

Event Finder Based on Current GPS Location: The city of Madinah as Use-case

Toqeer Ali, Turki Alghamdi and Hatem M. El-Boghdadi
Islamic University of Al-Madinah Al-Munawwarah
Saudi Arabia
toqeer.dr.turki,helboghhdadi@iu.edu.sa

Abstract— The Global Positioning System (GPS) is widely used in many portable devices for positioning purposes. Many applications were developed to use this service for tracking of objects in different environments and wide range of applications. In big cities, there are always many kinds of educational, medical, cultural and religious events. Residents and visitors to these cities need to be aware of the ongoing and upcoming events in the city. In this paper, we employ the GPS and propose a framework to use mobile application connected with the GPS to deliver the activities and events in a certain geographical area within the city. The users of the application get the current activities and events going on in certain geographical area as they pass by it. The paper uses GPS technology available in most smart phones to make the events available to users based on their location. A resident/visitor passing through a geographical area get informed about the events, activities, and news going on in that area. This paper took the city of Madinah, Saudi Arabia, as a use case, considers some of its important places and facilities.

Index Terms— Geographical Positioning System, Android, Event Finder, Mobile Application, Location System, Operating System

1 INTRODUCTION

In the era of smart cities, trials are made to increase the digital life of residents and visitors of different geographical areas. The slow dissemination of information is a problem usually happens in big cities with many on-going activities and upcoming events. The residents and visitors of a certain city need to be aware of these activities and events. Owing to the dynamic nature of city life, widely announced activities and spontaneous specific activities are planned and/or changed. Consequently, affected residents and visitors need to be readily aware of the relevant information. In this paper, we propose to use mobile and location based information and communication technology to solve problems related to the slow dissemination of religious, academic, cultural and health related information to residents and visitors of a certain city. The city of Madinah is used as a use case. Concurrent research in mobile computing considers user mobility, where mobile computing uses location determination systems, e.g. the Global Positioning System (GPS) to determine user(s) positions while roaming and/or moving [2, 3]. The paper addresses the establishment of an information dissemination on-city service system for residents of Madinah and visitors. Through mobile computing, it is possible for different entities and organizations participating in this system to make selected events readily and conveniently accessible to residents and visitors of Madinah through the use of handheld and portable computing devices; e.g. smart phones and portable devices. Also, it is now possible for the governorship of Madinah to announce different news for the residents and visitors. As an example, the governorship could announce a hold of schools/universities due to weather conditions. This could be a step forward to take the city of Madinah to the era of smart cit-

ies. This paper selects a set of organizations and entities with different activities and accordingly investigates, analyzes and designs a mobile computing system to provide residents and visitors with readily specific relevant information. Examples of city life events could be related to: religious events, academic events (e.g. seminars, conferences), medical events (specialist's visits, workshops) cultural events (public lectures, exhibitions) and emergency events (power failure, water failure etc.).

1.1 Use Case:

Here we provide a specific use case, the city of Madinah for our application. Madinah Munawwara is a busy city where each year during the religious festivals like Hajj, millions of people do come to Saudi Arabia to perform pilgrimage. Similarly, whole year, Saudi Arabia serves people from around the globe during performing Umrah including Madinah. These visitors do require facilities as well as information regarding different events in the city. AL-Madinah Al-Munawwara, as well as other busy cities, is developing new organizations, such as, universities, hospitals, cultural cities, food street etc. However, when visitors first arrive to the city or even from other location within the city they do not know much information about the area. For example, a person who arrived from outside of the country or from the city, he would like to know more about the areas and what are the on-going activities. We need such applications on the mobile phones that search activities for us based on our profile. In fact, we are unable to find such system in the literature. One might argue that such information is usually available

online. However, our point is that the person is visiting the city doesn't know about the location [9].

Visitor moving around Madinah getting Events

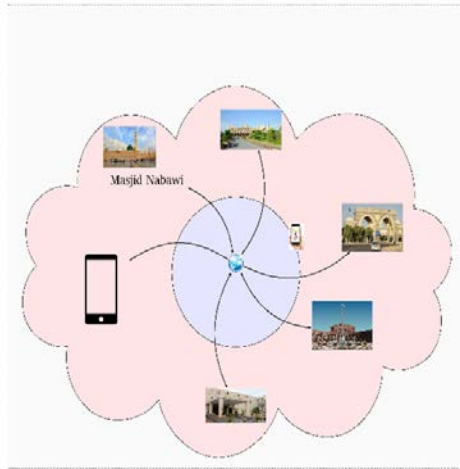


Figure 1: Use-case

For example, a person is looking for job and would like to know, how much universities are present in this area that he/she can visit. Similarly, how many cultural or hospitals are in the surroundings and what are current activities going on. This kind of information usually people cannot get from the websites or some other way.

1.2 How it will Work:

The proposed system will work as follows. A visitor visits some location in Madinah and he is using our newly developed system. First, visitor will need to create the profile and put his interests. In fact, there will be two interfaces of the application. One, for the visitors to create their profile and second will be the organization interface, those will put location information, their organization details and current activities going on within the entity. Now, when the visitors reach a location and would like to know, for example, how many hospitals are available in the surrounding area. As soon as he/she arrives, will get the current activity's information from the organizing entity. There are applications available, which can get information of the entities available in the surroundings, for instance, the petrol pump, mosque etc. However, its solely getting static information from the GPS, there is no interaction with the entities within a specific location. In our research, both parties will get the latest information using our proposed app, this kind of solution is not available in the existing systems. Figure 1 shows that if a person who is running the proposed application moves around the city of Madinah, he/she will get information related to his location. Such information is dynamic and changing updating itself from entities such as Islamic University in Madinah and King Fahd Hospital as well as static information from religious places such as Al Haram.

1.3 Contribution:

The scope of this paper covers two areas; communication and mobility. The research proposed area of application would be within the city of Al-Madinah, using the prophet's mosque geographical area, Islamic University of Madinah geographical area, and other selected city areas for experimentation, testing and validation. Regarding the nature of information to be transacted would be mainly information of interest to residents and visitors. Regarding communication, the paper considers the implications of using Internet in getting data as most smart phones has an Internet connectivity. As for mobility, the research examines the consequences of changing locations, such as location-dependent responses to user queries and system configuration. The system that we propose has the following main objectives to achieve:

- To investigate the importance of location based system in dissemination of information that is either static or dynamic.
- To propose a system that offers dissemination of Location based latest and dynamic information in the city of Madinah
- To provide fast responses to user queries about events in different entities participating in the system
- To provide an application to users and organizations with different popular mobile and/or portable devices.
- To offer users with an easy human-computer interaction that supports most common practices

The rest of the paper is organized as follows. Section 2 and 3 discuss related work and background of our proposed research. Section 4 started with the components of the proposed solution and its methodology. The next Section 5 is about the implementation details of the Android app and the management side of the events. Finally, Section 6 briefly present the performance and the end application. Section 7 adds some concluding remarks.

2 RELATED WORK

This paper solves the problem of slow dissemination of information in big cities. The problem typically occurs in cities, such as Al-Madinah, with many organizations and entities that offer numerous services and hold events, all of which are geographically distributed. The residents and visitors of Madinah may not know about the activities going on in their city. They might not know about academic events in universities, visits of medical specialists, or cultural events such as international exhibits. The paper proposes to empower residents and visitors of AL-Madinah with new technical capabilities to provide them with readily access information about their surrounding environment as they move within the city. This will enable the users to discover the on-going events as they go around the city. Based

on the location of the users, the system provides them with the events going on in the area they are passing by. In this section, we provide a detailed literature review of the related work and show how our proposed system differs from the existing systems.

Global positioning systems are used widely in developing systems that essentially used in tracking objects. These systems could be also used for real-time tracking and management of objects. A number of systems were used to track vehicles and transfer useful information to vehicles. This paper uses the GPS for fast dissemination of information to residents and visitors of Al-Madinah. Amit et. al [6] have explained location based services and presented the idea of giving information of the entities to user nearest to his/her location. They ensured that the person visiting a place should not carry information about the place and can get the local information from his handheld. For example, if someone is in AL-Madinah near Al-Haram and would like to know about the specific hotels or petrol pumps, he/she should get that information easily. However, the solution given in this research differs in our proposed solution. They are retrieving static information of the entities surrounding the location. While in our proposed solution we intend to provide the current/dynamic information of entities, a user is interested in. Singhal et. al [13] also proposed a solution on location based services. However, their work is based on using google web services to provide services to user based on their location. Verma et al [14] proposed a system that can track targets in all weather conditions. This system uses GPS and GSM technologies as well as Atmega microcontroller MAX 232, 16x2 LCD. The software layer interfaces all the required modules and to the web applications.

Le-Tien et al [7] proposed a system that is based on using GPS and GSM. It describes a system for routing and tracking of vehicles in outdoor environment. Finally, the position of the mobile vehicle will be displayed on Google Map. Abid et al [5] proposed a system that can track an object precisely via global positioning system and determine its location. Kshirsagar et al. [12] introduced a smart tracking system that is Android based. The system allows users to create, store and view their vehicles and other related information. They use Google maps where each vehicle can be shown on the map with all the visited locations. It uses the technology of GPS to locate the vehicle and GSM to send and receive data. Vimlesh et al. [1] introduced a dynamic GPS based system for automatic fare calculation. It enables the user to be in more control of his travel, check where exactly he is driving to and checking fare and the distance. The system can detect faulty meters. Lita et al. [8] proposed a solution for automatic localizing system using GPS. The system can transmit the position to the owner on his mobile via SMS. This solution is also not aligned with our system and differs in many ways. Pervez et al. [11] are providing a new idea of tracking a vehicle based on GSM system, however, our work is related to getting location of the entity via GPS. Similarly, the work done by Sadagopan et al. is just tracking theft car and sending SMS to the owner of the car which is also different than our work. According to the above mentioned survey and our other related Android-based applications survey, the proposed system in this paper is the first to find solution to find current information of

the organization, such as, Universities, Hospitals, Cultural places, Al-Haram Al-Nabawi etc.

3 ANDROID BACKGROUND

In this section we provide a brief introduction to the Android framework and its main components. The proposed application in this paper is built on Android [10, 15, 16]. Thus, we conducted a thorough study of Android system to design and develop a state-of-art art application (see Figure 2.).

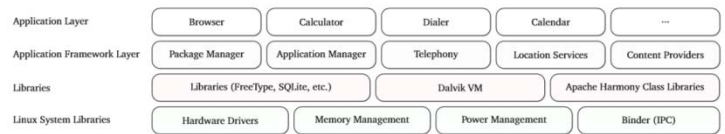


Figure 2: Android Architecture

3.1 System Libraries and Android Runtime

Android system libraries or native libraries are a set of low-level C/C++ code that contains the common functionality for various tasks. They are exposed to the application framework and Android runtime (ART) through Java based core library APIs. Direct access to native libraries is provided through Java Native Interface (JNI) bridge. ART is primarily responsible for executing Android's applications and framework daemons.

3.2 Application Framework

Android framework contributes to the runtime environment in which Android application can be executed and managed. i.e. a middleware. The fundamental function of application framework is to give level one foundation to applications as different Android classes. Components of this layer are mostly executed as services/daemons that run in the background. Some of major parts are portrayed below.

3.2.1 Components of Android Framework

Activity manager is a daemon that monitors active applications. It is in charge of overseeing services like terminating a process if the device is running out of memory. Similarly, content provider is one of the major component that is used to share data between various applications, e.g. the contact list information can be utilized by different applications. Therefore, it should be stored in a content provider. Intent is a request from an application for performing a certain action, while Google defines intent as follows. "Intent is an abstract description of an operation to be performed. It can be used to launch an activity and to send it to any interested receiver components, and to start a service or bind any service to communicate with a background service. Intents provide a facility for performing late runtime bindings between the components of different applications. It's most significant use is in the launching of activities and interactivities communication, where it can be thought of as the glue between activities [4]."

3.3 Location Manager and GPS

This service is responsible to give out device's current by utilizing the Global Positioning System's sensors, which gives applications occasional updates on phone's geographical location. The Global Positioning System (GPS) is a space-based global navigation satellite system. It provides reliable location and time information in all weathers, all the times, anywhere on or near the Earth when and where there is an unstructured line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible by anyone with a GPS receiver. GPS was created and realized by the U.S. Department of Defense (DOD) and was originally based on and run with 24 satellites. It was established in 1974 to reduce the large number of navigation aids and to overcome the limitations of previous navigation system. GPS satellites broadcast signals from space, which each GPS receiver uses to calculate its three-dimensional location (latitude, longitude, and altitude) plus the current time.

3.4 Applications

Applications are the software components that are used to get the most out of a computing device. They add user centric functionality to the device. Android comes with some built-in Apps for various purposes e.g. Dialer for making phone calls, Chrome for web browsing, Gmail application for reading and sending emails. These are some of the built-in Apps, while there are many other 3rd party Apps developed by various developers and companies e.g. word processing application MS Office, navigation softwares like Sygic, a lot of different types of games, video players to watch and synchronize videos.

4 PROPOSED SOLUTION

Our proposed solution, MadinaInfo, for event finding have two parts, one is the event organizer's (or event maintainers) view and second is the mobile application where the end users can install the Android app to view different events in the currently visited area. It also contains geographic positioning system that perform two things. One, is to show events of visitors current defined zone. Secondly, it provides periodic events as soon as visitor enters the zone.

4.1 Location-based Event Finder

The first part of MadinaInfo is based on Android application. Usually, the location-based application can help in finding the objects around. However, no further information can be received via that application. There are many apps available on google playstore that can be downloaded and that can detect a device location or the objects of your interest. However, there is no system available that can help visitors of Al-Madinah or any other city that can find various events that belong to the existing location. Specifically, we have taken the city of Al-Madinah as a

use-case for this application to provide events information in area of his current location.

MadinaInfo has the capability to send the authorization key of the application, the existing latitude and longitude of the device and the radius of the complete area to the server. The request is made via Restful API in JSON format that further calculates the existing location (latitude and Longitude) with the radius defined by our application. Based on the results, server sends all the events within the range of a specific radius area. The visitor of the city can see all the events announced in the specific place of visitor via MadinaInfo Android application. Further, he/she can select the event to get detailed information. For example, users can see the timings of the event, exact location, topic of the event etc.

The GPS calculation in the receiver uses four equations in the four unknowns x, y, z, t_c where x, y, z are the coordinates and t_c is the time correction for the GPS receivers clock. The distances $d_1, d_2, d_3,$ and d_4 from all satellites are calculated as:

$$d_i = c(t_{t,i} - t_{r,i} + t_c) = \sqrt{(x_i - x)^2 + (y_i - y)^2 + (z_i - z)^2}$$

Where c = speed of P

$t_{t,1}, t_{t,2}, t_{t,3}, t_{t,4}$ = times that GPS satellites 1, 2, 3, 4 transmitted their signals. Similarly, $t_{r,1}, t_{r,2}, t_{r,3}, t_{r,4}$ = times that signals from GPS satellites 1, 2, 3, 4 are received. x_1, y_1, z_1 = coordinates of GP S satellite1 (these coordinates are provided to the receiver as part of the information that is transmitted). Similarly for x_2, y_2, z_2 etc. The receiver solves these equations simultaneously to determine the x, y, z, t_c .

Based on the current location of the user, MadinaInfo calculates the latitude and longitude. Similarly, we have defined the radius covering the complete city of Al-Madinah. As soon as the user is in that radius, the visitor of MadinaInfo can see the events in the city. The province of AL-Madinah is expanded across 1500K km in total. However, we considered only the city area and took around 500K km out of the total area. To convert complete area of Al-Madinah into the radius we can say $50000\text{km} = 7:8392514456$ Earth's equatorial radius.

A known technique to calculate the distance between two end points is Haversine formula. MadinaInfo has also adopted the same technique to calculate the user location. Based on that calculation, we show the events around the visitor's current location. The user further can click on the event on the maps itself to get further information.

If the user's device is on any one point in the range to calculate the distance, we can write the haver function like this

$$\text{haver}\left(\frac{d}{r}\right) = \text{haver}(\theta_2 - \theta_1) + \cos(\theta_1)\cos(\theta_2)\text{haver}(l_2 - l_1)$$

Algorithm 1 Finding the events in the defined area based on the user's location. Algorithm will take three inputs, 1st the total covered of the city of Madinah. Second, the latitude and longi-

tude of the current user's location. Third input will be to get any point on the circle of the covered area. Once, the user's location is varied to be in the covered area, all the events will be shown to the user related to that area. Similar algorithm is utilized for getting alerts of the events as soon as the user enters to the boundaries of an events origination point.

$$\cos(\text{rad}(\text{Longitudeofcircle}) * \sin\left(\frac{\text{receivedlatdiff}}{2}\right) * \sin\left(\frac{\text{receivedlatdiff}}{2}\right)$$

Haversine second calculation of Tangent = $2 * \text{receivedcal} - 1 \tan 2(\text{sqrt}(\text{receivedhaversinecal} - 1)), \text{sqrt}(1 - \text{receivedhaversinecal} - 1)$

Final Distance = Covered area * Final Value Received from Haversine

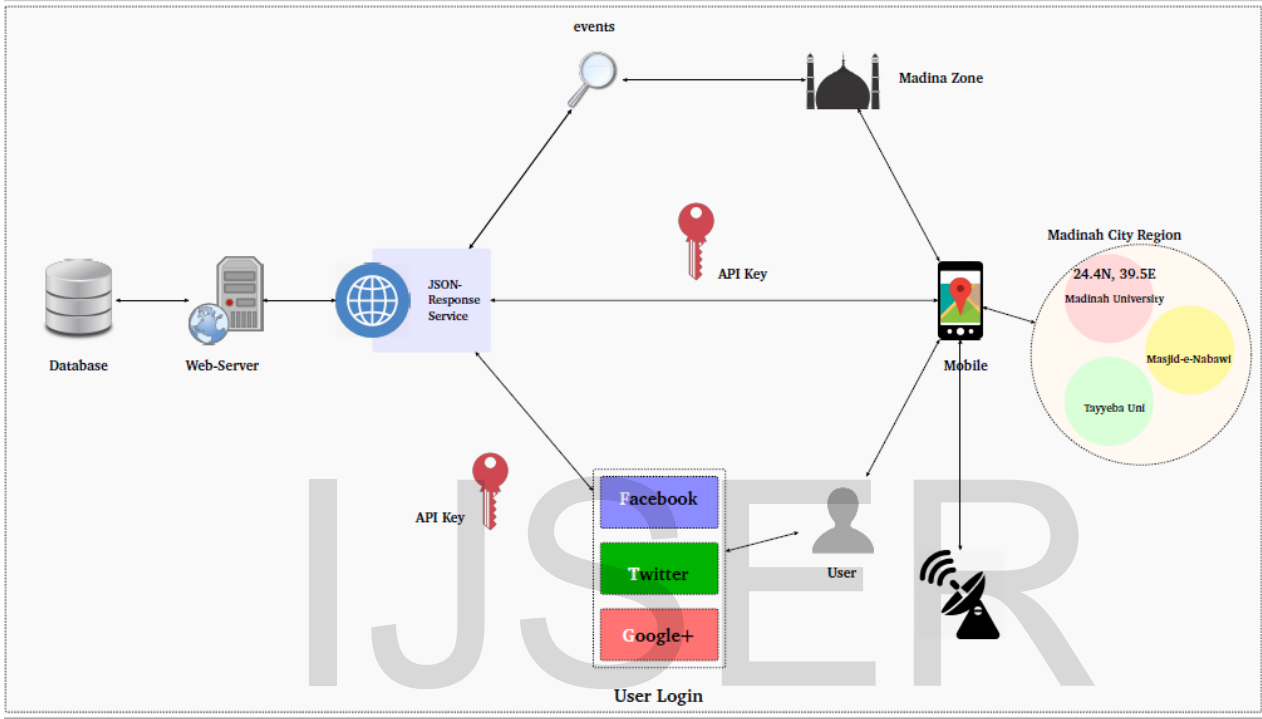


Figure 3: MadinaInfo: Event Finder Proposed System

Input: Defines the radius to be covered
 Input: User's current Location Latitude
 Input: User's current Location Longitude
 Input: Latitude of any point on the circle of the covered area
 Input: Longitude of any point on the circle of the covered area
 Output: Distance between user's location and the covered area
 calculate Latitude Distance = Rad (User's Latitude - covered area Latitude)
 calculate Latitude Distance = Rad (User's Longitude - covered area Longitude)

Haversine sin and cos calculation = $\sin\left(\frac{\text{receivedlatdiff}}{2}\right) * \sin\left(\frac{\text{receivedlatdiff}}{2}\right) + \cos(\text{rad}(\text{User's Latitude}) *$

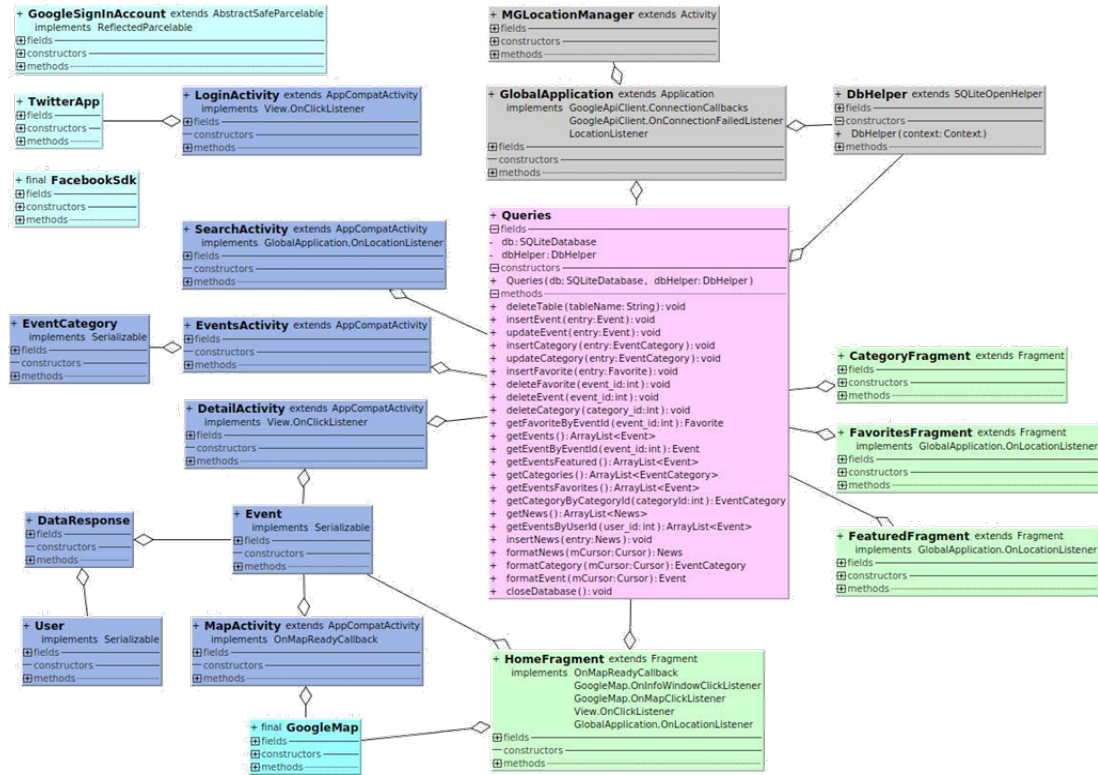
$$\text{haver}(\delta) = \sin(\delta/2) = 1 - (\cos(\delta)/2)$$

d is the distance between a point (Lat, Long) on circum-ference and the user's current position.
r is the radius of the sphere

l1, l2: latitude of point 1 and latitude of point 2, on circumference
θ 1, θ 2: longitude of point 1 and longitude of point 2, on circumference

The distance for any user in the circumference of AL-Madinah city is calculated and all those events will be shown on his/her

application. Algorithm 1 has shown the procedure to calculate the user's location and show the resulted events. The same algorithm is utilized for giving alerts to the user as soon as the visitor enters the zone of the events. However, the latitude and longitude of the two calculations will be different.



4.2 Management of Events

We have contacted many authorities in the city of Madinah that usually organize events in the city. Based on

those organizations we have divided the events in multiple categories, for example, Education, Cultural Events, Government announced events for Public, Medical Institutes and hospitals related workshop etc. In Madinah the more crowded place is Masjid Nabawi, where thousands of people visits every day. There are many talks related to Masjid Nabawi that is expanded in quit huge covered area. Sometimes it is very difficult to find a specific place so we have added a specific category as Masjid Nabawi.

The visitors can find the talks exact location in the mosque. Creation of categories based on organization involved. Similarly, it also helps in creating different kinds of events, management of users etc. It also communicates with the Android app via Rest-Ful API. The transfer of data is performed between the client and the server based on JSON response. Similarly, while the organizers are setting up an event, it also fetches the location of the event via google API. Moreover, it also helps in adding the images and manage the users belongs to different organizers. The complete architectural diagram of our proposed solution can be seen in Figure 4

Figure 4: MadinalInfo Class-Diagram

5. IMPLEMENTATION

Implementation of the proposed system involves two sections, a Website section which provide the events creation and user management and the Android section which fetch data from website and display them to the user. The Website section is used to create different Events categories and their relevant events. A single event can be a part of multiple categories. The Website section is a restricted administrative area where normal user is not allowed to enter. Some useful APIs are used to pick location latitude and longitude data easily with the click on the Google Map. Administrator can set event start date and time and when that date come by, end user can easily navigate them on their smart phones. For security purposes, MadinaInfo uses a random 16-digit secret number in both sections for the authentication section. When a request is generated from the mobile device to view an event or its details, it is generated in a JSON request which is processed on the website level. The intelligent database queries result is displayed back to the mobile user. The result is also in a JSON format, Listing 1 shows the detailed JSON response generated by the website. During this, the requesting body is authenticated using the match of secret key, user registered ID matching and user current Latitude and Longitude with requested search radius value. All the events displayed to user are only those which are

Figure 5: Event Details

Figure 6: Event on Map

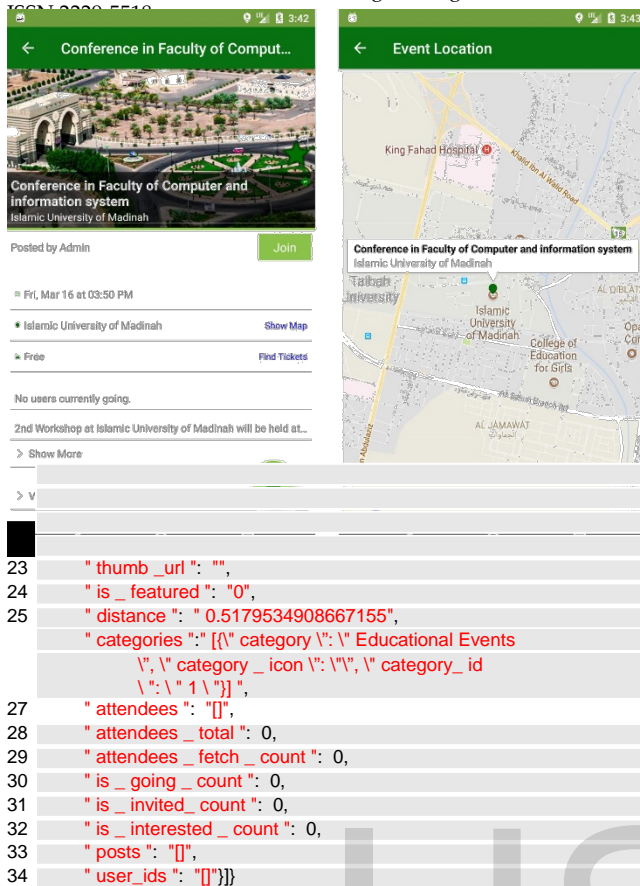
near to him in a specific radius (which is in Km). User can easily

change its search radius from the application radius slider. Class diagram 4 shows the complete architecture of how Android application is managed and developed. One can see from the class diagram that MadinaInfo has its own database which is built in SQLite. MadinaInfo will work in case there is no connectivity with the web server. With each sync from the website, MadinaInfo updates its database values. For performance purposes, only those events are changed/alterd which are forced to be changed. One can see some special bits in the JSON request that tells the MadinaInfo to either delete the events or update the events.

This way only required changes are reflected to the application. MadinaInfo uses Android Fragment techniques to handle its dynamic view. It also uses Android Google API which provide different value that tells user automatic distance calculation from the events and provide the full directions navigation to the events. With specialized google map markers and their respective title and description, one can easily get the details on the map. By clicking on a marker, a new window is also displayed to the user which give the details of the event e.g. its picture, descriptions, links etc. These details display are integrated with Google Map view in a way that they are shown as a one unit. Each user need to sing-up for the application using easy Facebook, Google and

Twitter API. With this integration, we can directly add them into our both database (i.e. website and Android application) and we can also add them on our pages made in Facebook, G+ and twitter. Through the social media platform, we can deliver them more support and features.

```
1 {"result_count": "1",
2   "status": {
3     "status_code": "-1",
4     "status_text": "Success"},
5   "events": [ {
6     "event_id": "4",
7     "address": "King Faisal Rd, Al Haram , Medina
8               42311, Saudi Arabia ",
9     "event_desc": "Lorem Ipsum is simply dummy text of the printing and type
10                  setting industry.",
11    "gmt_date_set": "2018 -03 -14 16:05:00 ",
12    "is_ticket_available": "0",
13    "photo_url": "http://yasarkhan.tk/upload_pic/event_photo_
14                5a8bddd99d22.png",
15    "lat": "24.465447571664647",
16    "lon": "39.61788654414704",
17    "ticket_url": "abc.com",
18    "email_address": "toqeer83@gmail.com",
19    "contact_no": "00966542015243",
20    "title": "Masjid Alnabawi talk by shaykh Abdullah "
21  },
22  "created_at": "1517749405",
23  "updated_at": "1520753407",
24  "is_deleted": "0",
25  "user_id": "-1",
26  "full_name": "Toqeer Ali Syed",
```

Listing 1: JSON Request Response

6. RESULTS

Keeping in mind the performance, speed and security, we have developed a very light weight JSON request mechanism which enables end user a robust experience. As we discussed in the implementation section that mobile uses its own database and our optimized code always looks for the right time to update this local mobile DB. As we allow user to see only those events which are near to its GPS location this also narrow down the events loading process. As shown in Figure 5 and 6 some of the events are rendered on user mobile. We also developed a very user friendly and optimized Web portal which enables our administrators to add, edit and delete any events. Through different customized API we help them to navigate google maps very easily.

7. CONCLUSION

Madinah is the city of millions of visitors every year. The work done in this paper is an effective contribution towards smart city projects and can be easily integrated with it. The paper adopted the idea of an event finder application while visitor is moving around the city. The developed application is a combi-

nation of web-based interface as well as an Android application. The solution adopted state-of-the-art technologies to provide efficient and secure application to users and administrator. Various stakeholders have contributed in the application to publish their events belonging to different categories.

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