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Evaluation of MicroAddress Recorder for Location Tracking

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Abstract

In this modern era, the appearance of mobile phones with wireless technology and featuring location based Services leads to a new level of computing. For safety point of view, the users are interested to get the exact location of their family and friends in very concise areas. The performance level and accuracy of the tracked location is major key point for a user. This paper describes the detailed experimental results of the mobile based Location tracking Application, called MicroAddress Recorder. The application is tested in real mode with Location and Distance updation in a particular time frame. Further, the paper evaluates the validation and accuracy of the results using different mathematical algorithms.

Keywords: Location based Services, Location Tracking, GPS, SUPL, MicroAddress Recorder.

Introduction

Location Tracking is one of the marvelous feature of Location based Services. Other features of Location based Services includes tourist guide information, fleet management, Navigation, fleet management and so on. The first Location based Service was appeared in 1996, in USA that allows the mobile network operators to track cell phones using GPS [2].GPS (Global Positioning system) with mobile phones work as a most important Service provider to give information regarding the location and also it is only a fully functional Global Satellite navigation System available [3].The general user need to get the information regarding the location of his/her child, one need to know the location of his cousin who is coming to meet. Generally the mobile users in this era purchase smartphones having Global positioning system facility to track the location. These phones are also installed with Android operating system, a software platform for mobile devices [16] allows GPS and other applications to run. An application called Google latitude [4] is provided on android phones, used to get the location of friends. The application gives displays the location in a broad area. This approach works on SUPL (Secure user plane location) platform with the integration of Mobile networks [6]. The mean error calculated for Google latitude is 13.6[8] .The results shows, if a user is moving anywhere in Sector 21C, there is no or little bit of change in Location is displayed, whether the user is at Home or in Society, same broad area is shown on the map. The paper describes detailed results of an application called MicroAddress Recorder. This application runs on any android Mobile phone. The detailed architecture of application is already described in our previous paper [7]. The application is used to track family and friends in micro areas. Further the paper is organized as follows. Section II presents the work related to Location based Services and location tracking using Mobile phones. Section III evaluates the results for accuracy and validity given by the application. Section IV presents the simulation. Finally Section V concludes the paper.

Related Work

A lot of Research is done in the field of Location based services. Location Tracking is one of the field of Location based Services. Different researchers had work in this area. Fernando De la Torre et al explore the usage of radio communication technologies to track the people [1]. The paper proposed dynamic multidimensional scaling algorithm for tracking based on distance estimation. The algorithm uses various Radio transmission technologies. The algorithm basically works in real time environment for adhoc networks. The accuracy of approach depends upon the number of nodes connected. If the number increases, the accuracy level increases and visa versa.A New project called Caalyx[9] was introduced in 2007.The project was based on the use of Location based services for health department. The purpose of this project is to provide easy light weighted

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device for the older people which tell the location so that they can interact easily with their care providers.A Centroid Localization algorithm [10] was used to check the accuracy of sensor networks for localization. This paper also provides the comparison of traditional and improved centroid formula to test the results. But the use of centroid on sensor network is a complex process. A client Server System [11] was developed in 2010, where users can locate their family and friends. it gives alert when friend is nearby. This system was implemented using JSP and the data was stored in Oracle 10g.The accuracy of the system ranges to some meters. This system was basically used for navigational purpose.Location based Services are used with Session initiated protocol with Internet Telephony [12]. The system is used to search nearest restaurant, nearest ATM machine, nearest book shop etc.A Cricket Location Support System [13] was implemented and evaluated in 2000.This system was run on Mobile phone to know the physical locations used by listeners. The system also introduces user privacy at lower cost. The system called Campus Tracking [14] was developed in 2009 to track the friends and colleagues in campus. The system works with WIFI points in campus and uses IMEI and IMSI numbers for identification. The system uses Integration of GSM modem with web server to get users location. A novel incremental Dijkastra's parallel algorithm [15] was proposed in 2008 to analysis the applications of location based services of various categaries such as searching a nearest restaurant, nearest school etc.

Evaluation of Microaddress Recorder Using Mathematical Formulas

The MicroAddress Recorder application is built for a general user to track their family and friends in a very concise way. The detailed architecture of the application is already described in our previous paper. The application works as an integration of LBSGeocoding activity and reverse Geocoding activity [7].The application is tested around the city of Faridabad at 100 locations. The performance level of an application is checked in various aspects.

A. Performance based on Location updation within particular time frame.

The application gives Latitude, Longitude and distance of tracked Location from nearby places. The two Screens in Fig 1 shows the results retrieved by the application. The results give the Longitude, Latitude and the distance of two tracked Locations when person is at third floor and then at second floor. These results are validated in a real mode. The screen shows that the location is updated with time frame of 1 minute only. At 8:31 p.m a person is at second floor and at 8:32 p.m, a person is at IIIrd floor. The threshold value of distance updating is <=1m while person is moving.

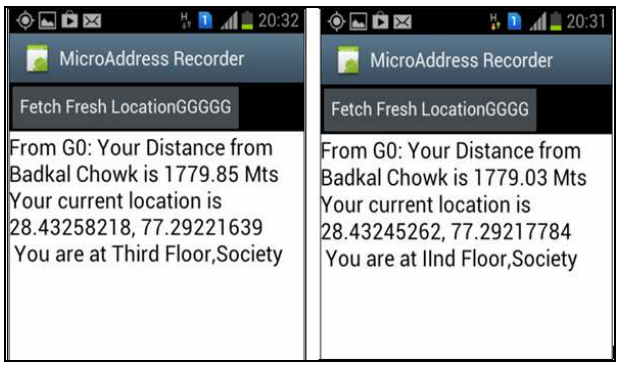

Fig 1. Two screens showing the user at different locations while moving

The code written for displaying Longitude and Latitude is shown in Fig 2.

```
public class Coordinates {
  private double latitude;
  private double longitude;
  String PlaceName;
  public Coordinates(double lat,double lon,String arg)
  {
   this.latitude=lat;
   this.longitude=lon;
   this.PlaceName=arg;
  }
  public void setPlaceName(String arg)
  {
         this.PlaceName=arg;
  }
  public String getPlaceName()
  {
         return this.PlaceName;
  }
 public void setLatitude(double lat)
 {
        this.latitude=lat;
 }
 public double getLatitude()
 {
        return latitude;
 }
 public void setLongitude(double lon)
 {
        this.longitude=lon;
 }
 public double getLongitude()
 {
        return longitude;
  }
}
```

Fig 2. Code to determine Latitude and Longitude on Mobile phone.

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The threshold value is checked for other locations while a person is moving are shown in table 1.

Sno	Latitude	Longitude	Location	Time	Distance from Badkhal chownk(meters)
1	28.43202391	77.29225865	Yu are at Home	6:55 a.m	1757.62
2	28.43180744	77.29220026	One room of home	8.16 p.m	1756.58
3	28.4318264	77.2921766	Second room of home	8.17 p.m	1755.47
4	28.43199663	77.2922735	Balcony	8.18 p.m	1755.39
5	28.43258218	77.29221639	You are at Third Floor	8:32 p.m	1779.85
6	28.43245262	77.29217784	You are at Second Floor	8:31 p.m	1779.03
7	28.43224328	77.29179519	You are at Society Gate	7:02 a.m	1807.98

Table 1. Change in time and distance while person is moving in a Home and Society

The Code to calculate the distance is given in Fig 3.

```
Public double getDistance (double lat1, double long1, double lat2, double long2)
        {

double R=6371;
double dLat=Math.toRadians((lat2-lat1));
double dLong=Math.toRadians(long2-long1);
lat1=Math.toRadians(lat1);
lat2=Math.toRadians(lat2);
double
=Math.sin(dLat/2)*Math.sin(dLat/2)+Math.sin(dLong/2)*Math.sin(dLong/2)*Math.cos(lat1)*Math.cos(lat
2);
double c=2*Math.atan2(Math.sqrt(a), Math.sqrt(1-a));
double d=R*c;
 return d;
        }
public ArrayList<String> getReverseGeoCodingLocationList(double latitude,double longitude,Context
context)
{
 ArrayList<String> alAddress=new ArrayList<String>();
Geocoder geocoder = new Geocoder(context, Locale.getDefault());
try {
List<Address> listAddresses = geocoder.getFromLocation (latitude, longitude, 1);
 if(null!=listAddresses&&listAddresses.size()>0){
String location = listAddresses.get(0).getAddressLine(1);
alAddress.add(location);
 } catch (Exception e) {
 e.printStackTrace();
  }
return alAddress;
 }
```

Fig 3. Code to calculate distance through application

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A. **Performance based on distances displayed by the application**.

From Section A, it is observed that there is a change in distance of <=1 metre with the updating location. To check the accuracy level, the data of 16 locations are tested using mathematical formulas. The data collected of 16 locations are shown in table 2.These 16 Locations are named from L1 to L16.The distance is taken in meters.

L1	L2	L3	L4	L5	L6	L7	L8
1362.63	1628.4	1630.1	1630.81	1754.6	1755.05	1756.31	1757.62

L9	L10	L11	L12	L13	L14	L15	L16
1800.69	1807.98	2353.75	2361.95	2362.74	3734.08	4779.19	4940.2

Table 2. 16 locations with distances retrieved through MicroAddress Recorder

The Graph in Fig 4 shows the change in Location and distance with time while a person is moving in a city of Faridabad.

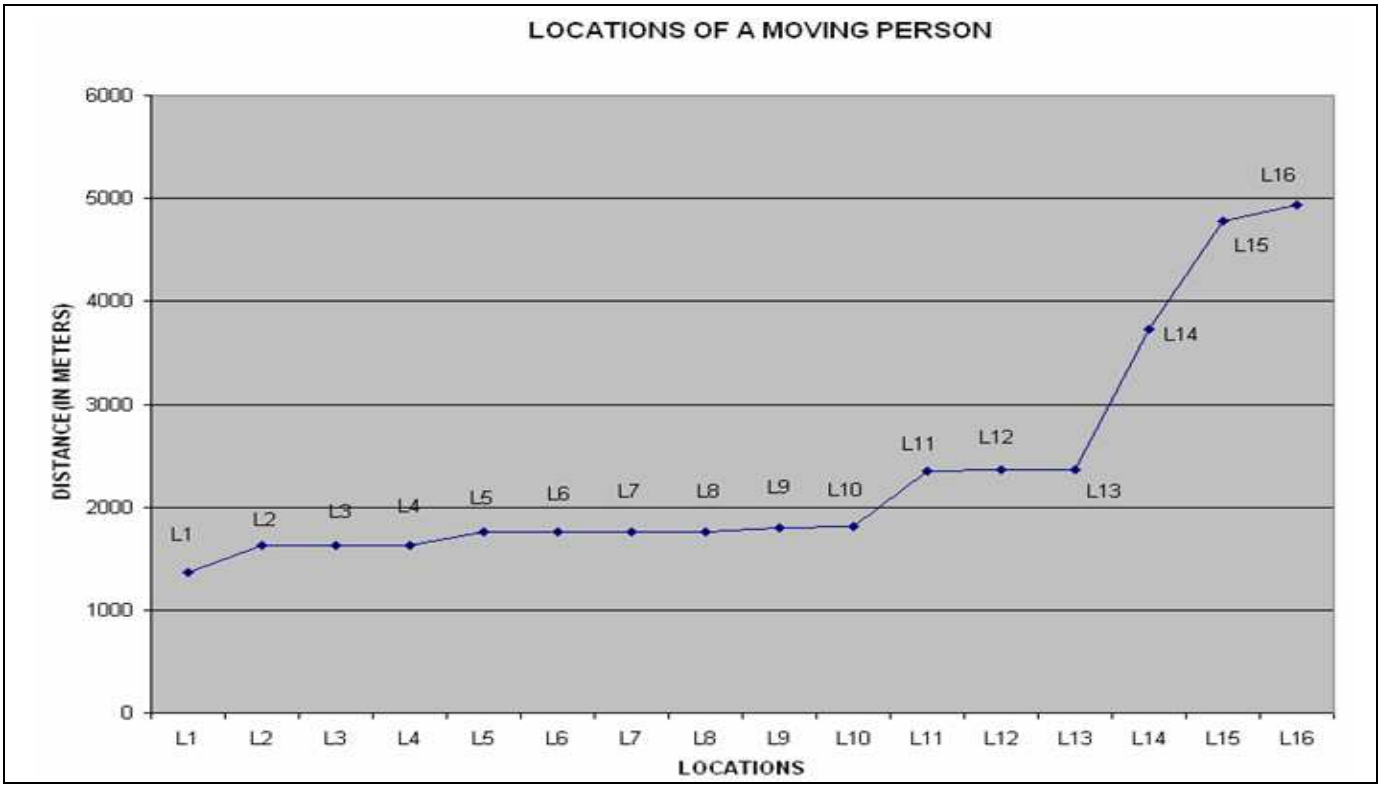

Fig 4. Graph showing change in Location of moving person

B.**Estimation Of Localisation Error**

The mean error is calculated using Root Mean Square formula. The data of 16 Locations are taken as shown in Table 3.

Sno	Location	PD	AD	D=AD-PD	D^2
1	L1	1630.1	1632	1.9	3.61

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2	L2	1630.81	1632	1.19	1.4161
3	L3	1628.4	1630	1.6	2.56
4	L4	1757.62	1760	2.38	5.6644
5	L5	1756.31	1760	3.69	13.6161
6	L6	1755.05	1760	4.95	24.5025
7	L7	1754.6	1760	5.4	29.16
8	L8	1800.69	1800	-0.69	0.4761
9	L9	1807.98	1800	-7.98	63.6804
10	L10	2353.75	2354	0.25	0.0625
11	L11	2361.95	2354	-7.95	63.2025
12	L12	2362.74	2363	0.26	0.0676
13	L13	3734.08	3800	65.92	4345.446
14	L14	1362.63	1365	2.37	5.6169
15	L15	4940.2	4950	9.8	96.04
16	L16	4779.19	4780	0.81	0.6561

Table 3 Mean error is calculated based on distances

In Table 3, there are two distances, one is PD called predicted distance retrieved by the application. Other is AD called actual distance. Using these two distances and by applying formula.

$$\text{Mean Error}=\left[\frac{n}{2}\sqrt{((AD1^2-PD1^2)+(AD2^2-PD2)^2+---+(ADn-PDn)^2}\right]$$

The Calculated Mean error of MicroAddress Recorder is =4.26, which is less as compared to other tracking applications.

B.2 **Derive New Straight Line Through Least Square Algorithm (Considering Error Only In Predicted Distance)**

Here, we will derive a new straight line, through which new values can be determined to check the change in error. Table 4 shows the data of 16 locations to fit straight line. Here we consider that the predicted distance contains an error and the actual distance is correct.

Sno	Location	AD	PD	AD^2	PD^2	AD*PD
1	L1	1.365	1.363	1.863225	1.856760517	1.85998995

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2	L2	1.630	1.628	2.6569	2.65168656	2.654292
3	L3	1.632	1.630	2.663424	2.65722601	2.6603232
4	L4	1.632	1.631	2.663424	2.659541256	2.66148192
5	L5	1.760	1.755	3.0976	3.07862116	3.088096
6	L6	1.760	1.755	3.0976	3.080200503	3.088888
7	L7	1.760	1.756	3.0976	3.084624816	3.0911056
8	L8	1.760	1.758	3.0976	3.089228064	3.0934112
9	L9	1.800	1.801	3.24	3.242484476	3.241242
10	L10	1.800	1.808	3.24	3.26879168	3.254364
11	L11	2.354	2.354	5.541316	5.540139063	5.5407275
12	L12	2.354	2.362	5.541316	5.578807803	5.5600303
13	L13	2.363	2.363	5.583769	5.582540308	5.58315462
14	L14	3.800	3.734	14.44	13.94335345	14.189504
15	L15	4.780	4.779	22.8484	22.84065706	22.8445282
16	L16	4.950	4.940	24.5025	24.40557604	24.45399

The Straight line is derived using formulas:-

$$na + b\sum AD = \sum PD$$

16a+37.5b=37.42

$$a\sum AD + b\sum AD^2 = \sum ADPD$$

37.5a+107.17b=106.86

The derived Equation is

$$Y = a + bX$$

Y=0.1+0.99X

Based on above equation, a straight line graph is shown in fig 5.Through this figure, any number of Y values can be determined for X values.

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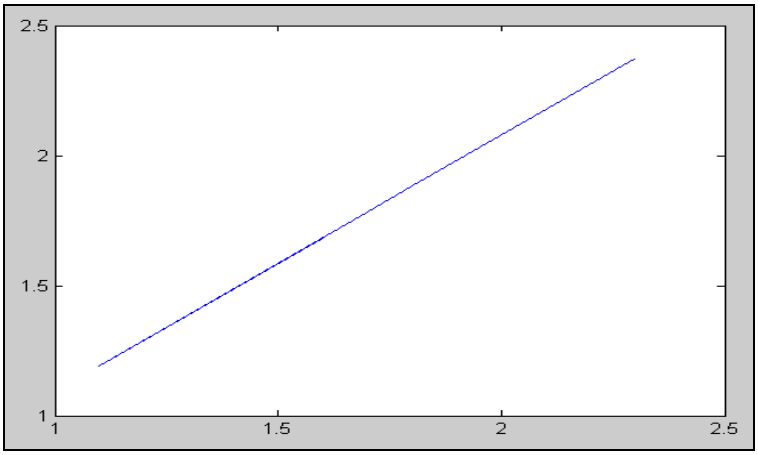

Fig 5: A Straight line graph based on equation y=0.1+0.99x

The new values of Y are calculated using the equation Y=0.1+0.99X.the values are shown in Table 5.

AD	1.365	1.63	1.632	1.632	1.76	1.76	1.76	1.76
PD	1.451	1.714	1.716	1.716	1.842	1.842	1.842	1.842
AD	1.8	1.8	2.354	2.354	2.363	3.8	4.78	4.95
PD	1.882	1.882	2.430	2.430	2.439	3.862	4.832	5.001

Table 5. New values of Y w.r.t X

B.2 **Derive New Straight Line Through Least Square Algorithm (Considering Error In Both Actual And Predicted Distance)**

A new straight line is derived with 16 locations using formulas:-

$$Xo = \frac{1}{n}\sum AD$$

X0=2.34

$$Yo = \frac{1}{n}\sum PD$$

Yo=2.33

$$A = \sum AD^2 - nXo^2$$

A=19.56

$$B = \sum ADPD - nXoYo$$

B=19.63

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$$C = \sum PD^2 - nYo^2$$

C=19.7

$$b^2 + \frac{A-C}{B}b - 1 = 0$$

b=1

$$a = Yo - bXo$$

a=-0.01

$$Y = a + bX$$

Y=X-0.01

Based on above equation, a straight line graph is shown in figure 6.Through this figure, any number of Y values can be determined for X values.

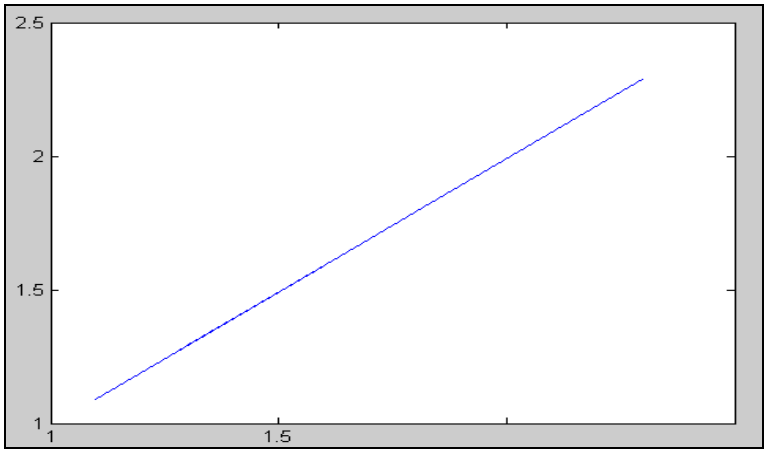

Figure 6: A Straight line graph based on equation y=X-0.01

The new values of Y using X values retrieved through equation Y=X-0.01 are shown in Table 6.

AD	1.365	1.63	1.632	1.632	1.76	1.76	1.76	1.76
PD	1.355	1.62	1.622	1.622	1.75	1.75	1.75	1.75
AD	1.8	1.8	2.354	2.354	2.363	3.8	4.78	4.95
PD	1.79	1.79	2.344	2.344	2.353	3.79	4.77	4.94

Table 6. New values of predicted distance using equation Y=X-0.01

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The Graph in fig 7 compares the Predicted distance retrieved through application derived through Algorithm 1 and through Algorithm 2.There are compared with the actual distance to validate the error and accuracy.

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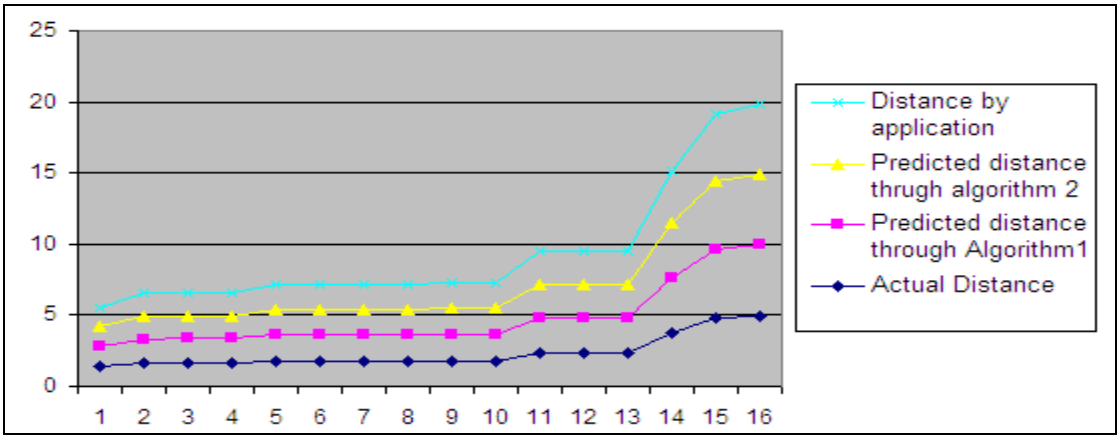

Fig 7 Graph shows comparison of predicted distances with actual distance

B. Correlation And Regression Algorithms

This Algorithm indicates whether Statistical relationship exists between the values of X and Y.

Regression of Y on X

$$byx = \frac{n\sum xy - \sum x\sum y}{n\sum x^2 - (\sum x)^2}$$

b_{yx}=0.99

Regression of X on Y

$$bxy = \frac{n\sum xy - \sum x\sum y}{n\sum y^2 - (\sum y)^2}$$

b_{xy}=1

Cofficient of Correlation $b_{yx} * b_{xy}$=0.99

As the value of Coefficient of Correlation is nearby 1 and positive. Therefore there is higher degree of positive correlation. This implies that the performance of application is positive**.** .

C. Locations displayed on map to make application more user friendly

To make the application more user friendly, the locations are displayed on maps with their distances. The two locations with their distances are shown in fig 8.

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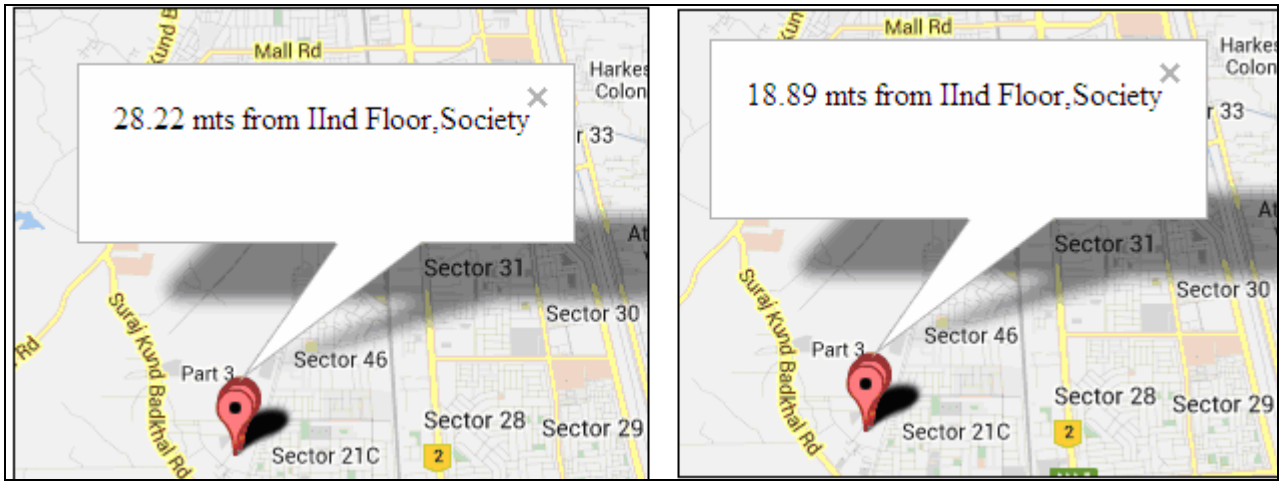

Fig 8. The change in Location and distance shown on mobile using Google Maps [5]

Simulation and Result Analysis

The performance of the application is based on distance retrieved through application w.r.t time. Different mathematical Formulas are applied to check the accuracy and error estimation. The simulation steps are as follows:-

1. The data is collected of various tracked locations. Calculate the threshold value of time for updating location and updating distance. The calculated threshold value is 1 minute with updating distance <=1metre.
2. The Mean error is calculated by taking 16 locations. The calculated value is 4.26.
3. Straight line algorithms are applied to create general straight line equation with two cases. Case 1: error only in predicted distance. Case 2: Error in both actual and predicted distance. using these derived equations, we can take any number of values other than 100 locations. to test the application..
4. Find the Correlation of Correlation using actual and predicted distance. If its value is –ve, the correlation is –ve.If the value is +ve and nearby 1, the Correlation is positive. The calculated value is 0.99.
5. The Location updation with change in distance is also displayed on map to make an application user friendly.

Conclusion

The use of various Mathematical Algorithms shows that the application MicroAddress Recorder achieved good and accurate Localization performance with mean error of 4.26(minimum as compared to others),the updating distance <=1 metre and the threshold value of time is 1 minute. The Cofficient of Correlation 0.99 shows that performance of application is highly positive.

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