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A Low Cost Inventory Location Identification Kiosk For Indoor Environments Using Passive RFID Tags And Open Source Hardware

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Abstract

In indoor environments, where density of people will be high such as offices, industries, colleges, banks, hospitals and others, if we want to locate a particular person or if some information has to be passed, it will be hard for us to search for that person. In a hospital if we want to locate the patients, wheelchairs, stretches and any other necessary equipment or in a ware house where you want to locate a carton, this RFID (Radio frequency identification) based system will be very useful and the information can be passed in time without much effort. The reader, which is located in specific locations, scans the tags which are in its range and using the unique identification number assigned to the tag. This tag information, along with reader address is passed to the receiver section using wireless communication. A database is maintained with all the received data such as tag ID, reader address and time stamps. The movement and position of these tags can be known through this system. A kiosk enables a user to place a query and get necessary data.

Keywords: RFID, Arduino, Raspberry Pi, Open Source Hardware, Indoor Location Identification, Kiosk.

Introduction

Many applications need location management systems for their operation, in order to determine the personnel or objects location in a real time. The automatic identification technology is growing largely at a faster pace and is being used in every field. The RFID is an automatic identification technology that uses radio waves from the electromagnetic spectrum to identify the persons or objects that are carrying tags. It is emerging as a major technology to identify people or assets in an indoor environment. It can be helpful in large industries or institutions to identify the location more quickly

which in turn saves time and provides the access control. It is a low cost, simple and reliable technology which makes use of RFID readers and tags. The robust design of the tags makes it suitable to be attached to the objects. The technology has been widely deployed for the automatic identification, inventory and tracking of animals, people, goods and other objects. Consider a large institution where each person is provided with a unique RFID tag. Each location in the institution is named for easy recognition and those locations are installed with a RFID reader unit. The system which is installed at various points in an area continuously reads the tags movement and restricts their access to sensitive areas in the organization.

International standards have been adopted for certain applications and many other standards initiatives are in process. The world RFID market in 2014 is worth $8.89 billion, up from $7.77 billion in the previous year. This involves tags, readers and software services for RFID cards, labels, keys or fobs and all other form factors. By 2024, the market value is expected to rise to $27.31 billion.

Need For The System:

A location identification system provides relative information about the location of personnel or objects, identification, tracking and monitoring of humans or assets in a real time. GPS (Global Positioning System) is suitable for location sensing and determining the positions in an outdoor environment. But, when it comes to indoor areas, GPS is not suitable because of its lower accuracy and poor reception of satellite signals in indoor environments. Previously, ultra sonic methods, infrared technology based systems and some other technologies were used for indoor localization. But they cannot provide a unique identification. Later, studies proved that RFID technology is the most suitable one for indoor location sensing. The use of passive RFID, overcomes the drawback of high installation and maintenance costs. So, this system will be useful in wide range of applications in various fields, which may need location tracing systems to determine the location of humans and objects in an area.

Several applications such as location identification of personnel and assets in hospitals, large offices or institutions and identification of tagged items in ware houses can make use of this system in order to obtain accurate localization results. In large institutions or offices, there will be hundreds and thousands of people working daily moving from one place to the other. If we want to communicate with a particular person, it will be hard for us to search for that person and also it is time consuming. It will be very helpful when there are a large number of people in a big room and we have to identify an unknown person.

In hospitals, this system can be used to track beds, equipment and patients. The hospital personnel can tag patients and highly needed equipment, so that they can locate them quickly in an emergency situation. It displays the patient and asset location data in real time. It will be helpful in providing better treatment to the patients. It increases efficiency in the use of processes and staff productivity. Hospitals are very sensitive areas and the deployed systems should not cause interference with the medical apparatus. So the passive RFID tags are used as they do not face signal interference problems and can withstand harsh environments.

In ware houses, this system can be used to efficiently monitor and control the movement and storage of products and process the associated transactions. The supply chain involves storage and movement of goods, to intermediate locations or to the final customer. The collected real time data from these materials is transmitted wirelessly to a central database. The status of goods in the stockroom can be known from the database and it can track where the necessary products are stocked and the total time period they are stored there. In this way, the system can be used in every application where location identification is needed.

Identification System and Working

The identification system is based on wireless communication between the reader unit and administration unit through zigbee. The RFID system consists of a reader, which transmits and receives signals and tags, which are attached to persons. The reader, whose function is to interrogate tags, consists of a RF module that transmits and receives radio frequency signals. Each reader has certain range of operation and so the reader and the tag have no need to be in line of sight. It can read the tag as long as the tag is in that range. The figure-1 shows RFID tags.

Figure 1: RFID tags

Each tag has a unique ID or serial number which makes it easy to identify and locate every individual among several others in a unique way. The system will be more useful in mobile prohibited areas. The transmitter of RF module consists of an oscillator to generate carrier frequencies, a modulator to impose data commands on the carrier and an amplifier to strengthen the signal so that it can awake the tag. The receiver has a demodulator to extract the data and an amplifier to strengthen the received signals. The tag comprises of a microchip and antenna, and has electronically stored data. A tag may be either passive or active. A passive tag does not have battery, so it uses the energy transmitted from the reader, whereas an active tag will have on board battery source.

The advantages of using passive tags are that they are inexpensive, can be of any size (from the size of a rice grain to a credit card), have longer lives and can withstand harsh environments.

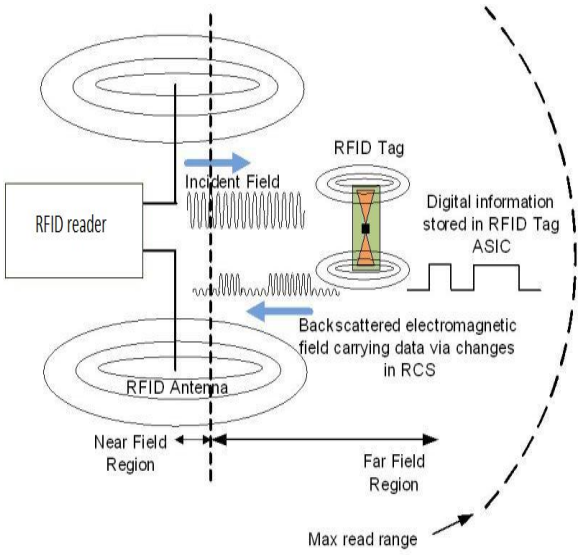

Figure 2: Communication Between Reader And Tag

Tags can store up to 2 kilobytes of data. This internal memory is used to store the details of the person such as personal information or unique identification features. The overview of communication between reader and tag is shown in figure-2: An electromagnetic field is emitted by the reader. It contains power and timing information for use by the passive tag. When the tag is within the range it receives the information which is fed to the IC and in response the IC changes its impedance states between a lower and higher value in a programmed manner. By changing the states the IC changes the radar cross section of the tag antenna thus changing the back scattered power. This power is collected at the reader and is used to identify the unique ID and information of the tag. Maximum read range is the distance to which a reader can successfully identify a tag.

The reader sends the signal to identify the particular tag and the tag responds to it by sending the ID and current location information of that person. The information collected in this way is used to query or update the database in a system, and is connected to a kiosk, which is designed to track the position. A kiosk is an interactive computer terminal which provides information to people. It requires a simple user interface, with a display and a keyboard, which can be used easily. It enables a user to enter and display information. This computerized kiosk stores data locally and can retrieve it from a computer network.

System Design:

The system consists of a transmitter section and a receiver section and their block diagrams are shown in the figures 3 and 4.

Transmitter section:

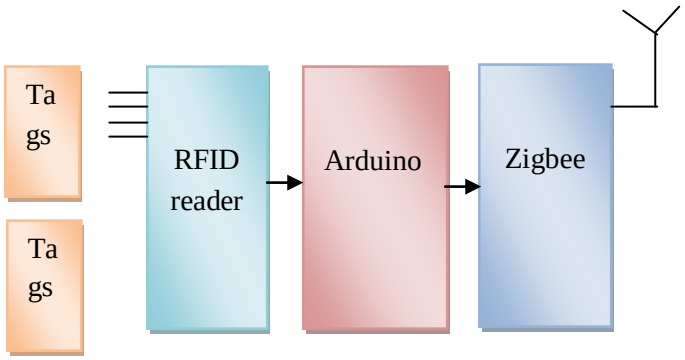

Figure 3: Transmitter Block Diagram

The transmitter section consists of a reader, arduino microcontroller and zigbee wireless transmitter module as shown in figure-3. In this a Mifare RFID reader MFRC522 is used which works at 13.56MHz frequency. It is a highly integrated reader or writer IC for contactless communication and uses SPI protocol. Its low power consumption, low cost, read and write chip and compact size makes it a best choice for any system. The arduino microcontroller using here acts as a controlling unit. The arduino is an open source physical computing platform having a simple microcontroller board. It also has a development environment for writing software for the board. It is inexpensive compared to other platforms, which makes it useful for designing low cost systems. It offers cross platform and simple programming environment. Since it is an open source platform, we can design our own version of the module making improvements depending on the application and the requirements.

In this, a reader is assigned to the entrance of each room in order to identify and read the contents of the tag when a person enters the room. The reader generates the magnetic field which enables the RFID system to locate the individuals that are within its range. If the information in the tag is matched with the data in the memory, then the details of the person such as name, designation etc., will be displayed. If the data is not matched, then it will display as unauthorized entry. If there are a number of tags at the same time, then the reader reads one by one and processes the data. The information from the RFID tag will be stored in the microcontroller and is sent to the receiver section through zigbee wireless communication.

Receiver section:

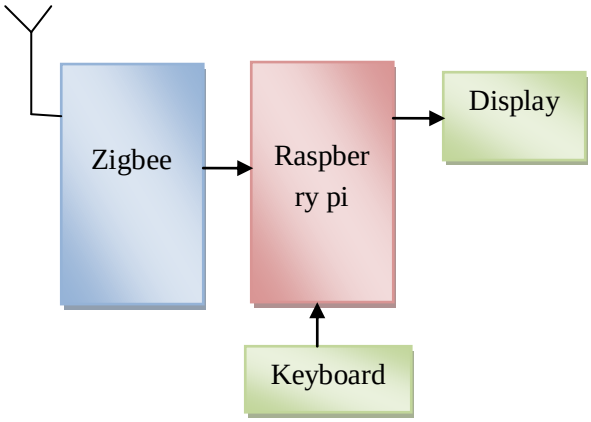

Figure 4: Receiver block diagram

The receiver section consists of a raspberry pi system, zigbee receiver module and a display as shown in the figure-4. The data from the transmitter section is received by the zigbee receiver module at the receiver section. The reason behind using Zigbee in this system is that it is a global standard for wireless technology which is simple, less expensive, consumes low power and provides wireless monitoring. It creates a network which is energy efficient and secure. It offers data transmission over long distances at a low data rate.

A raspberry pi system is used to maintain the database of the information collected about the tag's identity and location and to display it. Raspberry pi can be said as a small computer that can be used in any electronic projects and for many things that a desktop PC does. When a query is made through the terminal, it searches the related date in its database and responds with the information. Then the information is viewed in the display with the help of computerized kiosk.

Authentication System:

The system can also serve as an authentication system which prevents unauthorized access to an area or devices. For example, the admin block in an institute should prevent unauthorized people from entering into it. Whenever it identifies an unrecognized tag it restricts the access to it and thus provides security and access control.

Discussion and Results

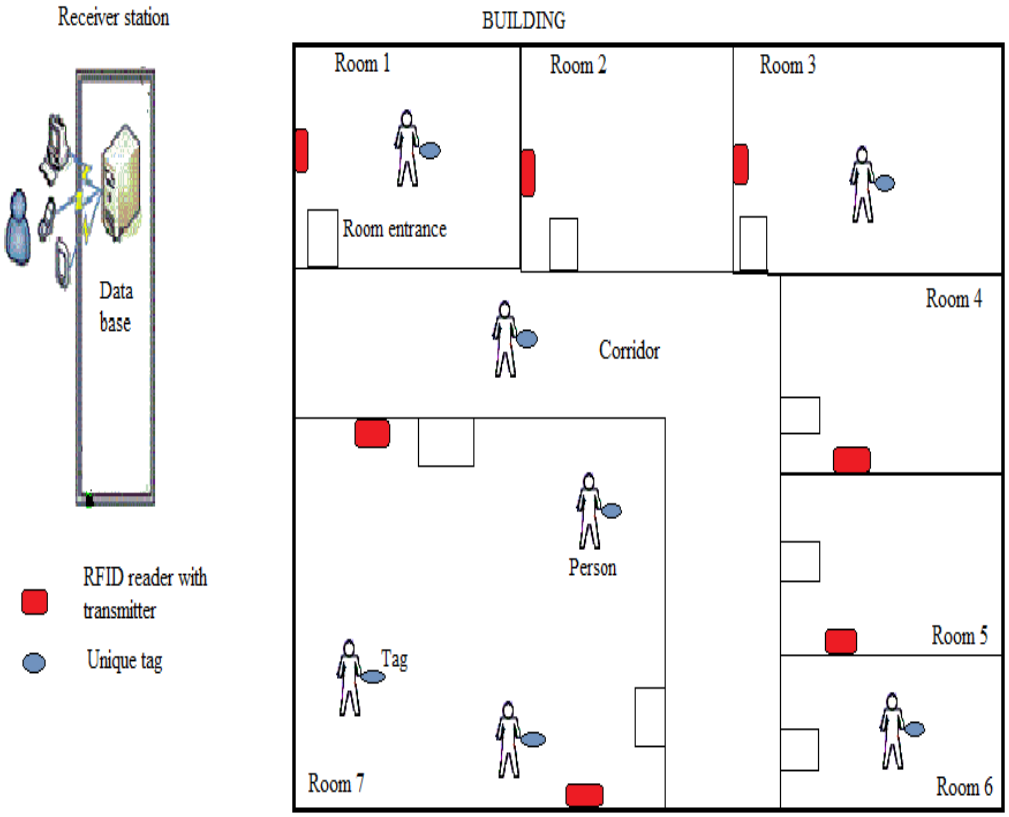

Figure 5: Location Identification and Tracking of People In A Building

The figure 5 shows an overview of the location identification and tracking of people in a building. RFID readers are fixed at the room entrances and the tags are assigned to every person. Whenever a person passes through the room entrance the reader scans the tag. The unique ID of the tag contains 12 bytes of data as 414AD6ED3021. The last two digits indicate checksum which is the result of XOR operation on the first ten bytes. The information is sent to the database wirelessly and is stored there. If we enter a person's tag ID, the reader scans the tag if he is in the range, and the results of his location and identification information are displayed. The location data of the people should be used properly following ethics. It should be in such a way to find their location under necessary conditions but not in a way that the personnel are kept under surveillance all the time.

Conclusion

In this, the design of location identification and tracking system based on radio frequency identification is described. The timely information given by the system,

about the location of a person would increase the efficiency and effectiveness of the system. Care should be taken that the tags are not lost and are always with the respective persons, without which their location identification is not possible. The raspberry pi system can serve as a web server and can give access to the data over the web. It can be used with any unit based on the requirement. This method will open new doors to large organizations and institutions to make them more reliable, accurate and secure. In future, this method can be used in various fields in different applications and many improvements can be done so that it can be made beneficiary to all the sectors.

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