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Effective Use of A-GPS for Generating Geographical Coordinates to Locate Natural Gas Utilities in Suburban Area

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Abstract : The purpose of this study is to see that how geographical coordinates (Latitude & Longitude) generated using AGPS device can be useful in improving the geographical location of point utilities. This study has shown the use of AGPS for improving the location of utilities (EG: pipelines laid underground, different valves, service regulators, etc.) in GIS software at any gas distribution company. An Assisted GPS receiver is used to capture the point location and get the geographical coordinates of that location. A survey in this study shows the accuracy of this AGPS under different urban circumstances. To assess the accuracy of Assisted GPS, its results are compared with DGPS instrument which has an accuracy within few centimeters. The results obtained shows that 68 times out of 88 AGPS has given accuracy within 10 meters, maximum error being 35.82 meters. If we compare it with current system, out of 505 SRs 65 are shifted from their position with range of 15 meters to 160 meters and 85 SRs are missing from their place which can be of any range may be in kilometers. This error is far more than the results obtained from AGPS survey hence it can be effective to use AGPS. Though this technique cannot be used where accurate point positioning is required but this cheap and economical technique is useful where dislocation problem is in large scale.

Keywords: Geographical Information System (GIS), AGPS (Assisted GPS), DGPS (Differential GPS)

INTRODUCTION

Geographical Information System (GIS) nowadays widely used tool for virtually managing the things in many organizations. A Geographical Information System is a tool, which can accept large volumes of spatial data derived from a variety of sources, retrieve, manipulate, analyze and display them according to user-defined specifications [9]. Mahanagar Gas Limited (MGL) also uses GIS for keeping and retrieving information about its utilities, those are laid on the surface of the earth. The utility is property of the company which is installed on the ground for the purpose. MGL is facing the challenge of dislocation of utilities in GIS software. This problem may be due to several reasons like errors in the drawing used to capture data, faulty capturing methods, etc.

Geographical coordinates i.e. latitudes and longitudes are used to indicate point location on earth's surface. It uses a three-dimensional spherical surface to define locations on the earth. Two coordinated indicated the two lines one is latitude and other is longitude, the intersection of which gives us point location. For example 27°10'30.0"N 78°02'31.4"E or 27.174996, 78.042056 indicates the location of Taj Mahal [8].

AGPS stands for Assisted Global Positioning System, now a days it is used in many mobile phones to identify the location. This location can be converted into respective geographical coordinates. AGPS is used in this study because it is easy and economical to generate geographical coordinates. The geographical coordinates are compatible with GIS software and location can be detected merely by entering coordinates in the software. AGPS works on the same principles as that of a GPS, the only difference here is that it receives the information from the satellites by using network resources like mobile network tower and bases. Hence we can say that AGPS gets assistance from fixed towers and bases to improve and accelerate the information to be received. If no assistance is available from the network, AGPS architecture allows the GPS to work in standalone mode. A GPS working principle is that it measures the time interval between the transmission and the reception of a satellite signal, and then it calculates the distance between the user and each satellite. To obtain a 2-D point position, information must be received from three satellites and for a 3-D point position, four satellites are required [12].

DGPS instrument is used as a reference device to analyze the accuracy of A-GPS device. The accuracy of mobile GPS is checked against the DGPS instrument *Trimble Geo XT*, it has accuracy within few centimeters. Differential GPS is basically a system which provide positional corrections to GPS signals. DGPS uses a fixed known position to correct GPS signals. GPS signals coming from satellites down to the ground have to travel through layers of the earth's atmosphere, so they are subjected to delays. This affects the time taken for the signal to travel from any given satellite to a GPS receiver, which introduces slight error into the GPS device, causing an error in the measured position. The ionosphere adds a ±16ns delay, to the signal being passed through. This can introduce around 5-meter error in position. For correcting signal DGPS uses Static Base Station. A static base station can be used to provide correction messages to DGPS instrument. This is done by setting the base station on the ground with exactly known location and then comparing this location with location received by DGPS instrument and thus correcting it. As DGPS instrument gives accuracy within centimeters hence the readings taken by mobile GPS are compared with DGPS instrument for analyzing its accuracy [4].

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In this study Service Regulator (SR one of the utilities of MGL) is used for the survey as SR connects the medium pressure pipeline with the low-pressure pipeline, it acts as a reference point for the pipeline also it gives an idea about the location of the pipeline, different valves and utilities around it. So just by correcting the location of any service regulator we consequently can improve the location of the majority of utilities.

Many researchers have done outstanding work in this area. Pragyan Paramita Das in his study analysed the effects of atmospheric conditions on GPS location [4], Ian Martin used GLONASS in conjunction with GPS to improve accuracy of point positioning [6], Paul A. Zandbergen in his research article 'Accuracy of i-Phone location' compared the accuracies of wifi and cellular positioning, M.D. Karunanayake in his study evaluated AGPS in weak signal environment using hardware simulator [12], Jia-Dong Zhang and Chi-Yin Chow in their study cited the use of geographical coordinates in location recommendation the paper shows how geographical coordinates can be used to recommend places to people where they usually go. Changsheng Cai, Jianjun Zhu in their study introduces the Chinese BeiDou satellite system and its comparison with the actual completed American GPS and the Russian GLONASS systems, this comparison is based on single point position, they used DGPS instrument for this study [1].

I. PROBLEM STATEMENT

MGL uses GIS software for identifying the location of the utilities laid on ground. This location information is tracked using Myworld software. This location information is inserted by GIS department using drawings prepared during actual installation of the utilities.

The problem MGL is facing is with the location of the gas utilities in GIS software. This problem is majorly due to drawings. To find out the root cause 505 drawings of service regulators has been analysed and it is found that 65 service regulators are shifted from their places in nearby premises and 85 service regulators are completely dislocated.

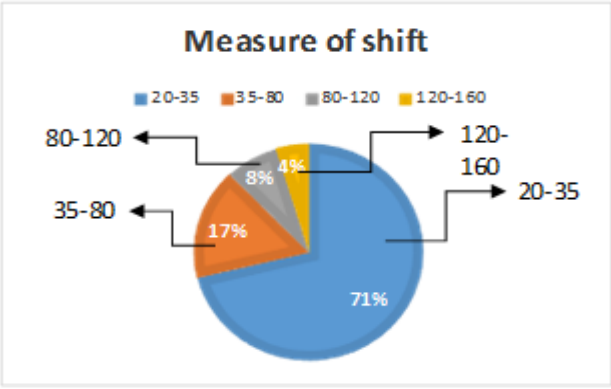

Figure 1 Dislocation error in existing method

The division of 65 SRs is shown in following pie chart. This chart shows division of 65 SRs according to their degree of shift. This dislocation distance varies between 20 meters to 160 meters. The case of 85 missing SRs indicates that these SRs may be dislocated in another area. So it is important that MGL should develop an effective capturing method. This study uses AGPS instrument to locate the utilities that gives much better accuracy to locate natural gas utilities.

II. METHODOLOGY

Finding the necessity of improving the location of utilities in GIS software at MGL, a survey is conducted to analyze the accuracy of geographical coordinates generated using AGPS. This survey is done in two different areas of Mumbai, one is near to base station and other is at distance from the base station. The purpose of choosing two different locations is to assess the effect of distance from the base station. Total 88 Service Regulators have been surveyed. The maps of two different areas indicating service regulators are taken out to cover every SR and to avoid rereading. The survey is conducted using Trimble's DGPS instrument and AGPS enabled Lenovo mobile phone. A step by step details of the survey is given below:

Table 1- Sample of readings taken

DGPS reading	AGPS reading	Difference(m)
19.0194319, 73.01720191	19.019478, 73.017215	4.46
19.01885192, 73.01635194	19.01884, 73.016448	10.21

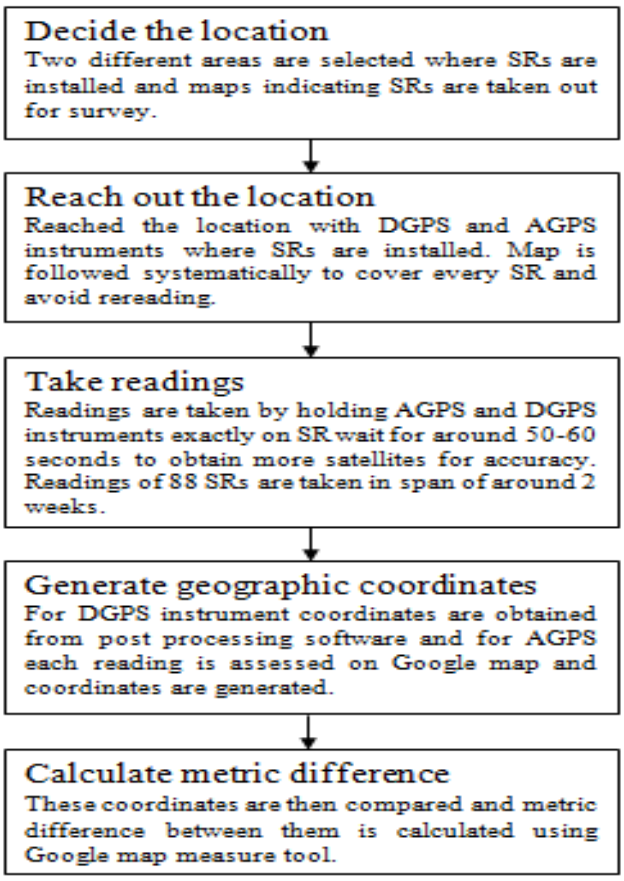

Figure 1- Flow chart of survey

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Maps of the area under survey are taken and SRs in those maps are marked with different numbers 1 to 88. The readings of 88 Service regulators taken simultaneously with the DGPS and AGPS instruments on the site area, the method consists holding both the instruments together over the exact position of Service Regulator and capturing the location in both the instruments simultaneously. The reading taken by both instruments gives the geographical coordinates of that location. In a similar way, all the reading are taken and coordinates are generated. For DGPS instrument coordinates are obtained from post processing software and for AGPS each reading is assessed on Google map and geographic coordinates are generated. After getting geographical coordinates of all SRs generated by DGPS and AGPS instruments, these simultaneously generated coordinates are compared and the distance between them are found using Google map's Measure tool, this distance between every simultaneous reading is considered as an error in AGPS reading. The flow chart shows the step by step process involved in survey. The results obtained later are compared with the results from existing process. For getting similar results from existing method 505 drawings are crosschecked with the GIS software and positional error is obtained in meters. This comparison has shown the effectiveness of use AGPS for capturing location.

III. RESULT AND DISCUSSION

The results obtained from the survey is shown in the figure below. It shows that 78% of the times AGPS gives the position within 10 meters of accuracy, out of 88 readings only 6 times it has shown the positional accuracy beyond 20 meters, maximum being 35.82 meters. This shows that the instances where utilities' dislocation range is in kilometers or where the whole area of location gets changed, in such situations the inclusion of geographical coordinates obtained from A-GPS is very useful. The table shows the range in meters and number of SRs included in that range. 68 SRs are within a 10 meters of accuracy.

In the line chart plot X-axis indicates the numbers of SRs whose readings are taken and Y-axis indicates the difference between readings taken by DGPA and AGPS instruments. The results obtained are shown in line chart, simple line shows amount of error of point position in meters obtained from AGPS instrument and dotted line shows the existing point error. 20 readings are compared to get an idea about effectiveness of AGPS instrument. Some readings are taken near the base station and some are taken away from the base station, there was a difference in these reading, the readings taken away from base station has much variation in error. This concludes that the accuracy and certainty of DGPS instrument reduces as the distance of area from base station increases. This is a major reason why DGPS instrument cannot be used for this purpose.

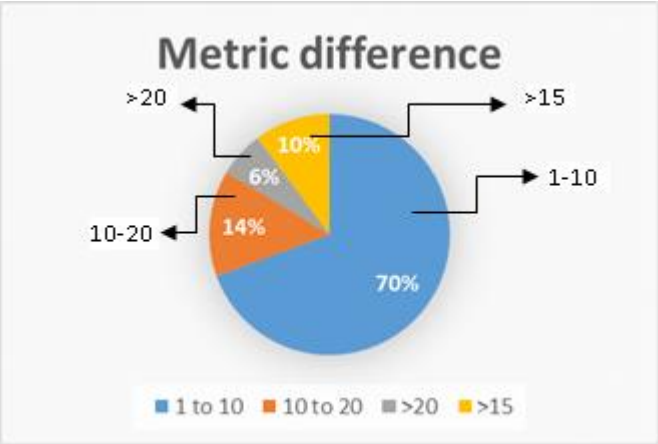

Figure 2- Division of result

IV. CONCLUSION

Use of geographic coordinates generated using AGPS mobile device for capturing location of utilities can be a good option to improve the positional accuracy. Though it cannot be used where accuracy required is within few meters but it can act as a good supportive feature in such cases. This system can capture the point location approximately up to 15 meters accuracy majority of times. The results obtained has shown that majority of the times AGPS gives the positional accuracy within 10 meters. If we compare this result with result obtained from existing method which gives positional error up to 160 meters and in 85 cases out of 505 SRs are not even at nearby premises which indicates complete missing of SR. So in these two cases use of AGPS will be very effective and this will improve positional accuracy of utilities.

Though this technique cannot be used where accurate point positioning is required but this cheap and economical technique where useful where dislocation problem is in large scale. This technique can help different organizations and people in instances where positional accuracy is to be analysed or crosschecked. There are different methods to capture positional data of utilities in GIS software especially drawings, geographical coordinates can be added in such drawing to crosscheck whether data is correctly captured or not. It is very important to maintain the accurate location in GIS software. This paper will give an idea to improve positional accuracy in GIS software, this study will be helpful for those organizations those are using Geographical Information System for different purposes.

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