications, the range between the tag and reader is greater than 30 cm and can be up to several tens of meters. Far-field antennas utilize electromagnetic coupling and dielectrics can weaken communication between the reader and tags.

IV. TYPES OF RFID SYSTEMS

1) Active RFID Systems

In active RFID systems, tags have their own transmitter and power source. Usually, the power source is a battery. Active tags broadcast their own signal to transmit the information stored on their microchips.Active RFID systems typically operate in the **ultra-high frequency (UHF) band** and offer a range of up to 100 m. In general, active tags are used on large objects, such as rail cars, big reusable containers and other assets that need to be tracked over long distances[6].

There are two main types of active tags: transponders and beacons. **Transponders** are “woken up” when they receive a radio signal from a reader, and then power on and respond by transmitting a signal back. Because transponders do not actively radiate radio waves until they receive a reader signal, they conserve battery life.

Beacons are used in most **real-time locating systems (RTLS)**, in order to track the precise location of an asset continuously. Unlike transponders, beacons are not powered on by the reader’s signal. Instead, they emit signals at pre-set intervals. Depending on the level of locating accuracy required, beacons can be set to emit signals every few seconds, or once a day. Each beacon’s signal is received by reader antennas that are positioned around the perimeter of the area being monitored, and communicates the tag’s ID information and position.

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2) Passive RFID Systems

In passive RFID systems, the reader and reader antenna send a radio signal to the tag. The RFID tag then uses the transmitted signal to power on, and reflect energy back to the reader.Passive RFID systems can operate in the **low frequency (LF)**, **high frequency (HF)** or **ultra-high frequency (UHF)** radio bands. As passive system ranges are limited by the power of the tags **backscatter** (the radio signal reflected from the tag back to the reader), they are typically less than 10 m. Because passive tags do not require a power source or transmitter, and only require a tag chip and antenna, they are cheaper, smaller, and easier to manufacture than active tags[6].Passive tags can be packaged in many different ways, depending on the specific RFID application requirements. For instance, they may be mounted on a substrate, or sandwiched between an adhesive layer and a paper label to create smart RFID labels. Passive tags may also be embedded in a variety of devices or packages to make the tag resistant to extreme temperatures or harsh chemicals.Passive RFID solutions are useful for many applications and are commonly deployed to track goods in the supply chain, to inventory assets in the retail industry, to authenticate products such as pharmaceuticals, and to embed RFID capability in a variety of devices. Passive RFID can even be used in warehouses and distribution centers, in spite of its shorter range, by setting up readers at choke points to monitor asset movement.

3) Battery-Assisted Passive (BAP) Systems

A Battery-Assisted Passive RFID tag is a type of passive tag which incorporates a crucial active tag feature. While most passive RFID tags use the energy from the RFID reader's signal to power on the tag's chip and backscatter to the reader, BAP tags use an integrated power source (usually a battery) to power on the chip, so all of the captured energy from the reader can be used for backscatter. Unlike transponders, BAP tags do not have their own transmitters.

Parameter	Passive	Active
Read Range	Up to 40 feet (fixed readers) Up to 20 feet (handheld readers)	Up to 300 feet or more
Power	No power source	Battery powered
Tag Life	Up to 10 years depending upon the environment the tag is in	3-8 years depending upon the tag broadcast rate
Ideal Use	For inventorying assets using handheld RFID readers (daily, weekly, monthly quarterly, annually). Can also be used with fixed RFID readers to track the movement of assets as long as security is not a requirement.	For use with fixed RFID readers to perform real-time asset monitoring at choke-points or within zones. Can provide a better layer of security than passive RFID.
Readers	Typically higher cost	Typically lower cost

Table.1 Comparison between passive tag and active tag

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V. EXISTING TECHNOLOGY

A.Design

The main components are:

- Microprocessor
- RFID reader
- Active RFID tag or card
- Display and Storage unit.

Microprocessor is the main processing device and all the connections are explained with respect to it. In this project, a Microprocessor board is integrated with an RFID reader module in order to process the data or the information retrieved from the RFID card or tag.RFID reader module is basically a radio frequency transceiver (transmitter and receiver). A simple RFID reader consists of an antenna, demodulator, data decoder unit and some filters. RFID readers can read and/or write data into the RFID card. RFID card or tag consists of an antenna and an IC for storing the data. RFID cards used here is active type which is powered by an external battery. The range of this tag is around 100 feet.

The communication between the RFID reader and Microprocessor is implemented using UART protocol.A display unit such as an LCD or a computer system is used to display the information that is retrieved from card.

B.Working

The aim of this project is to transmit the data read by the RFID reader to Microprocessor and display it on the LCD.

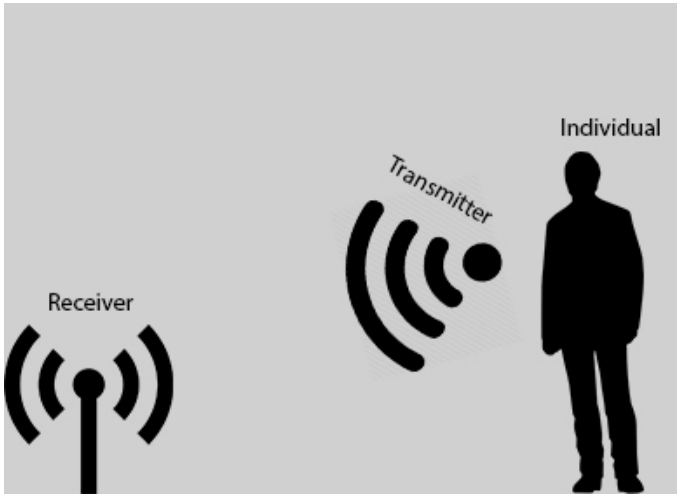

Figure 5 Transmitter and single receiver

Each individual is given with a unique ID which is transmitted by the active tag. When the individual carrying the tag comes close to a RF reader the unique ID transmitted by the individual is received by the reader. The ID is stored in the database. Using backend table and coding the ID is linked to the respective individual and his details are updated in the database like the time of his entry into the block etc. Using search algorithms the details of a specific individual can be fetched from the database. The ID can be linked to NAME, MOBILE NO, ENTRY TIME, PHOTO etc.

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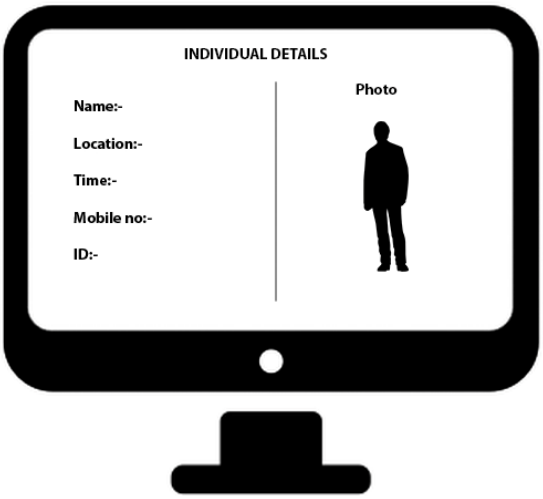

Figure 6 Details of the individual monitored

As the RFID system used here is of active type, the details about the employee is first programmed on the RFID card or tag. In order to read the data, the card must be brought around a range of 100 feet of the reader. The RFID reader module continuously emits Electromagnetic radiation in the form of radio waves at a frequency of 125 KHz. When an RFID tag is brought near this field, due to the power source (battery), the IC in the card gets sufficient power and transmits the data through the antenna which is in turn is received by the antenna of the reader. The data received by the RFID reader is now transmitted to Microprocessor using UART communication protocol. Microprocessor in turn displays this message on the display unit.

- **IMPROVEMENTS TO CURRENT TECHNOLOGY**

Instead of placing the reader at one location, it can be placed at the entrance of every block to detect or to monitor the location and activity of every individual in the place.

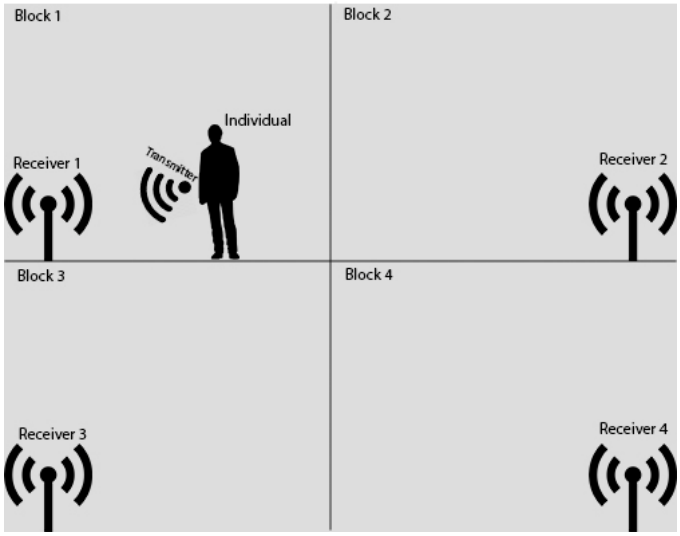

Figure 7 Transmitter and receiver at each block

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From fig.7 if an individual is in the First block of the region then the individual block number can be loaded into the database of the computer system by identifying the receiver from which the individual data was received. By using many receivers the accuracy of the locating the individual can be increased.

VI. ADVANTAGES OF PERSONNEL TRACKING SYSTEM

- Full visibility of the staff and students in real time.
- Strengthens security and helps to know about the people within an area.
- Rapid attention in the case of an emergency.
- Alert triggers for unauthorized movement or access.
- Monitor the presence and location of security guards.
- Capture video of people movement.

VII. CONCLUSION

In this paper, we have provided a comprehensive overview of the emerging RFID technology application. RFID has even greater application in the future. RFID has greater advantage than the currently used biometric scanner and the barcode. In the current world where time is money and each second is precious RFID applications prove to be time saving and well adaptable to meet all our needs.

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