Let’s Meet In The Middle: Calculating Geo Mid-Point

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Abstract: *Nowadays, cell phone has become most important for daily activities and is used by population worldwide. One of the activities includes use of mapping services. These services provide route planning for traveling, directions to a place, and real time traffic conditions. Mapping applications always depend upon the current location or preferred location of the individual. Individual location can easily be calculated but it is not feasible when it comes to find a location considering a group. Considering the above condition, the objective of this paper is to develop an App with a website running on IIS server and connects it to SQL database and implementing algorithms like Mid-Point calculation algorithm and Orthodromicalgorithm to calculate the meeting point for the group using technologies like Location based services, GCM, GPS. The Admin of the group will be able to host an event using web application by selecting members registered, the members shall be asked to accept the event, their locations will then be collected and the mid-point of the members of the group will be calculated and the result will be displayed on the user mobile App.*

Keywords: *IIS, SQL database, Mid-point algorithm, Orthodromic algorithm, Location based services, GCM, GPS.*

I. Introduction

Location Based Service (LBS) has emerged as an important software application for mapping services. Location Based services uses Smartphone’s GPS technology to track a person’s location, if that person has allowed to access its location. Many locations methods can be used to find user’s equipment for LBS. Basically, these techniques works in two steps-signal measurements and location estimate computation based on the measurements [1]. LBS provides variety of usage for companies to use device’s location such as roadside assistance, proximity- based marketing, mobile workforce management [2].

The focus of this research paper is to use Location Based Services with correspondence to Global Positioning System to find the feasible mid-point among group of people. The study involves calculations using algorithms like Geo Mid-point Algorithm and Orthodromic Algorithm.

The process involves registration of the people from the mobile application as well as from the website, there will be an admin who will be able to host an event like organizing a business meeting or a meeting of friends. The admin will be given authority to choose members for an event from the number of registered people. The message will be sent to each and every member whom admin has selected and as soon as the individual accepts this event, he/she allows to access its location which will be used to generate a meeting point.

The research work is to achieve the objective: to develop an application to quickly and easily find a place to meet halfway between two or more locations.

II. Literature Survey

It is the centre of any land location on earth’s surface calculated by using some specific boundary. There are different methods to find a centre because there is no any official definition.[3]

We can find this centre by first finding the locations, specifying an appropriate edge and then look for the centre of gravity of that specified boundary.

There are many websites which were developed to find the geographic midpoint .

Earlier different methods were used for calculating geographic midpoint are as follows:

According to “Kreis Lippe“, the former principality Lippe that existed up to1945 are nearly the same.

So it is clear that you declare the home of the duke, Detmold castle, to be the centre of Lippe.

You mark the three biggest towns and look for the centre of gravity of the triangle they form. You find it as the intersection of the medians. You can still take into account the number of the inhabitants of the town, when you look for the centre. More: You can take all towns.

You lay a rectangle around specified location that touches the border in four points. The intersection of the diagonals can be seen as the centre of Lippe. There are many possibilities to choose a rectangle.
The next centre is that of a circle. You find the centre by this:

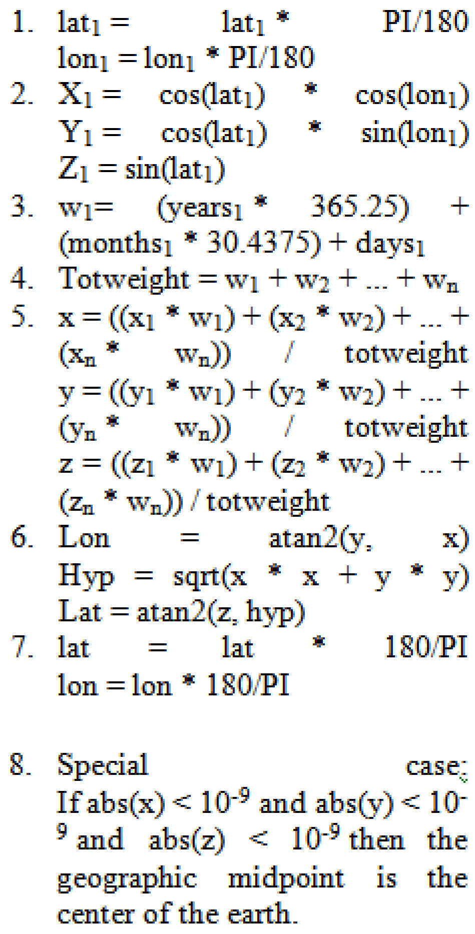
>Choose three clear-cut points A, B, C on the border.
>Draw the triangle ABC.
>Draw the normal from the midpoints of the sides of the triangle.
>Take the point of intersection.
The centre of the circumscribed circle is the centre.
This centre can be found in an experiment.

You transfer the shape of the boundary on cardboard and cut it out.
Then you hang up the slice on two points A and B one after the other and determine the vertical lines (red) going through the respective point.

The intersection is the centre of gravity and so the geographic centre.
Finding the locations and taking average of all of them.

2.1 Proposed system: We have developed an android-web application in which can easily deal with mobile and no need of using laptops or computers.
And now here we have implemented our project using Geographic Midpoint formula and Orthodromic Midpoint formula,
First formula is to calculate the geographic midpoint for two or more points on the earth's surface. A second formula is to calculate the center of minimum distance, and finally we calculated the average latitude/longitude. In first two methods we assumed that the earth is a perfect sphere. Each location
Firstly, to get the longitude and latitude for each location, we have used the GPS system, and to locate and show in map this requires an API key

Geographic midpoint:The geographic midpoint is calculated by finding the center of gravity for the locations tracked. The latitude and longitude for each location is converted into Cartesian (x, y, z) coordinates. The x, y, and z coordinates are then multiplied by the weighting factor and added together. A line can be drawn from the center of the earth out to this new x, y, z coordinate, and the point where the line intersects the surface of the earth is the geographic midpoint. This surface point is converted into the latitude and longitude for the midpoint.[4]



1. $lat_1 = lat_1 * PI/180$
   $lon_1 = lon_1 * PI/180$
2. $X_1 = \cos(lat_1) * \cos(lon_1)$
   $Y_1 = \cos(lat_1) * \sin(lon_1)$
   $Z_1 = \sin(lat_1)$
3. $w_1 = (years_1 * 365.25) + (months_1 * 30.4375) + days_1$
4. $Totweight = w_1 + w_2 + ... + w_n$
5. $x = ((x_1 * w_1) + (x_2 * w_2) + ... + (x_n * w_n)) / totweight$
   $y = ((y_1 * w_1) + (y_2 * w_2) + ... + (y_n * w_n)) / totweight$
   $z = ((z_1 * w_1) + (z_2 * w_2) + ... + (z_n * w_n)) / totweight$
6. $Lon = atan2(y, x)$
   $Hyp = sqrt(x * x + y * y)$
   $Lat = atan2(z, hyp)$
7. $lat = lat * 180/PI$
   $lon = lon * 180/PI$

8. Special case:
   If $abs(x) < 10^{-9}$ and $abs(y) < 10^{-9}$ and $abs(z) < 10^{-9}$ then the geographic midpoint is the center of the earth.

A. ***OrthodromicDistance formula***: The **great-circle distance** or **orthodromic distance** is the shortest distance between two points on the surface of a sphere, measured along the surface of the sphere. Through any two points on a sphere that are not directly opposite each other, there is a unique great circle. The Earth is nearly spherical, so great-circle distance formulas give the distance between points on the surface of the Earth correct to within about 0.5%. [6]

This method uses a mathematical algorithm to find the exact point that minimizes the total travel distance from all locations in 'Your Places'. The mathematical implementation of this algorithm is fairly complex, but the general steps are described below. All distances are calculated using the spherical law of cosines given below.[4]

Spherical law of cosines

Distance = acos $(\sin(lat_1)*\sin(lat_2) + \cos(lat_1)*\cos(lat_2)*\cos(lon_2 - lon_1))$

B. ***Average latitude/longitude***: This method finds a simple average latitude and longitude for the locations in 'Your Places'. This is equivalent to finding a midpoint on a flat rectangular projection map. When the distance between locations is less than 250 miles (400 km), this method gives a close approximation to the true geographic midpoint in Method A.

1. Use the values calculated in Method A for each location: lat_1 to lat_n, lon_1 to lon_n, w_1 to w_n, and totweight.
2. $lon_1 = lon_1 – lon_{Geographic\ Midpoint}$.
3. $lat = (lat_1*w_1 + lat_2*w_2 + ... + lat_n*w_n)/totweight$
   $lon = (lon_1*w_1 + lon_2*w_2 + ... + lon_n*w_n)/totweight$
4. $lon = lon + lon_{GeographicMidpoint}$

**The center of minimum distance concept and algorithm developed by GeoMidpoint.

III. Architechture Design Flow:

The proposed work is divided into following steps as shown in fig 5.1.

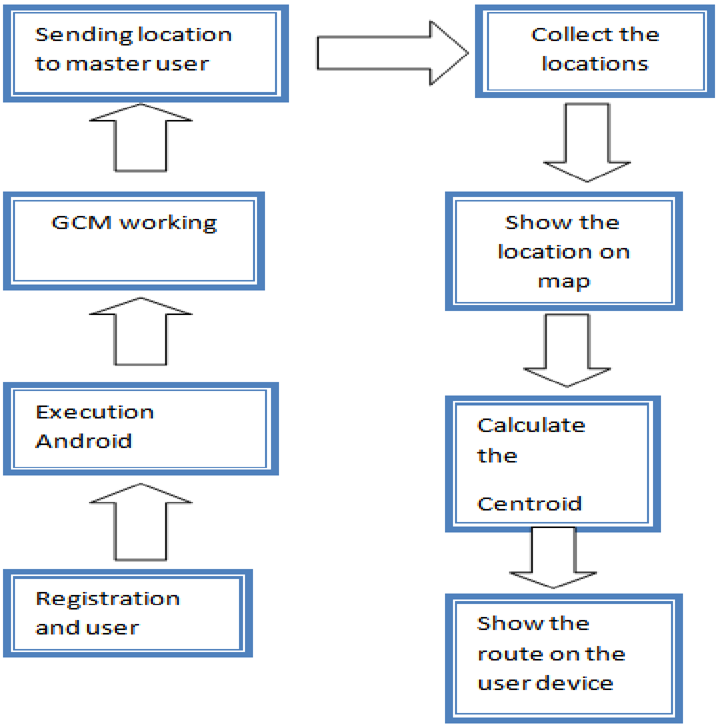


Fig 5.1:- Steps of Flow of Project

I. REGISTRATION OF USERS:

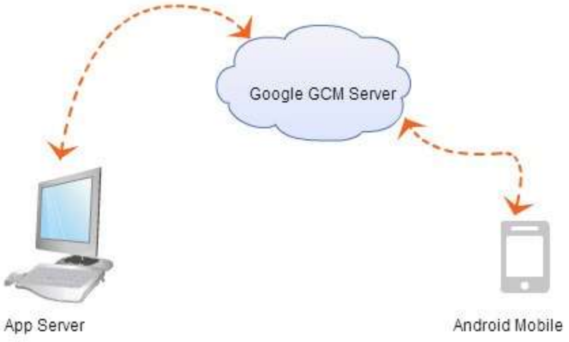
- Admin and users register themselves by entering their details in our website.

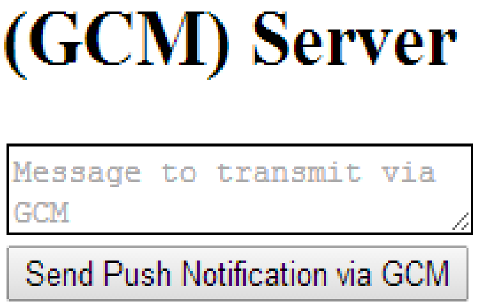
II. EXECUTION OF ANDROID:

- After registration of all members,admin selects the user with whom meeting should be done or where the group should gather.
- Now here as per the users or employees with whom the master wants to take meeting or gather with them sends a message to them.

III. GCM WORKING:

- Sending a message to them is done through GCM.





(GCM) Server

Message to transmit via GCM

Send Push Notification via GCM

- Part A – A custom web application running in an application server. This will connect to Google GCM server and post notification.
- Part B – An application running in an Android virtual device (emulator) with an Intent capable of receiving the push notification from the GCM server

IV. SENDING LOCATION TO MASTER USER:

- In this when the master user sends the message for meeting to the users then the users must select the approval button for the conformation that they are attending the meeting.
- As soon as the user approved for the meeting the present locations are send to the master user .

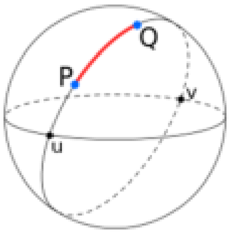
V. COLLECT THE LOCATIONS:

- Master user collects all the approved users' location.

- These locations are taken and the midpoint is calculated.

VI. CALCULATE THE CENTROID:

- Here the actual mid location is calculated where the meeting should be held or to gather the users.
- This is done by the midpoint algorithms explained earlier i.e.



Orthodromic Distance Algorithm

VII. SHOW THE ROUTE ON THE USER DEVICE:

- After calculating the exact location where to meet the, app shows the route to all the particular user in their mobile phone.
- And they reach to the location.

IV. Technologies And Tools

4.1 The technologies used for design of the proposed system are:

i. **Google Cloud Messaging:** Google Cloud Messaging (GCM) is a free service that enables developers to send messages between servers and client apps[8]. The app server sends messages to the client app. The app server sends a message to GCM connection servers. The GCM connection server enqueues and stores the message if the device is offline. When the device is online, the GCM connection server sends the message to the device. On the device, the client app receives the message according to the platform-specific implementation. A client app receives a message from a GCM connection server.

ii. **GPS**: "Global Positioning System" GPS is a satellite navigation system used to determine the ground position of an object. It provides geolocation and time information to a GPS receiver anywhere on or near the Earth [10].

iii. **IIS Server:** Microsoft provides a most powerful web server which is Internet Information Server that is able to host and run web applications. Internet Information Server (IIS) provide Internet based services to ASP.NET and ASP web applications. IIS can serve both standard HTML web-pages and dynamic web-pages, such as ASP.NET applications and PHP pages. All the features that are required for hosting a website includes in IIS.

4.2 The Programming tools used for design the application are:

i. **Android Studio**: For designing and coding of native android applications this software is used. Android studio contains XML files and Java files. The reason behind choosing these programming languages is most of the work involved in developing applications for Android will be performed using the Android Studio environment. Android Studio is subject to frequent updates and it is possible, and as the trend of mobile generation use of android mobiles are in demand. Also it support for building Android Wear apps.

ii. **Android SDK**: For developing android applications this software is used.

iii. **ASP.NET**: We preferred **ASP.NET** as webdevelopment technology as Asp.net is purely server-side technology [13]. It provides a programming model which is a web development platform. A various services and exhaustive software infrastructure required to build up robust web applications for mobile phones, as well as PC. Using extensible and reusable components present in .Net framework ASP.NET applications are written.ASP.NET is used to produce reliable, platform independent, interactive, data driven web applications over the internet. Asp.net framework is language independent and provides fill support for XML. Asp.net reduces the line of code and is easy to deploy.

iv. **SQL Database**: SQL programming can be effectively used to insert, search, update and delete database records. In fact it can do lot of things including, but not limited to, optimizing and maintenance of databases. SQL (relational) databases have a mature data storage and management model. This is crucial for enterprise users. Also it support stored procedure sql which allow database developers to implement database easily. Moreover SQL databases have better security models.[15]

5. IMPLEMENTATION:

5.1 Following are the android mobile appimplementation of proposed system:

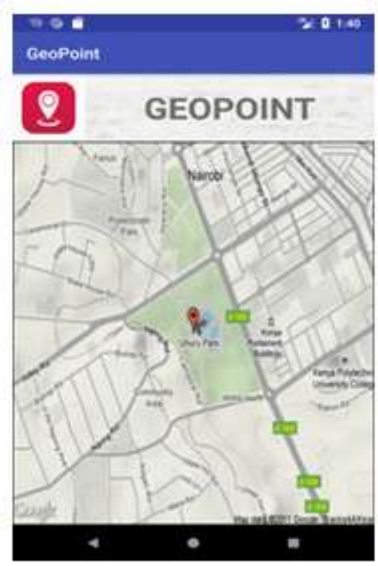


Figure 1: Splash Screen

The figure 1 shows the splash screen after launching of the program.

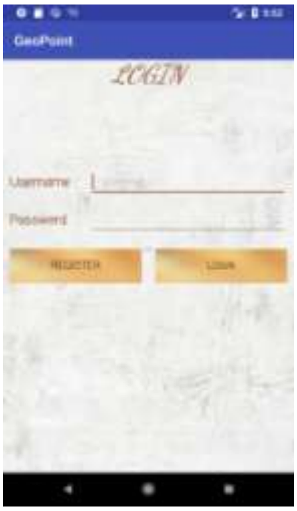


Figure 2: Login Page

The figure 2 shows the login page,after the splash screen login page is invoked. In this page all the users have to login on this by creating a password .If users are already logged in then they can jump to registration page by clicking **REGISTER** button.

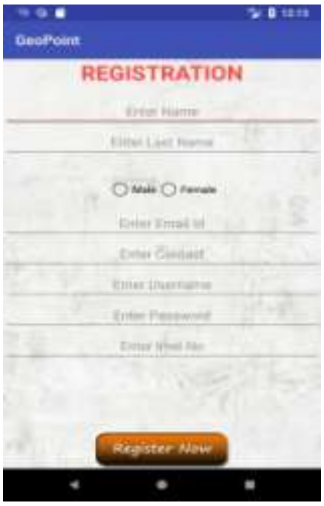


Figure 3: Registration Page

After the login is done then users have to registered by filling the all necessary details like user name, last name etc . After entering all the details of user click on the **Register Now**button .

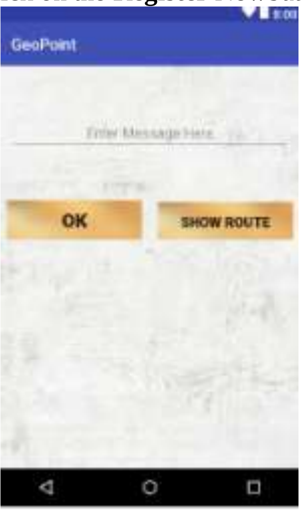
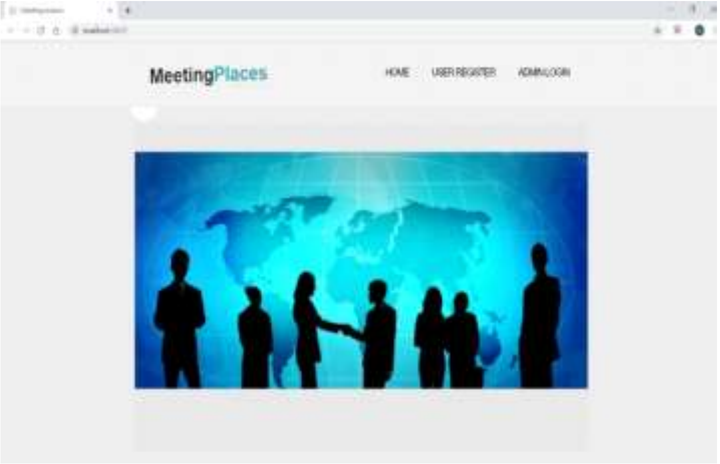


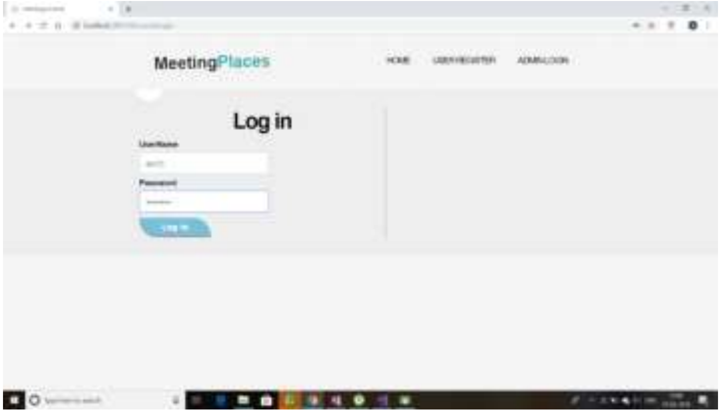
Figure 3: Notification Page

In above page user receives notifications send by admin. It also display longitude and latitude when user clicks on **OK** tab and when user clicks on **Show Route** tab it will display the route from his location to the midpoint calculated and it will be same as route shown in Google maps.

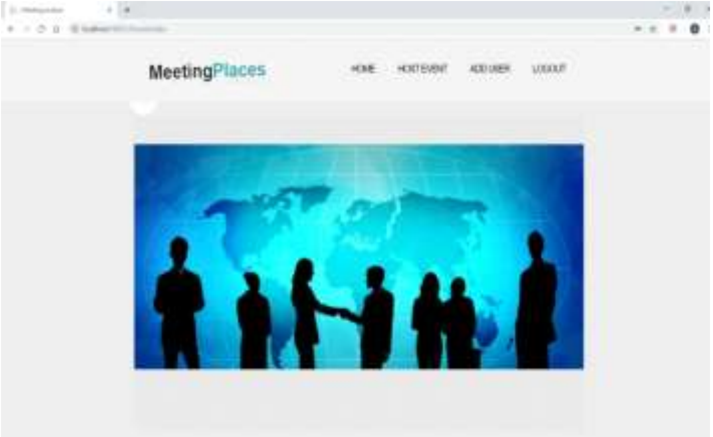
5.2 Following are the implementation of website of the proposed syatem:



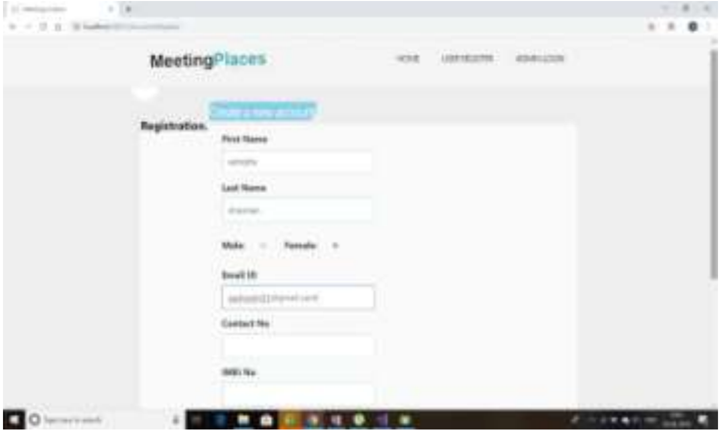
The above figure will be the homepage of the web application. This page also adds the functionality just like the android app in the mobile for registration of the user. The admin of the group will be able to login and host and event.



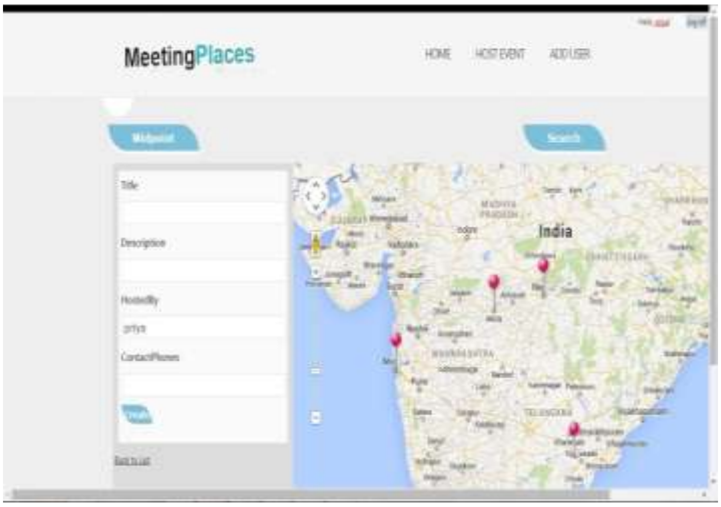
The above figure defines how an admin will be able to login through his own login and password.



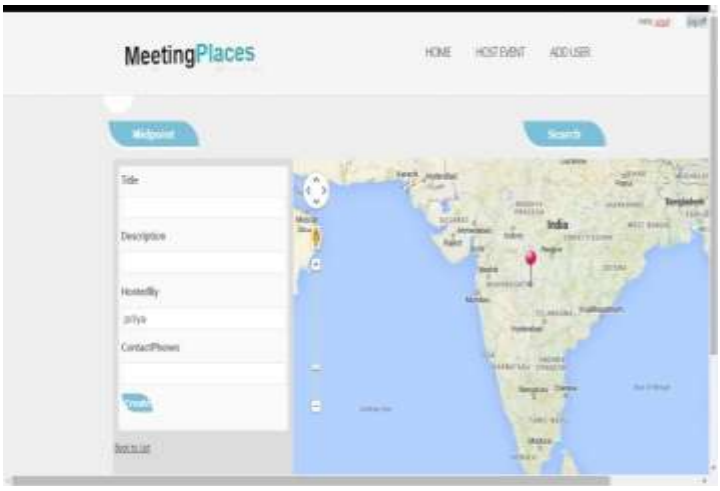
The figure illustrates how an admin will be able to add an event and add users for an event.



The figure is same as in android app for registration of user through website.



The figure shows the scenario after the users have accepted the invitation for an event, their locations will be used to calculate the mid-point.



The figure the result of the mid-point calculated on the web application, the same result will be generated on the mobile application of the individual user.

V. Conclusion

We have successfully developed an android-web application which aimed at finding the preferred and central location for the group of users at different locations using the two algorithms i.e. Geographic midpoint and Orthodromic distance algorithm as mentioned above along with the mapping technologies like LBS and GPS system. Two major factors such as web browser and GPS services, both of these functionalities are already implemented but in additionwe have implemented an android mobile app, specially designed to be accessed from an application installed on a Smartphone device running an Android operating system.

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