# DESIGN OF WIRELESS SENSOR NETWORKS FOR PILGRIMS TRACKING AND MONITORING

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**Abstract:** At present, there are so many problems regarding the crowd control, medical emergencies, security issues, identification and tracking of the pilgrims in the holy areas. Especially during pilgrimage, the pilgrimage authority finds it difficult to manage the situation. The technologies implemented in Saudi Arabia during Hajj pilgrimage to reduce these types of problems were not so effective in solving these problems. This paper deals with RFID technology which describes the design and implementation of a system for tracking and monitoring the pilgrims. The system consists of transmitting and receiving sections. The pilgrims will have the RFID tag. The transmitting section consists of RFID reader, microcontroller and zigbee transceiver. Every pilgrim will have a unique ID. The transmitting unit will send the current location and unique ID to the server unit using zigbee transceiver. The receiver unit consists of zigbee transceiver, external EEPROM unit and microcontroller unit. The received location and unique ID will be stored into the external EEPROM periodically. A heart beat sensing unit is connected to the transmitting section to monitor the medical condition in case of emergency. The pilgrims can be thus tracked and sent the medical assistance in no time.

Keywords: Radio Frequency Identification (RFID), Zigbee, EEPROM Unit, RFID tag, RFID reader, medical assistance

#### **1. INTRODUCTION**

Wireless communications has emerged as one of the largest sectors of telecommunication industry, evolving from a niche business in the last decade to one of the most promising areas for growth in the 21stcentury[1][9]. As an emerging technology, WSN(Wireless Sensor Networks) have lot of applications like health, security, military and several other in various domains. Object tracking, which is also called target tracking, is a major field of research in WSNs and has many real-life applications such as wild life monitoring, security applications for buildings and compounds to prevent intrusion or trespassing, and international border monitoring for illegal crossings. Furthermore, object tracking is considered one of the most demanding applications in WSN due to its application requirement [6].As the number of pilgrims visiting holy places has been increased, the problems faced by the pilgrims also increased.

The following are some of the common difficulties faced by the pilgrims and the authorities alike:

- Identification of pilgrims.
- Medical emergencies.

- Guiding lost pilgrims to their camps.
- Crowd control.

A description of ubiquitous technologies including RFID tags and scanning devices are available and can be effectively used in monitoring and managing movements of people .The growing number of pilgrims has brought serious safety and health care challenges to the authorities. These pilgrims are from diverse background, social status, gender and ages. RFID is fast and reliable. It is a technology used to identify tagged objects using radio frequency mainly composed of an electronic tag attached to the object[10].Radio Frequency Identification(RFID) technology has emerged as a practical solution to aid automatic object identification and tracking .These wireless system enable non-contact reading from a distance and their deployment is highly effective in manufacturing and other hostile environments where the employment of bar code labels was infeasible.Being a non-line-of-sight technology,RFID triumphs over the bar code labels for tracking mobile objects because they can be read regardless of their orientation[5].

#### 2. RELATED WORK

There has been quite a number of tracking and monitoring systems being developed, each of its own various means and facilities and has their own way in increasing the effectiveness of the system.

Most researches in the area of tracking systems was conducted a few years ago using dedicated GPS as trackers [12]. Wide range of these systems were used in tracking vehicles. Some of these systems uses short range message service to send locationdata from GPS receiver to monitoring side. Other systems used general packet radio service (GPRS) for the same purpose. After the wide spread use of mobile phones with embedded GPS receivers; several researches proposed the usage of smart phone with GPS receiver for tracking purposes. The system considered the usage of mobile phone with embedded GPS receiver or dedicated GPS devices with small size keychain patterns as trackers. This feature makes the system flexible because users who already have smart phone don't need to rent the tracker. All what they need is to install the application on their smart phone [3]. Many researchers avoid use of dedicated GPS devices because of cost issue. The researchers proposed a pilgrim locator system, where they suggest building special networked antennas to locate the pilgrims. The main objective of the system was to solve the crowding problem using antennas [3]. Likewise transportation control is also a main issue in crowded areas. There is an integrated solution to the problem of pilgrimage transportation control while tracking the shuttle bus from its starting point till its final destination .The application identifies a particular bus by the RFID tag fixed on it. The passengers boarding or getting down the bus are identified on the basis of RFID cards they have and finger identification [11]. One of the most widely recognized is the tracking via RFID chips. Another approach is by having object recognition where a picture, usually a landmark, is taken, using a built-in camera in any common mobile phone ,to identify their location based on the picture taken. It also used the GPS to read the actual position if available and if the data cannot be obtained, it uses an approximate estimation of the cell information of the phone -network provider. As good as the system might get, it relies solely on Internet connectivity [4].

Another approach is by implementing a low cost tracking system using GPS and GPRS. The system allows a user to view the present and past positions

recorded of a target object on the Google Maps through internet. It reads the current position of the object using GPS, the data is sent via GPRS service from the GSM network towards a web server. It also argues that using SMS as a means of communication with the server is expensive. The other approach for tracking and monitoring system, every pilgrim is given a mobile sensor unit that includes a GPS unit, a microcontroller, antennas and a battery. A network of fixed master units are installed in the holy area. Upon request or periodically, the sensor unit sends its UID(User Identification)number, latitude, longitude and time[4]. The close by master unit receives the information and passes it to a server that maps thelatitude and longitude information on a Google Map or any geographical information system.

All the above discussed approaches provide a means of tracking the pilgrims. In this paper, RFID technology is used to track and monitor the pilgrims in which every pilgrim will be given an RFID tag and readers are used to read the tags, including the need of urgent medical service.

# 3. PROPOSED SYSTEM USING RFID TECHNOLOGY

Even though many projects have been done based on the specified technology, this paper is presented with an advantage. The growing number of pilgrims has bought serious safety and health care challenges. In the proposed system, a heartbeat monitoring system is attached to the pilgrim's side. The main objective is to provide the medical assistance in no time.

Radio Frequency Identification usually incorporates a tag into an object for the purpose of identification using radio signals. RFID based localization and tracking technologies may include tag based, reader based etc. These technologies mainly use the readily available resource of radio signal strength information to localize the target objects. The challenges include multipath propagation, interference and localizing objects among others [7]. The continued increase in the number of pilgrims causes many problems such as overcrowding which results in delaying a large number of pilgrims at the main ports. Many people may get lost, especially elders, which adds to the burden of authorities to search for them. Health authorities are also facing difficulty to know the health status of the patient pilgrims when there is no document showing the health status and disease they suffered[2].Cases of missing Hajj pilgrims are not uncommon although several tracking and navigation devices have been introduced. Such a framework for tracking pilgrims in a crowded environment is the Hajj Locator [8].A typical RFID system is shown in figure 1



# Figure 1. Typical RFID System

# **3.1.**Components of the proposed system *3.1.1RFID Tag*:

An RFID Tag is a tiny silicon microchip composed of anantenna, a wireless transducer and an encapsulating material.It contains the unique ID of the pilgrims and whenever the tag detects a reader, it transmits the information stored in it to the RFID reader in wireless mode.The components of RFID tar is shown in figure 2.



Figure 2: Components of RFID Tag

# 3.1.2 RFID Reader:

An RFID Reader is an electronic device used to generate and receive RF signals. It can have various capabilities including reading and writing data to tags. These readers have to be deployed in every place where the pilgrims need to be monitored.

#### 3.1.3 Heart Beat Monitoring System:

This unit detects the heartbeat of a pilgrim and stores the best pulse in the RFID card. The heart beat sensor generates the digital pulses which corresponds to pilgrims' heartbeat. By using external interrupt in PIC, the pulse is counted and written to the RFID tag.

#### 3.1.4 Microcontroller:

The microcontroller is the main part of our system. It transmits the pilgrims' unique ID and heart beat through zigbee. In this project, the hardware is modeled to process multiple pilgrims' medical status. The controller will prioritize the data transmission according to the receiving heart beat values of pilgrims.

# 3.1.5 Server Unit:

The server unit receives the pilgrims information via zigbee and show that to PC using RS232 connection.

# 3.1.6 Zigbee Module:

Zigbee unit is used to transmit the reader information to the server.

# 3.2 Block diagram:

The block diagram can be described as three units namely: Pilgrim's unit, Readers unit and Server unit. Pilgrims section consists the heart beat monitoring system. The block diagram of the pilgrims unit is shown in figure 3.



#### Figure 3.Block Diagram of Pilgrims unit

The PIC microcontroller will continuously send the read command to the reader to collect the pilgrims

information. The block diagram of the readers unit is shown in figure 4.



Figure 4: Block Diagram of the Readers Unit

In the server side,Zigbee will receive the pilgrims information along with heart beat.Here an alarm can also be used as an indicator.The block diagram of the server unit is shown in figure 5.



Figure 5: Block Diagram of the Server Unit

# 4. SIMULATION

The flowchart for simulation is shown in figure 6. Since the project is based on wireless mode, the design environment used here is Network Simulator 2. The simulation process is carried out by Ubuntu OS.NS2 core uses many packages and optional software .Tools like Xgraph is used for graphical plotting and other one is network animator. The simulation scripts are written in OTcl language, an extension of the Tcl scripting language. According to the requirement, the network designer designs the network using the simulator on the basis of topology and network traffic. NAM (Network Animator) is an animation tool for viewing network simulation traces. The trace file is usually created by NS. Once it is created, NAM can be used to animate it. NAM visually shows the topological design of the simulation network as output and also displays the communication between the nodes as representing the exchange of packets between the nodes. The traffic can be monitored by the designer using the analyzing tools which shows the position of the network at different times in accordance to the real time simulation.



#### Figure 6: Flowchart of the Simulation Process

The flowchart explains the various steps through which the entire simulation is carried out. Initially the process is started. The nodes (consider as pilgrims) are created and configured. The nodes then moves out and at certain point, they form clusters assigned with specific energy levels. The nodes are separated. It is then checked that whether a node possess different energy level other than the created clusters. If so, a connection is established and signal is transmitted to the base station. Thus the required help can be made available. If not, the simulation is stopped. Number of nodes and the level of hierarchy are defined using different set of parameters by these libraries.

# 5. RESULTS

The output of the simulation is obtained through various stages. The simulation includes a number of

nodes and base station. Figure 7.1 represents the random movement of nodes.



#### Figure 7(a): Random Movement of Nodes

On reaching certain stages, the nodes are indicated with various colors. This corresponds to different energy levels. The isolated node, which is represented in white, act as the victim. Figure 7.2 represents the grouping of nodes into clusters.



#### Figure 7(b): Node Grouped into Clusters

At the final stage, the node transmits the signal to the base station. The window in which the output is obtained is named as network animator window. Figure 7.3 represents the nodes transmitting signal. The signal transmission indicates that the pilgrim is in need of help which enables to send the necessary aid.



#### Figure 7(c): Nodes Transmitting Signal

#### 6. CONCLUSION

Tracking and monitoring of individuals in a large group is a very complex task. It becomes even tough when hundreds of languages, traditions and beliefs are involved. Many difficulties may occur due to such a situation. Especially during pilgrimage, crowd control, health and security issues rise to an optimum point. Most of these problems can be solved with the help of those technological means which are acceptable in society. There is no reason for employing these technologies to solve current issues of human sufferings. Even though provisions exist, the security systems lapse due to people's sectarian perceptions or ignorance.

There are many works related with RFID technology which has helped in tracking. Apart from tracking, the proposed system has a great advantage. It presents an option for a pilgrim in case of medical emergency. The developed system automatically monitors the body conditions of the pilgrim under pressure which helps in getting medical aid in no time. Thus the system can satisfy the need of pilgrim without any objection.

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