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A Review on Radio Frequency Based Navigation and Management System for KUMBH

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Abstract - KUMBH is the largest gathering of humanity on the planet. The *KUMBH* is an ancient pilgrimage festival that happens four times every twelve years at four different locations in India. It attracts 10's of millions over six to eight weeks to take bathe in a sacred river. *KUMBH* covers a large amount of area with huge crowd. In this type of crowd, pilgrim may miss their relatives and friends which become more complicated to find their location within the *KUMBH*. If Pilgrims sometimes needs emergency services like medical service then it requires some extra time to manually inform about an emergency to the authority. Pilgrims are from different regions of the country, so they require the proper information and location of the temples, rivers, hotels, etc. which are sometime unknown to them. Solution to these types of problem can be achieved by using technical approach. We are using passive RFID embedded wrist band to track the pilgrim within the *KUMBH*. Keeping the track of each pilgrim can be useful for locating the pilgrim. Pilgrim can inform about the emergency immediately using the radio frequency band available on his/her hand. Important places can be located using the application in the smart-phone like android attached with open source Map.

Keywords - *Radio Frequency; Android application; Emergency services; OSM (Open Street Map); Web services; Location based services; Crowd Management.*

1. Introduction

Crowd management becomes more complicated task when it is about managing the crowd of human being [1]. *KUMBH* is one of them which is India's largest fair event celebrated at several places like Nasik, Allahabad, Haridwar and Ujjain. This event is celebrated by Indian pilgrims and directly leads to huge crowd about 3 to 4 millions. Managing such a crowd is just more than a tedious task. Common problems in the crowd are missing of peoples from their relatives and friends, asking for emergency services, finding important static places and some more. These problems are mostly faced in *KUMBH* event. Emergency services like medical service cannot be notified immediately, also finding the important static places requires more time for the new comers. These problems can be solved manually by other peoples in the management section. But, this approach is not that much convenient because it requires a lot of human effort which is not possible. System with technical efforts can be made to take care of crowd management system. The system used here is real time tracking of each pilgrim using RFID system. RFID is Radio Frequency Identification system. Pilgrim is allowed to wear a wrist band which contains the passive RFID tag. Radio frequency receiver is located at every 80 meter on the road side from where the pilgrim will pass. Each radio frequency receiver is having aliased name depending on the location name where it is situated. Pilgrim's band will transmit the pilgrim's ID towards the road sided RFID receiver. This ID is then indirectly written to the database by the road sided receiver with the Timestamp and the pilgrim's location is update with the aliased name of the road sided radio frequency identification receiver. The database will consist of all pilgrims' recent location which will help the client to track the pilgrim's location using the web-services. The web-service is integrated into system for the client because web-service provides the GUI (Graphical User Interface) which can help the client to view the user information in more clear way. The system is also consisting of emergency services. These emergency services can be triggered if there are unwanted events like fire, rumor, etc. occurred.

The system is also providing the solution for new comers to the *KUMBH* for finding the important static places like temple, hotels, etc. This solution is implemented on Android operating system. However, any person from the pilgrim's family with smart phone can have Android Application installed on it. This application will consist of the offline OSM (Open Street Map) will show the important places highlighted within the OSM (Open Street Map) in the application. This application will be offline so there will be no need for internet connection on the Android smart phone.

2. Related Work

Traditional crowd management system implies lots of human efforts. It ultimately leads to the problem of

managing resources like economical and ecological resources. Now days, there are many state of art technology which can help us to solve the crowd management issues without stress. Some of states of art technologies are LBS (Location Based Services), RFID (Radio Frequency Identification), Web Services, Cloud Services, Mobile Computing and much more[1].

Some of these states of art technologies can be integrated to build up a superior expert system for crowd management. Each and every technology has its advantages and disadvantages. While integrating we should focus on the advantages issues. Here we have explained LBS and RFID.

2.1 RFID System

Till now, with the grown popularity of the RFID system, many researchers have utilized RFID system in order to provide the localization services [2]. Radio Frequency Identification (RFID) has been used in object tracking, supply-chain management and inventory management system on the large scale [3], [4]. A significant amount of work is performed in the field of RFID system. Finding location of the object (living and non-living) is one of the important task performed using RFID system. RFID system is the tag identification [5] system and hence object localization is possible using this technology (RFID system). RFID tags are normally used with attached to object [6]. RFID based localization can be categorized into *tag-localization* and *reader localization* [2]. In *tag localization*, object holds the RFID tag and one of the readers from the distributed readers identifies the tag and updates the location of the object near the reader at the server [1]. In reader *localization*, moving object is attached with RFID reader and reader identifies the tag from the distributed tag within the environment and then read the location data from the tag [7], [8]. These are some ways in which the object is located using RFID system. R. E. Wagner and Matthew Whiting [9] propose the system for fiber optic cabling component location tracking and connectivity of cabling infrastructure. The propose system is based on RFID system. Using the RFID tag, network operators are able to automatically track the location of cable component in real time.

Wei Cheng and Xiuzhen Cheng [8], propose a RFID assisted navigation system for vanets. This navigation system act as an alternative to the GPS navigation system, when GPS is unavailable. The propose system is for the lane level navigation. RFID-ANS (RFID-Assisted Navigation System) contains the RFID tags are deployed on the road and RFID reader is installed on the moving vehicle. The deployed RFID tags on the road stores the data for the navigation system. RFID reader when comes in contact with RFID tag, it reads the navigation data and hence provides the line navigation for vehicle. For the successful read of the tag, the read request from the vehicle is rescheduled by initiating the read attempt when they have entered into the new road segment or changed the road. The RFID tag is deployed in such a way that the reader reads one tag at a time and is capable to read the tag successfully. System is illustrated with an example of intersecting highways at the United States. In the example, data size of 64 bits and EM2333 chip is employed as the reader. It assumes that system needs the vehicle to successfully read a RFID tag once at every 60 feet.

Po Yang and Wenyan Wu [10] propose a sparse distribution approach for efficient object localization with RFID tag. The proposed scheme focuses on improving the localization precision of a passive RFID localization system. Po Yang and Wenyan Wu [10] also described the accuracy in passive RFID localization system related to RFID tag distribution. Localization accuracy, precision and efficiency are derived for the efficient localization of objects. Accuracy, the term defines the ability of system to find the minimum moving distance of the object and precision define how the system works consistently. In the experimental term, with reference to the grid pattern and tag distribution, accuracy is define as the distance between two grids and precision is defined as possible number of passive RFID tags detected at the boundary level of the RFID reader. Beyond this, the System reading efficiency (SRE) is also experimented and validated. The object whose location needs to be found is attached to the RFID readers, and multiple RFID passive tags are sparsely distributed on the floor which is used to get the location object. The RFID reader always reads the passive tag within its provided range. The tag's id and other data read by the RFID reader are converted to the some useful form of data which is then used to find the location of the reader (Object). The moving RFID reader is able to read the multiple RFID passive tags at a time at each multiple step.

It works on the localization algorithm which tends to find position of object using data received from the passive RFID tag. Since, the system uses the approach of the sparse distribution of the passive RFID tag; it uses a theoretical rule that as the new tag is found along the moving direction, new position of the RFID reader is found. Based on this rule, the sparse distribution of the passive RFID tag is used to locate the position of the object with reader when it reads the new tag.

2.2 Location Based Services (LBS)

Lots of research has been performed on location based services [11], [12], [13]. Over the past decades, a wide attention has been paid to mobile positioning system and advance development in wireless communication which made the LBSs more popular [14]. LBS are the services

which is dependent on the positional data [15]. A location-based service uses the GPS, A-GPS, Wi-Fi and other technologies to locate the position of the object [16], [17], [18]. In recent researches, a RFID has become an alternative to these technologies which can be used to locate the object [19], [17], [20], [7], [21], [22]. Shu Wang and Jungwon Min [16] explain the concept of Location Based Services (LBS). [16] Describes the GPS (Global Positioning System) that how GPS co-operate to find the location of the object (Humans and other objects). The basic view is that how the LBS can be achieved using wireless technology. The mobile network also explained how mobile network is used to locate its position on the globe. Also, OSM's (Open Street Map) integration with the GPS to provide the LBS is demonstrated.

Stefan Steiniger and Moritz Neun [23] focuses on GIS (Geographic Information System) and LBS. [23] describe LBS as a wireless-IP service which uses geographic information or data to serve the user or client. LBSs also act as information service accessible by the mobile user through mobile network to utilize the location of the mobile devices. LBS and GIS are related depending upon their similar features such as handling data with positional reference and spatial analysis functions. LBS service can answer the queries like *what is my location, what is nearby* or *how can I go to*. As reported by [23], an example of searching Chinese restaurant by mobile user is illustrated. The mobile first find its location via GPS or network position and then finds the Chinese restaurant and also roads and ways available to reach the restaurant. This way user is able to find the restaurant. [23] Discuss the capability of LB-services like *High performance, Scalable Architecture, Reliability, Real-Time Information, Mobility, Security and Interoperability*

Mike Hazas [24] elaborates that the sensing technology can be used as location-aware application in today's era. Accordingly, to provide the variable length location-aware applications, researchers are working with techniques for retrieving data from multiple sensors or base stations and drawing contextual information from local information. RF (Radio Frequency) infra-structure can be used to locate the object within the specified range like ultra wideband radio, infrared, TV signal, mobile phones, GPS, Bluetooth, Wi-Fi and more. Lots of location sensing system developed till now works on radio waves. Using the visibility of server (base station) and strength of the signal (radio waves), the location of the Wi-Fi-enabled devices can be found with the accuracy from several meters to tens of meters. Since Bluetooth is having shorter range than Wi-Fi, it can be used to find the more accurate location than Wi-Fi. But it requires more fixed base station to provide accurate positioning. Location of the objects can also be found using the RFID technology which works using Radio waves and identification terminology. Several ways of location sensing terminology is examined. Using mobile system, Cambridge positioning system has examined accuracy of 20 meters, whereas Rosum examined 3 to 25 meters with digital TV signal. Ultrasound can provide the distance between known points and mobile tags in the environment. Computer vision-system does not require the tag for the user and hence it has lot of difficulty in identifying the user and sometime tracks many users.

2.3 Crowd Management

Anand Kulkarni and David Rolnitzky [25] propose a quality based crowdsourcing architecture. The process in the system provides the way for the crowd members to how to solve the new task or problems. The system uses MobileWorks as crowd platform which is independent from the market place model which in cause provides the high accuracy and robust result using up to three technologies. The system is integrated with three system which are *dynamic work routine system*, *peer-management system* and *social interaction system*. Dynamic work-routine system finds the expert people from the crowd and then results in work completeness within a time given for the job. It also counts the wages for each people working for given job. The role of peer management system to find and prevent form the wrong answers. Social interaction techniques make the best worker to manage and teach other crowd peoples or members.

Claudio Martella and Maarten van Steen [26] presents a system approach to manage and study the crowd. It explains the crowd behavior when applied to the crowd of human beings. Every individual in the crowd shows its appearance using a device. This device gives the information to the infrastructure and depending upon the information suitable, set of algorithms is used to sense the dynamic crowd behavior. The system uses the proximity graph to show the crowd texture. The crowd is considered in terms of textures. Proximity graph shows the individuals as a node and the distance between the two peoples are shown using edges. Sensing an individual is done using radio wave technologies like GPS, RFID, Bluetooth and some more. Each individual is found in the crowd using its unique device identification. In a real-world experiment performed at railway platform. This experiment got 139 users wearing the device. Each user is present on their main track of interest. To communicate, the device is connected to ad-hoc wireless network. Due to correct architecture as described by the system, crowd is calculated on the platform. The crowed density in the train and density on the platform is measured. The measured density is used to guide the individual people towards the less crowded coaches.

Giuseppe Cardone [27] proposes a smart-phone based application for crowd sensing in urban areas. The smart-

phone application uses the open source solution called as MoST (Mobile Sensing Technology) API. The MoST is used for activity detection and geo-fencing. The sensor used in the Smart-phones is used to find the each individual in the crowd and hence results in crowd sensing. MCS (Mobile Crowd Sensing) also act as smart crowd management system. The proposed system also provides the geo-fencing, activity detection and geo-location. MoST is an important API used in the application which is used to collect, process and transmit raw sensed data and also used for level inferences like voice detection, physical activity and sleep pattern. Geo-fencing and geo-location is also supported by MoST API for MCS system. Activity detection has its own algorithm for automatically detecting the physical activities like cycling, walking, running or driving using the hardware such as accelerometer and gyroscope. The proposed system act as an alternative for the system implemented using the costly infrastructure investment.

2.4 Web-Services

Different approaches have been developed and services are implemented behind many researches. Researches engaged for web-services recommendation, web service search, falut-tolerant web-services [28], robust web-services [29], social web-services [30], location using web-services [31] and some more.

Juha Puttonen and Andrei Lobov [32] propose the approach for managing production systems using composition of semantic web-services. The approach consists of three services that help to achieve production target using domain web services. Three services used to maintain the semantic model for the current system state and a model to domain web services composition. Domains services are used to produce event notification to automatically update the system model. Using the semantic model, web services can be invoked automatically for the factory production. Xiuguo Zhang and Hongbo Liu [33] propose a model for interacting context-aware web-services. It is based on CAPN (context-aware process network. CAPN is extended and used to catch the contextual data from the external environment using kind of sensor processes to obtain the context-aware web services. The logical behavior of the model is explained by calculus of communicating system process. The model works using the behavior adapted and contextual-awareness. Model adapts the behavior and context dynamically and describes service changes and behavior.

3. Analysis

3.1 RFID Based Location Tracking

Compare to location tracking system via RFID system leads to both advantages and disadvantages.

- *Advantages*
  - RFID system works on Radio Waves, so it does not require the wire medium and hence reduces the wire complexity within the RFID system.
  - The RFID system uses the encryption for data stored in the tag which increases the security of the system.
  - RFID system works on unique identification, so there are no chances for tag conflict.
  - Now days, RFID system can read the multiple tags without collision.
  - It can be integrated into the environment where the radio wave is present.
  - Location of the object can be tracked using either *reader localization* or *tag localization.*
- *Disadvantages*
  - Lots of computation and algorithms are required in the RFID system to find the location of the tag attached to object.
  - Tag must be present within the reading range of the RFID reader, otherwise tag is not located by system.
  - Different kind of the architectures are required to find the accurate position of the tag.
  - Accuracy of the tag is not guaranteed.
  - RFID system cannot be used in the larger areas for tracking the peoples, because as the area increases, large number RFID reader is required which is sometime more economically heavy.

3.2 Location Based Services (LBS)

The purpose of the using location based services (LBS) is up to large extent. Using the LBS is some time useful but on other side if we consider all the technological, social and ethical issues then it has both positive and negative impacts.

- *Advantages*
  - LBS provide the location of the device requesting for the position.
  - Using the LBS, different types of object can be tracked.
  - The object can be navigated within the specified region or within the globe.
  - Now days, smart-phones contains the devices like GPS, Wi-Fi, etc. which provides the LBSs.
  - LBS can also show the nearby places.
  - Important static places can also be located by using LBSs.
  - LBS can be utilized for providing the emergency services.
  - It also plays an important role in crowd management by performing the crowd sensing.

- *Disadvantages*

  - Mostly GPS services lead the LBS which is sometime unavailable at covered places like indoor places, under trees, etc.
  - Security is not guaranteed by the LBSs
  - LBS consume more power when used in smart-phones and on other platforms.
  - Low internet speed affects the LBSs experience.

3.3 Web-Services

Web-services connect different applications and provide the data transfer between them. Web-services follow the standard protocol for communication. There are some pros and cons for web-services discussed below.

- *Advantages*

  - Service-oriented architecture (SOA) provides the services via its functionality.
  - Web-services are capable of consuming and producing large datasets.
  - REST (Representational State Transfer) API can be used to send and receive the data successfully via HTTP (Hyper Text Transfer Protocol).
  - Virtually, web-services are platform-independent.
  - Web-services are not component based model, which makes the easy to re-use the web-services component into other services.

- *Disadvantages*

  - In web-services, data transfer is challenging task.
  - REST API is not efficient for transferring the large datasets.
  - HTTP and HTTPS ate the stateless protocol, where server and client do not have of knowledge of each other when there is no data transfer between them.
  - Server works on session identification for the client to identify different clients. Client always needs to provide the identification to the server, which in turn needs more work to be performed by developers in the implementation process.

4. Conclusion

The state of art technology like RFID, LBS: GPS and A-GPS and Web Services can be used in many ways to implements the system for various problems day to day life. The problem of managing and controlling the issues of crowd is very typical task to perform. The crowd can be form at various places where humans gather at large quantity because of different causes.

The technologies reviewed in the paper can be integrated to solve the problems or issues caused due to the presence of crowd. The location of humans in the crowd can be tracked within the crowded zone when he/she is lost into the crowd. The location of the lost humans can be viewed on the web apps using web services.

The revision of RFID system is very important process because the RFID system gives the real time location of the human/people found within its zone/area. Current location of the pilgrim in the KUMBH is obtained using RFID system with integration to other technologies. Finding of pilgrim location is very important to provide him/her the emergency services like medical services. Pilgrim can also locate important places like temple, hospitals, hotels, etc using LBS: GPS and A-GPS.

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