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Reviewing WSN with RFID

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Abstract— Wireless Sensor Networks are being used in environment that was impossible earlier. WSNs are applicable in battlefield monitoring, underwater deployment and vehicle tracking. Applications areas and security features can be expanded many folds by integrating WSNs and RFID technology. The tracking network is being explored further with these new emerging technologies. This integrated technology enhances secure way to electronically follow an object. To make such tracking network RFID readers are experimented with Freescale Zigbee boards. This network would be able to track unique object passing nearby to the readers.

Keywords — RFID, RFID Tags, WSN, RS232, Tracking Network

I. INTRODUCTION

In recent years the use of monitoring items has augmented to help in all walk of lives. Their areas of applications will increase further as the technology is being explored to enhance manufacturing. Wireless Sensor Networks (WSNs) is a technology that allows monitoring to take place in competent and non-disruptive ways. They do not need putting wires for power or communication. They are cheaper and easier to install in existing developments, and also allow users to set up networks in areas without established power sources. On the other hand a Radio Frequency Identification (RFID) technology allows items to be tagged with electronic ID numbers that can be read or sensed via radio waves. In this study, we experimented the mixture of these two technologies for the intention of making a resource tracking system.

II. BACKGROUND

RFID is a growing field as it allows the unique identification of an object via radio waves, where the tag itself does not need to be visible or touched. Wireless Sensor Networks are a broad area in that they have potential in research, both in the study of WSNs and the things they can record and sense, but also in commercial applications.

A. WHAT IS WIRLESS SENSOR NETWROK?

The Wireless Sensor Network (WSN) consists of small battery powered by devices. WSNs can measure t movement, pressure, temperature etc. Basically this sensing device works in real time environment.

Wireless Sensor Networks are having varirty of applications. Which were not possible earlier. Some areas of applications are battlefield monitoring, wildlife monitoring, underwater deployment and vehicle tracking. Recent developments in the area of information technology are competent of providing security to network. WSNs have been benefitted up to limited extent. These sensors are exclusive in nature because they own limited resources, still they are being deployed in the situations where highest security is required. Research has proved that WSNs have a large number of security threats. In such scenario the importance of a security protocol for WSN plays a vital role. As the technology improves, and different approaches are explored, more efficient power saving algorithms and hardware have been developed [1].

B. WHAT IS RADIO FREQUENCY IDENTIFICATION?

Radio Frequency Identification - RFID system is one of the most challenging devices in recent years. The primary goal of RFID technology is to automatically identify objects that are contained in electromagnetic fields. RFID tags do not require physical contact for identification. This allows objects to be read in large numbers without physically handling the objects. Most RFID systems contain small and inexpensive passive tags in which it derives its power from the signal.

RFID has the potential to replace the bar code systems. It can also be used to differentiate original and duplicate product. There are large number of applications areas such as product supply chains, tracking, airline baggage, road toll management, access of hotel rooms and so on. In order to promote RFID technology there must

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be a drastic reduction in RFID tags. Sometimes it is quite difficult to manage because price of RFID has been more than the product. [2]. To overcome security related problems associated with low-cost RFID systems, a large number of authentication protocols were proposed. However, these protocols would not satisfy the RFID security requirements and operational requirements. As per the experts' knowledge, there is no published authentication protocol that facilitates successfully on security and operational requirements.

RFID technology had been used since World War II to identify enemy aircrafts, still being used today. [2]. This technology was selected because early radar could identify an aircraft, but could not establish to whom it belongs. In this situation RFID signal can be emitted and if the genuine response was returned the plane was considered friendly. The use of RFID has increased by the Government of United America in the year of 1960's when they started to tag and sense nuclear and other dangerous materials. In 1972 the use of RFID was commercialized for access control applications, which coincidently was also the same year the UPC was introduced and the use of bar codes took off [2]. RFID technology has been developed over the years since its introduction to now where there are applications for RFID in manufacturing, distribution & inventory, retail, document tracking, security, and healthcare, to name a few. These are further being developed to allow the realization of intelligent items that will recognize one another from their ID and have the ability to interact through various protocols, some of which have already been developed [3]. The application of RFID in tracking items has also begun to be realized in several different applications such as library media management. Over 130 libraries in North America including the Santa Clara City Library of California, the University of Nevada, Las Vegas Library, and the Eugene, Oregon Library have equipped the entirety of their collections with RFID tags [4]. However the deployment of RFID within the library is mostly for inventory management, to register if a specific book is checked out and leaves the library, and when it returns and is checked back in. There are many similar products available, but they do not track the location of an object on a real-time basis, but instead on an event-driven schedule.

C. TRACKING VIA RADIO FREQUENCY IDENTIFICATION TAGS

Presently RFID tagged products can be sensed through a reader. In real-time environment it is bit different as it doesn't supply the findings directly to the users, but it operates in the background to store information and retrieving later. A perfect tracking network is one that operates in such a way that is inconspicuous to those using it. For example a user's keys are attached to a RFID tag. When the user enters his house the tag is read and its last known time and location of sighting is logged on a database. As the user roams in the house the key's tag is read at different positions and locations and hence database is updated. If the user loses his keys, the database will tell the user about the keys were last detected by the network. (See Figure 1)

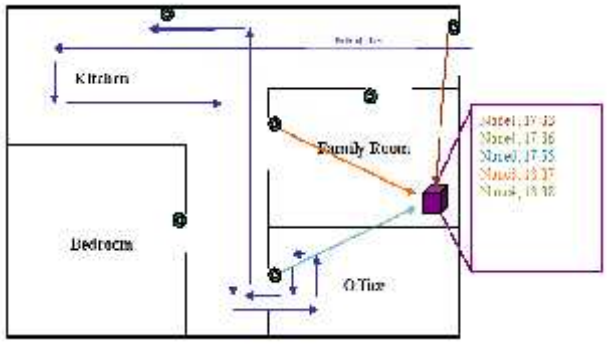

Figure 1: Example Tracking Network

II. DESIGHNING TECHNIQUES

The combinations of RFID technology with WSNs allows the advantages of both technologies to be fully employed. WSN will be developed to gather sensor data on the RFID tags it reads by integrating wireless node and RFID reader circuit. The main advantage is that it is easily to install. The benefit of using RFID as a method to track items as opposed to motion sensors or other optical sensors is that objects of interest will be distinguished from one another so many items can be tracked within an environment.

Freescale's Zigbee developed a kit MC13192 it allows simple setup of a wireless network among the nodes. The setup ensures the IEEE 802.15.4 standard. Higher frequencies can be used and main advantage is the possible communication range of 150-375 feet indoors and greater range outdoors.

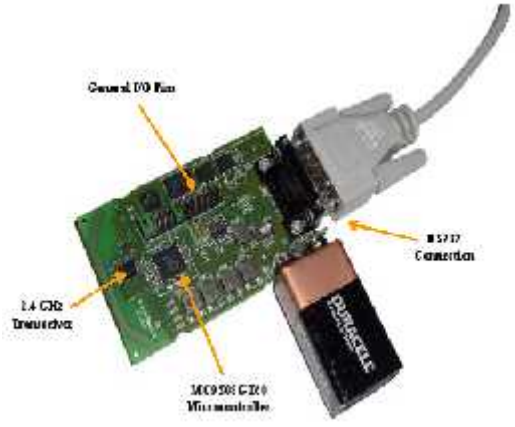

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Figure 2: Freescale Zigbee MC13192 Development Board

The RFID technology chosen was a development kit purchased from Custom Computer Services, Inc. The EM4095 RFID reader provided with the kit operates in the 125 kHz band allowing a tag within several inches or feet to be read, depending on the style of tag. It is important to note where an application requires the tag be placed. In the example network the proposed location is on a key ring somewhere on the user. A problem arises when a tag is placed near metal and/or water due to a lessened electric field[5], however using lower frequencies partially alleviates this issue, thus allowing the tag to be placed in the vicinity of metal and/or water, and still function. It is also important that the reader and the wireless nodes do not operate on the same frequency as they may interfere with one another. The selected frequency is advantageous for this reason as well.

The reader collects data as dictated by the onboard PIC16F876A and sends this data to connected hardware via a RS485 to RS232 converting board, allowing information to be read from its serial port. The tags selected for use were also provided with the kit. These EM4102 tags are read-only, with 64bit memory fields broken up into a header, a 40bit data field for customer ID and tag ID, and several other fields for parity checks. Tags with larger read ranges and different memory capabilities could easily be incorporated into a tracking network; however the ones chosen were adequate for this development of this network.

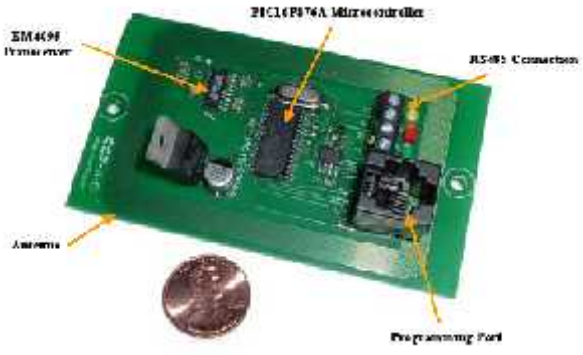

Figure 3: CCS RFID Reader Development Board

A. PROGRAMMING RFID READERS

Software designed for a separately functioning RFID reader, that is, one utilizing its own microcontroller, needs to take into account the layout of the data fields on the tag it wishes to read. Depending on the application, a tag may require more memory for storage of data, or may only need a few bits to distinguish itself. The tag may also have error detection build in, in the form of parity bits, to aid in determining if the packet was received correctly. There is also the situation of read/write tags which allow the user to edit the information stored on the tag, sometimes this is used in conjunction with password protection to prevent unwanted access to the information stored on the tag. As these features may or may not be present, the software for the reader will need to be specialized for that type of tag, or those types of tags in the case of heterogeneous tag usage.

Customer ID	Tag ID	Tag ID	Tag ID	Tag ID

Figure 4: Structure of data field for EM4102 tag

In the case of the example network the PIC C Integrated Development Environment (IDE) included with the RFID development kit was used to program the RFID reader to collect data in the desired format. The data fields of the tag can be seen in Figure 4, with the Customer ID accounting for 8 bits of the data field, and the remaining 32 bits being reserved for the Tag ID, allowing over 4 million unique ID numbers. The tag is read using the functionality provided by a driver included in the IDE for the EM4102 tag. The reader detects a tag by querying for a tag within range, when a response is generated the reader listens until it has heard nine consecutive 1's signifying the presence of the desired tag type. It then listens to the data transmitted and decodes it by parsing the data until 40 data bits and 10 parity bits have been found. When a cycle of querying has been done the driver returns a 1 bit integer to the calling program signifying if it was successful or not in finding a tag.

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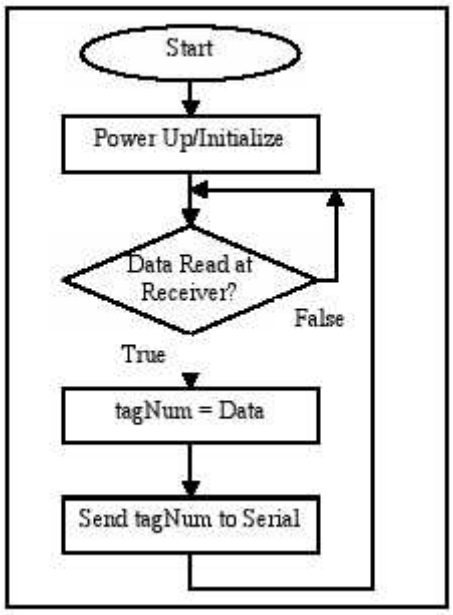

Figure 5: Flow Chart for Reader Software

For the example network a simple program was written to collect data from the tag ID fields and send it over the RS232 connection. The logic for this program can be seen in Figure 5. The software for the reader simply cycles through the program checking if a tag has been read, and relaying information when it has collected some. This code was written to simplify the data processing that would need to be done by the wireless node to which it would be connected.

B. SOFTWARE FOR THE WSNS

Software development for the network is truly the most important part, as it determines its functionality, efficiency in data collection, and lifetime assuming it is operating off a limited power source. These parameters dictate appropriate power saving techniques be used in addition to effective programming. If data needs to be collected more often by the nodes, efficient power usage will be paramount. However if data only needs to collected when a certain event occurs, the focus can be more directed at reliably recognizing that event. These issues must be considered in a tracking network because if nodes are powered down often and there is an abundance of tags in the environment there will be many sightings that will need to be declared to the base node. The same is also true if the nodes are awake for longer periods and there are few objects to be observed. Simply put, it is important to understand the environment and to adapt to changes.

The software development for the example network proved to be much more involved that that of the reader because of its multipurpose usability. Initially the boards were programmed to read data from the general purpose I/O pins, however because data needed to be received from the reader via a serial connection the software needed to be adjusted to collect information from its serial port. In addition, the baud rate at which the serial port of the boards operated at needed to be changed so that it could communicate with the readers which operated at a baud rate of 9600. Effective software for the sensor nodes was not developed as part of this project as it was not the main focus of the research.

C. INTEGRATING HARDWARE

During the development phase of a network such as this, existing hardware can be used to create and test the concept. Once this has been completed a single piece of hardware can be created which would integrate the previous components, removing need for extraneous connections. However during development hardware needs to be programmed to function with other hardware it was not originally intended for. This may prove to be simple or more difficult depending on the hardware selected. For the example network, hardware was purchased which would allow the two boards to be connected via their serial ports. Software was developed for the RFID Reader board that would transmit its collected information over this serial connection to any hardware attached.

A WSN with RFID reading capabilities is not that far beyond creating a WSN to sense temperature, the main difference being what is sensed. In fact the difference between an active RFID tag enabled with sensors and a wireless node with sensors is rather small [6]. A single piece of hardware could be created to include all the functionality of an RFID reader and wireless sensor node. As well a RFID reader could be packaged as an external node and added to existing wireless sensor nodes like a sensor.

IV. RELATED WORK

Tracking of objects is a possible application for both WSN and RFID technology separately. RFID has been used in the past for event tracking of objects. One of the earliest uses was the tracking of tagged fish passing through dams on the Colorado river [2]. Object tracking has been explored as well with various methods involving infrared, ultrasonic, and RFID. One such application developed an Ultrasonic Sensor-driven Position System (USPS) which they deployed within a building[7]. This network operates by the user carrying a transponder which emits ultrasonic waves on

demand, and sensors deployed through the structure calculate their distance from the transponder. This allows objects to be found within a range of 1cm accuracy. The drawback of this method is that at least 3 sensors must recognize the presence of the transponder in order to locate it.

V. SECURITY

Many things are to be considered when an object tracking network is being installed Such as security and privacy of users. The main area of concern is controlling unauthorized access. Application of this technology is important in medical where individual privacy is of immense importance. When a patient's personal information is saved electronically, a most secure system must be placed for example public-Key infrastructure [8].

VI. CONCLUSION AND FUTURE WORK

WSN and RFID technology is a challenge. Both these technologies will penetrate in the day to day scenario. The commercial usage of RFID is increasing many folds. In future it will replace bar code use within a decade [9]. This type of deployment, RFID tagged items will be available everywhere allowing the tracking of material for various reasons and purposes. Further, WSNs are also being designed for a bulky range of applications.

Tracking network is being proved more challenging than expectations. The knowledge and experience achieved through the development and research of such a network was a giant contribution. This is an area of overwhelming concerns.

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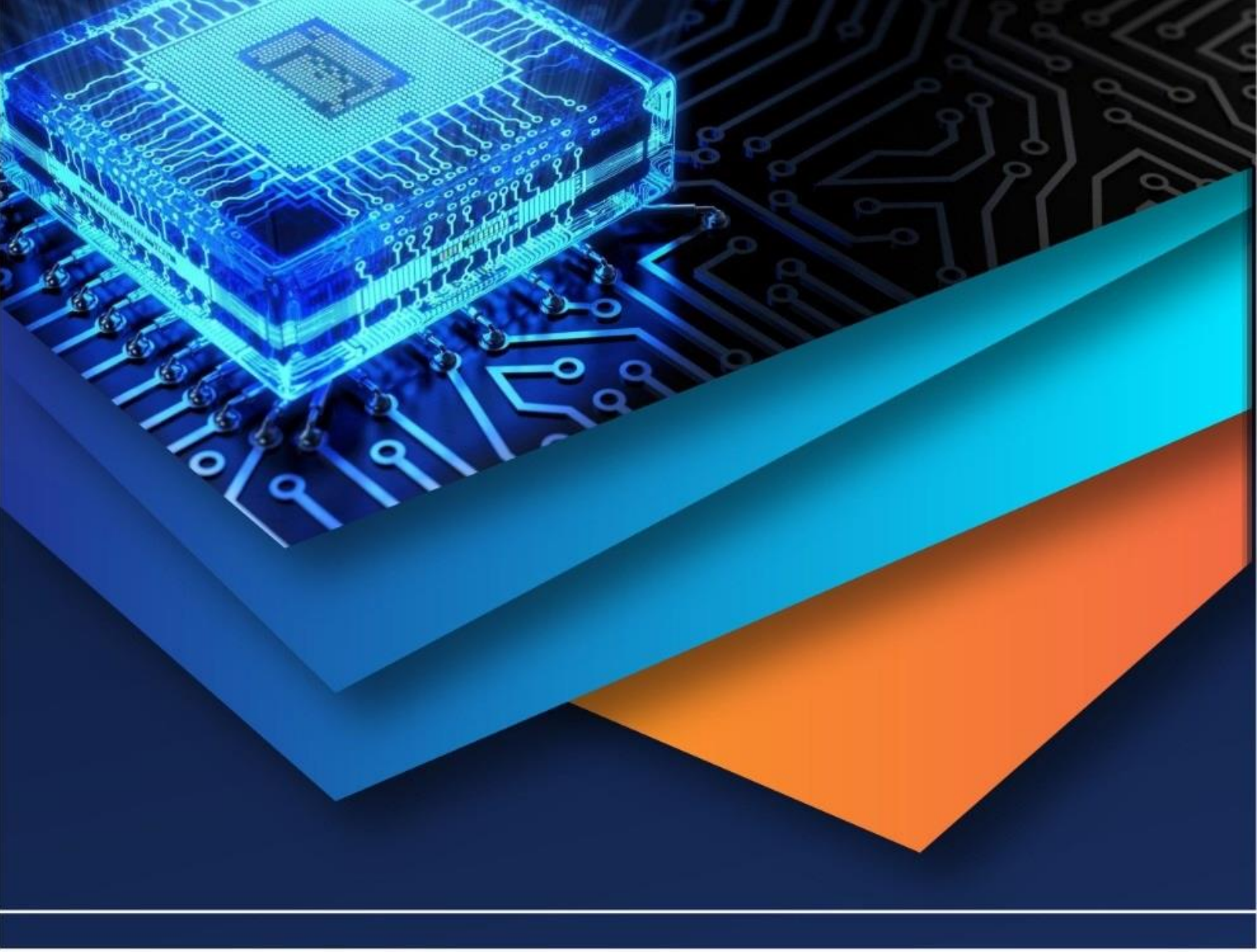

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