

Crowd Management with RFID & Wireless Technologies

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Abstract

The recent spread of communicable diseases like swine flu, disasters like stampedes and ongoing security issues have made management of large crowded events more critical than ever before. Managing large crowds is a very complex, challenging and costly exercise. Many of the problems encountered in crowd management can be minimized by the use of RFID and other wireless technologies. These technologies are already being used in managing and administering many activities of daily life. However, the effectiveness of these technologies is yet to be tested for managing dense crowds and poses a challenge to the industry. The aim of this paper is to provide a management framework for large & dense crowds. The analysis of the technological framework is done with help of Hajj & Kumbh case studies. The research is industrial in nature and we hope that it would help the organizers of crowded events and law and order enforcement agencies.

1. Introduction

Many people die every year because of the poor organization of crowded events. Recently thousands of people have perished in fires and stampedes due to overcrowding and mismanagement. Overcrowding can be contained, and hence catastrophes can be prevented, by efficient crowd management using modern technology. Most of the crowded events are usually religious in nature and often involve simultaneous movement of very large groups of people. The risk of spread of communicable and contagious viruses and diseases such as swine flu, cholera, HIV Aids, Hepatitis has made crowd management more important than ever before. In addition, mismanaged crowds are also prone to stampedes, fires and other disasters and pose the problems in tracking and identification in case of emergencies when people are lost or require urgent medical care. An account of problems and solutions of

some of these situations and problems can be found in [15, 16 and 17]

Many of the sensor & wireless devices available today, including RFID can be used for efficient management crowd movements. However there are performance issues with these devices when it comes to tracking individuals in very dense crowds. A description of ubiquitous technologies including RFID, tags and scanning devices are available for example, see [3, 8], and can be effectively used in monitoring and managing movements of people.

In this paper we present and analyze a number of problems of crowd management and discuss some of the cost effective and realistic solutions to deal with the kinds of crowded events that are difficult to manage. The problems and their solutions are discussed in cases of Hajj, Kumbh and Badrinath Yatra but can also be applied for many other similar crowd management problems.

2. The Hajj Case Study

The Hajj case study is very interesting as it has a hugely complex set of activities and poses a challenge to their managers. The Hajj is an annual pilgrimage to Mecca and the surrounding areas in Saudi Arabia, whose details can be found in [5 and 6]. The Hajj is performed during 8-12 Zilhijja, an Arabic lunar month. Four to six million people, from various parts of the globe, perform Hajj every year. To enter the Hajj precinct known as Hejaz, one must have valid visa or, in case of the Saudi citizens, permission. Anyone outside Saudi Arabia intending to perform Hajj applies for a Hajj visa through travel agent in their country of residence by furnishing information and undergoing some medical examination and immunization. The Hajj visa is granted by Saudi government once the visa conditions are met including the approval of the Hajj management in Saudi Arabia. Once a Hajj visa granted, each pilgrim is assigned to a Hajj

Management group, known as Munazzim, who is responsible for organizing travel and accommodation in the Hejaz. The Munazzim groups are the official representatives of the National Hajj Committee, a wing of the Interior Ministry.

The foreign pilgrims are processed at Jeddah airport, which is about 90 KM from the Jeddah airport and is the nearest airport to Mecca. Currently there is only a road link between Jeddah and Mecca. Most of the pilgrims also visit Medina, a city which is about 400 KM from Jeddah and 450 KM from Mecca. After the immigration processing at Jeddah airport, the pilgrims are required to hand over their passports to their Munazzim and then they travel to their hotels in Mecca or Medina in the care of the Munazzim group.

On the 8th of Zilhijja, all pilgrims travel to, and spend the night in the tent city of Mina, which is about 20 KM from Mecca. On 9th of Zilhijja, all pilgrim travel to the Valley of Arafat Mountains, about 20 KM from Mina, and must stand there during some part of the day. Just after the sunset, all pilgrims must travel back to Mina by stopping and praying (during the night) at a hill town known as Muzdalifa. In the morning of 10th Zilhijja, all pilgrims in Mina perform certain rituals including symbolic stoning at sites of devils known as Jamarat, and travel to Mecca where they again perform some more rituals at the holy mosque and then return back to their tents at Mina. On 11th, pilgrims remain in Mina and perform a set of rituals and on 12th, after another set of rituals at Mina, the Hajj is completed and the pilgrims go back to their hotels in Mecca or Medina and prepare for their turn to travel back home. Once the overseas pilgrims are back at Jeddah airport, their passports are given back to them.

3. The Kumbh & Badrinath Yatra Cases

Kumbh is the largest gathering anywhere in the world, whose details can be found in [10 and 11]. It takes place every 12 years at the meet of the holy rivers in Allahabad, India. There are other smaller Kumbh events such as half or Ardh Kumbh organized at different locations in India. Unlike Hajj, Kumbh pilgrims mostly come from within the country and therefore do not require a visa (and hence do not furnish information to the Kumbh organizers). Although the Kumbh pilgrims are required to undergo some immunization before they can enter the Kumbh precinct but its implementation is very difficult due to huge influx & infiltration of pilgrims. The Kumbh, like the Hajj, also involves many rituals in which dense crowds move simultaneously.

The Badrinath Yatra, for example [4], takes place every year involving brisk & crowded climbing to the sacred sites in the foothills of Himalayas in India. Like Kumbh, there are no arrangements for collecting data of the pilgrims of Badrinath Yatra. There are many similar crowded religious gatherings at different temples and shrines like those of Vaishno Devi, for example [14], and Kamakhya temple, for example [9].

4. The issues in Crowd Management

During the intense crowded travel and rituals, as described in the Hajj and Kumbh cases, many pilgrims go on missing whereas others require urgent medical attention. Overcrowding often results in stampedes, not all of which are reported in the press due to safety and political reasons. The occurrence of traffic & human jams and hazards is frequent. The possibility of the spread of communicable viruses such as swine flu, bird flu, HIV, hepatitis is very high. There are security issues as well.

In order to provide a management framework, we need to be realistic as to what is critical, useful, manageable, feasible and economical for large and dense crowd management.

5. The Pilgrim Database

An absolutely essential aspect of any crowd management is to collect, analyze and organize data about the entities, including the finger, palm and retina, of the participants into a database using a distributive database management system (DBMS) capable of efficient searching through a large amount of data. Analytical methods of analyzing large and complex data can be efficiently done through Semantic Analysis, for example [18]. A prototype of a Semantic Temporal database for large crowd management would be reported elsewhere.

Acquisition of data of the Hajj pilgrims is easy and straightforward as most of the pilgrims furnish their data at the time of their visa application. However in the cases of Kumbh and other events like Badrinath Yatra, it would require institution of a new regime as the pilgrims currently there are no mechanisms in place to collect the pilgrim data. Once a database is available, it can be used to retrieve and disseminate information for the purpose of planning and administration of the event in conjunction with other wireless and sensor technology and tools. The historical data of the previous events can also be mined for better planning and organization of future events. An account of Hajj management may be found in [15, 16 and 17].

6. The Pilgrim Tracking & Identification

It is critical to track pilgrims for administrative and management purposes. Many organizations are using RFID chips to track and monitor people and products. For example, passports of all Malaysian nationals are RFID enabled, which leads to a very fast processing of Malaysian nationals at their airports. An account of the usage of RFID can be found in [13]. The RFID technology, for example [3 and 8], through sensor networks such as a GPS tracking device shown in Fig 1 can be used for tracking. The RFID chips are available in various sizes and strengths, for example see [2]. However if each person in a very dense crowd carries an RFID chip, tracking of individuals has accuracy and other performance issues, for example see [1]. Installing sensor networks for sensing and reading chips would have some serious economic considerations in cases of irregular events like Kumbh.

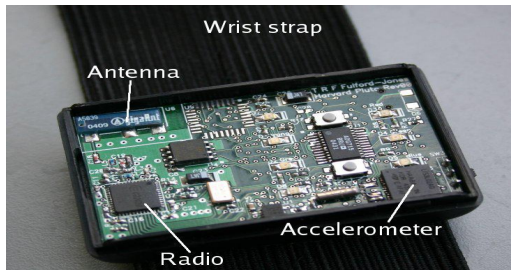


Fig 1 RFID tag

The RFID technology can however be used very effectively for identification purposes. A human readable ID coded RFIDs can be very effective in identifying, reporting and helping people requiring urgent attention – ordinary people can do effective reporting only if they can read the ID. These RFID would ideally carry some PDA, as shown in fig 2, readable data which can be used for medical emergencies and for uniting lost pilgrims with their wards or groups. The RFID device should be linked to the event database to facilitate the retrieval and updates as and when required



Fig 2: PDA

In addition to RFIDs, the human limb data stored in the database would help tracking and identification. Recently Saudi airports have installed finger and eye-lid scanners. However, the data collected from these devices is only used for the purpose of identifying those immigrants who overstay in the country. The use of this technology can be extended for the purpose of identification of pilgrims. The need for the identification of pilgrims was discussed in [17]. Similar identification mechanisms can be used by the managers of the Kumbh, Badrinath Yatra and other events once the problem of data acquisition is solved

7. Prevention of the spread of diseases

Recent outbreaks of H1N1 virus commonly known as swine influenza or swine flu and bird flu have made the crowd management more challenging. In order to check the spread of these other viruses such as HIV and hepatitis, each pilgrimage, be it Hajj or Kumbh should only be allowed for those who can undergo a comprehensive medical examination and provide their medical data, including that of immunizations, into the event database. This however isn't enough in the light of recent outbreaks of H1N1. A very strict monitoring and isolation of swine flu cases would be required. Moreover, pilgrims with HIV virus and Hepatitis B & C bacteria should be specially managed. The key to managing pilgrims with deadly viruses & diseases and preventing spread of communicable diseases is gathering the pilgrims' medical data and store it in the Pilgrim database. It is largely possible in case of Hajj but would require a lot of organization in cases of Kumbh and hundreds of other religious gatherings in India. If the medical data is organized in the backend database, it would also be simpler not only to deal with medical emergencies but also to identify badly mutilated bodies due to stampedes, fires and other disasters.

8. Conclusions

Organizing densely crowded events is very difficult, especially when religious perceptions are taken into consideration. However the catastrophes and stampedes like the one which took place at the mountaintop Naina Devi temple in 2008, for example [8], and the fire leading to stampede during Hajj 1997, for example [7], could be avoided by employing the simple technological solutions discussed in this and other papers, for example [15, 16 and 17]. The solutions that we have suggested in this paper can also be applied for the management of some other crowded events. To ensure accuracy of data, privacy of pilgrim data must be ensured. Many problems related with the

crowd management can also be minimized by improving facilities. Technological solutions, however, are many a times rendered ineffective because of the ignorance, which prevails in almost all religious congregations.

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