DESIGN AND IMPLEMENTATION OF RFID TAGGED OBJECT LOCATOR

Shailesh D. Rokade and Swati Kadlag
Department of Electronics and Tele-communications,
Symbiosis International University, Tq : Mulshi, Dist : Pune-412115, India

ABSTRACT

In our day-to-day life we have to carry many things such as keys, cell phones, laptop charger, etc; Many times it is a difficult task to remember which thing is kept where in the room. For example: If a person has forgotten where he has kept his laptop charger then, for that, he has to search the entire room to find that charger. This task is very tedious and time consuming. Many times, it becomes more tedious if the user is in hurry. To make searching simpler and time saving, the idea is to design such a system, which uses embedded system and Radio frequency Identification technology. The RFID technology consists of two main parts a Reader and Tags. In this system, the RFID reader will be able to detect the location and distance of the objects with the help of passive tags.This device is portable and works as a tracking device so as to locate the objects and their positions from the user. The aim of the paper is to provide the details of the RFID reader designed with its advantages over the other technologies.

KEYWORDS: Radio Frequency Identification (RFID), Object locator, RFID reader, Location, Distance.

I. INTRODUCTION

Accurate location determination systems plays a very important role for large scientific institutions and military installations (for some time), but such systems are much too complex and expensive for use in smaller areas such as home, schools, offices and clinics. Many systems that track subjects in real time have severe limitations when tracking individuals in a smaller areas, such as a room or building. Due to the number of limitations of tracking systems for smaller areas a system is need to be developed that could deliver quick and accurate position information (i.e. within a meter) at minimal cost. This system could have many extremely useful applications, such as monitoring the portable things like keys, wallet, cell phones , Laptop , the whereabouts of patients in a hospital. In order to design such a system the best solution is use of RFID technology. Radio Frequency Identification (RFID) is an automatic identification technology that is widely used across a multitude of applications, including security, safety and asset tracking. A modulated radio frequency signal is used to transfer data from transponders, attached to people, animals or objects, to a reader in the vicinity[1][4][9].
Recently, there is development in the localization and tracking section were technology have allowed the location of transponders to be calculated while interfacing with the reader. RFID technique is very useful to meet the indoor object localization[1][13]. The idea is to design a portable device which will not only able to localize the objects but also able to find distances of the respective objects based on RFID. To monitor this, the device is kept at fixed location for example: at the door in the house[2].
This paper describes an indoor location aware approach to provide the information about positioning of various mobile devices. The advantages, superiority, various components, working and design of RFID reader are described in next sections: Section II describes limitations of various determination technologies, Section III describes about RFID system, Section IV describes about the design of RFID reader, Section V describes about Working of the RFID reader, Section VI describes about the

Advantages, Section VII decribes Results and Section VIII describes about the Conclusions and Future scope of the work.

II. LIMITATIONS OF VARIOUS LOCATION DETERMINATION TECHNOLOGIES

ZigBee : ZigBee is based on the IEEE 802.15.4 standard for Wireless Personal Area Networks. Zigbee is based on Received signal strength(RSS) mechanism. Depending on the strength of the received signal, the various objects within the indoors are get tracked.

Using ZigBee for implementation of a location determination technology has the advantage that the system can work for indoors, but the cost of implementation is very high. Also,the complex network infrastructure may need constant maintenance[2][14].

2.1 Mobile cellular systems : Implementation of location determination technology using Mobile phones is well suited for larger distances ,but it doesn't suits for smaller distances. Mobile phones when switched on, send out a signal to cell towers within its vicinity. By comparing the time for the signal to arrive and relative signal strengths from multiple towers, an estimated location of the handset can be obtained.

Mobile phone tracking is expensive and works only in more developed areas in range of multiple cell towers. Position estimation, to within an average of fifty metres, is very inaccurate[5][6].

2.2 GPS : The Global Positioning System (GPS) is a Global Navigation Satellite System (GNSS), employing a network of twenty-four satellites launched by the United States Department of Defence[1].

GPS devices require line of sight with satellites in order to be tracked correctly, meaning devices cannot be tracked indoors or in some areas surrounded by tall buildings.GPS is used in navigational systems for automobiles, aircraft, ships, spacecraft and even pedestrians, emergency location, location-based games, mobile satellite communications[1][2][15].

2.4 Wi-Fi/Place Lab : The Place Lab software uses an online database of the coordinates of known wireless base stations, known as landmarks.

Place Lab requires quite a number of entries in the database for a user's location in order to provide accurate position information over a wide area. Some large cities, have a large landmark database. It is unlikely, however, to find many landmarks for smaller, less developed areas[1][14].The summary of comparison of indoor locating techniques is mentioned in the following table :

Table 1 : Comparison of Indoor locating techniques[1][6].

Performance	GPS	W i- Fi	Bluetooth	RFID
Accuracy	Low	Medium	Medium	High
Signal error ratio	High	High	Low	Low
Power consuming	High	High	High	Low
Penetration	Bad	Good	Good	Good

It is essential to design a system for monitoring small areas like homes, offices, etc; having a good efficiency and low cost. To design such a system RFID is the best approach. The details of RFID system is discussed in next section.

III. RFID SYSTEM

Radio Frequency Identification (RFID) is an automatic identification technology which has seen increasingly prominent use over the last few decades. RFID was first used during world war II in friend-or-foe identification system. Its many applications include supply chain management, asset tracking, security clearance and automatic toll collection. RFID has become a new and exciting area of technological development, and is receiving increasing amounts of attention. An RFID device typically consists of RF tags, reader with one or more antennas and code to process the data. The technology uses modulated radio frequency signals to transfer data between its two main components, the reader and the transponder[2].RFID requires no line of sight for identifying objects which is a very important feature as compared to other identifying technologies[6].

Depending on the application that is used, the actual characteristics of the different components will vary greatly. However, the primary components of a typical RFID infrastructure include :
(a) A ***transponder*** or tag with a unique identifier that facilitates auto-identification of any object to which the tag is attached.
(b) A reader or ***interrogator*** that manages the radio frequency communication with the tags.
(c) A ***middleware*** or reader interface layer, which is essentially a type of software that acts as an interface between the basic RFID hardware components, and the software application tasked with data collection related to tag[1][2].

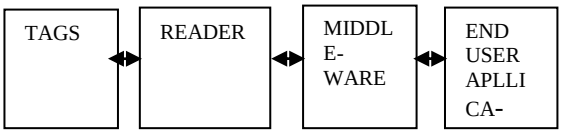

Fig 1: RFID System[1]

3.1 Tags :

In modern RFID technology there are four types of tags : Passive tag, semi-passive tag ,active tag and semi- active tag. Passive tags does not associated with power source while, active tags are directly associated with power source[3][4]. Passive and active tags can either be class 0(read only) or class 1(read/write) tags. The approved radio frequency range for RFID applications is 900 MHz for class 0 and either 13.56 MHz ISM band or 860 to 930 MHz for class 1,depending on the strength of the signal required. The comparison between Passive and Active tags is mentioned in the following table :

Table 2 : RFID tags[3][7]

Parameters	Passive	Active
Read Range	Up to 20 feet (for fixed readers) Up to 40 feet (for handheld readers)	Up to 300 feet or more.
Power	No power source	Battery powered
Tag Life	Up to 10 years depending upon the environment in which the tag is used.	3-8 years depending upon the tag broadcast rate.
Tag Costs	$.10-4.00 or more depending upon quantity, durability, and form-factor.	$15-50 depending upon quantity, options , and form-factor.
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 Lower cost.	Typically higher cost.

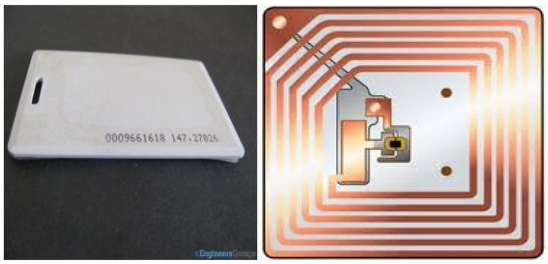

Fig 2 : RFID tag[4]

3.2 Reader :

The reader can come in many different forms, such as a in a hand-held portable device (as shown in Figure 2), fixed in a “portal” that reads any tags passing through it. Readers send out a signal that interrogates any tags in its vicinity. This interrogation can be as simple as a request for all data

contained in a tag's memory, or it can request specific data from different portions of memory. Some readers can also write data to tags that have writable memory.
Readers receive a signal back from a tag it has interrogated, demodulates the signal and then decodes it into digital data.

Fig 3 : A handheld portable RFID reader[1].

This data is then passed onto a computer system for processing. The readers can be classified as either "intelligent" or "dumb." Intelligent readers are those that can operate on different protocols and filter data they receive. They can read tags functioning on different frequencies at the same time. A dumb reader can usually only read one type of tag on one frequency using a single protocol[2].

3.3 Software:

Intelligent readers are often computers in themselves, while more simple readers are networked to a separate computer system. Readers only read data from tags, which would be useless without an application that makes use of it. Most reader software will also include functions for the direct control of the reader itself, writing data to tags, error correction and the handling of duplicate tag reads[2].

IV. DESIGN OF RFID READER

To design a RFID tagged object locator firstly RFID reader has to be designed. The various components required in order to design the RFID reader are :

1. Microcontroller MSP430f2370
2. Trans- Receiver IC: TRF7960
3. Voltage Regulator IC:7812
4. IC : MAX 3232

The general block diagram of RFID reader is as follows :

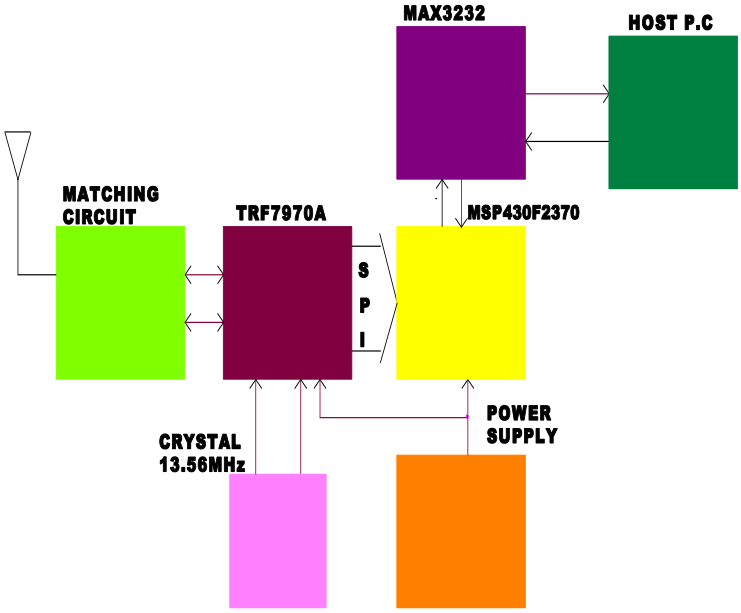

Fig 4 : Block Diagram of RFID Reader

There are various sections in the design of RFID reader as mentioned below:

4.1 Power Supply Section:

The input supply voltage is 24v D.C. It is converted into 12v by using voltage regulator IC 7812, which is used to drive the relay. This 12v are then converted into 5.0v by using IC 7805, which is used to drive the IC TRF 7960A. From VDD_X which is pin number 32 of TRF 7960 3.3volts are generated and given to the IC's MSP 430f2370 and the IC MAX 3232.

4.2 Antenna Matching Circuit :

It is designed in order to interface the antenna with the RFID reader. User can interface an external antenna with the reader having impedance from 4ohms to 50ohms.

4.3 Microcontroller MSP430f2370 :

The Texas Instruments MSP430 family of ultra low power microcontrollers consists of several devices featuring different sets of peripherals targeted for various applications. The architechture, combined with five low power modes is optimized to achieve extended battery life in portable measurement applications. The devices that feature powerful 16-bit RISC CPU 16-bit registers and constant generators contribute to maximum code efficiency. The digitally controlled oscillator(DCO) allows wake-up from low power modes to active mode in less than 1us.The MSp430f2370 is an ultra low power microcontroller with two built in 16-bit timers, one universal serial communication interface(USCI),a versatile analog comparator and 32 I/O pins.

4.4 Trans- Receiver IC: TRF7960A :

The TRF7960A is an integrated analog front end and data-framing device for a 13.56-MHz RFID and Near Field Communication system. Built-in programming options make it suitable for a wide range of applications for proximity and vicinity identification systems. It can perform in one of three modes: RFID and NFC Reader, NFC Peer, or in Card Emulation mode. Built-in user-configurable programming options make it suitable for a wide range of applications. The TRF7960A is configured by selecting the desired protocol in the control registers. Direct access to all control registers allows fine tuning of various reader parameters as needed.

V. WORKING OF RFID READER

The RFID reader is designed for shorter range (approx.10cm) is based on the Near field coupling mechanism. The EM field in the near-field region is reactive in nature-the electric and the magnetic fields are orthogonal and quasi-static. Depending upon the type of antenna, one field (such as the electric field for a dipole or magnetic field for a coil) dominates the other. A current flowing through the coil of a reader produces a magnetic field around it. This field causes a tag's coil in the vicinity to generate a small current. Communication between a reader and a tag is through a mechanism called load modulation. Any variation of the current in a tag's coil causes a small current variation in a reader's coil due to the mutual inductance between the two, and the variation is detected by reader. A tag varies the current by changing the load on its antenna coil, and hence the mechanism is called load modulation. Because of its simplicity, inductive coupling was initially adopted for passive RFID systems[4][5][7].

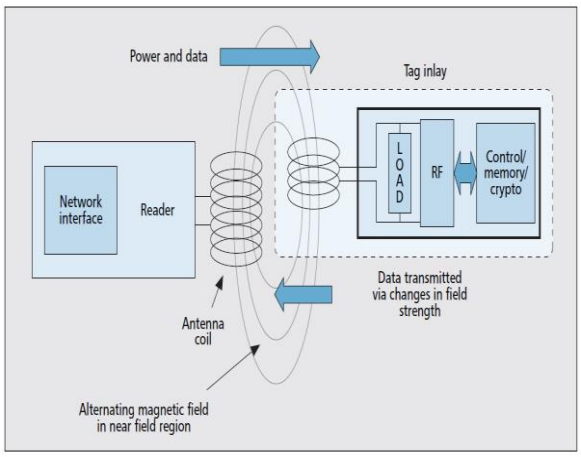

Fig 5 : Near field coupling mechanism[4]

VI. ADVANTAGES

i. Low power consumption.
ii. Output power Control 100mW or 200mW.
iii. Support for Interfacing an external antenna with impedance matching circuit of 4 ohms to 50 ohms.
iv. Support for tags based on ISO 14443A/B,ISO 15693.
v. JTAG interface for on board chip programming.
vi. Test points in order to analyse waveforms at various points in order to get the proper results.

Fig 6 : Photograph of Designed RFID Reader.

VII. RESULTS

In order to workout with the searching of the various objects, the RFID reader plays a very important role. To track the objects, the design of the RFID reader with the range of approximately 10cm has been completed. The RFID reader has been operated on 13.56 MHz and found good efficiency.

VIII. CONCLUSION AND FUTURE SCOPE

In order to implement the indoor location system based on RFID, the design of RFID reader for short range approximately 10cm is completed. In order to enhance the range the external antenna design is need to be developed. By designing the external antenna the range is increased and hence the

monitoring of small areas can be done easily. Thus, this approach is very cost effective and advantageous as compared to other tracking systems.

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AUTHORS

Shailesh D. Rokade, has received the B.E. Electronics and Tele-communication from Sant Gadgebaba Amravati university, Amravati May 2011, He is pursuing M.TECH-II in Electronics & Telecommunication Engineering from Symbiosis International University; Pune, India. His research interests includes RFID applications & Embedded system design.

Swati U. Kadlag, Has received the Diploma Electronics from Mumbai University 1999, B.E Electronics from Pune University 2009, M.E Electronics from Shivaji University 2011. She has Overall 10 years of experience in teaching at degree level in various engineering and Technology Institutes of repute. Currently she is Faculty at Symbiosis Institute of Technology, Pune. Her research includes Application of RFID, Image processing applied to toll plaza and check post, Mobile adhoc networks, optical network design.