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Automatic Vehicle Location Systems

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Abstract**—**In this article, a single application is suggested to determine the position of vehicles using Geographical Information Systems (GIS) and Geographical Position Systems (GPS). The part of the article material included mapping three dimensional coordinates to two dimensional coordinates using UTM or LAMBERT geographical methods, and the algorithm of conversion of GPS information into GIS maps is studied. Also, suggestions are given in order to implement this system based on web (called web based systems). To apply this system in IRAN, related official in this case are introduced and their duties are explained. Finally, economy analyzed is assisted according to IRAN communicational system.

Keywords**—** GIS-GPS-UTM-LAMBERT.

I. Introduction

NEW problems have occurred according to more increase in public or private transportation at urban transportation (or outer transportation) that different solutions are suggested and implemented to solve the problems (one of the most common solutions for solving the problems presented is using GPS[1]). Today, this method is used in many developed countries to show the location and speed of the vehicles.

Developed countries, usually use this system implemented by E-Commerce corporations and related organizations. The system could be used to tracker stolen vehicles and shows it's location on central computer monitor. Complainer' stolen vehicle announces vehicle plate number to police station (up to 24 hours after steal) to find the vehicle. The police trace the vehicle and after finding its location and reports it to the nearest police station for arresting thief and giving the vehicle. Such E-Commerce systems have many applications in different organizations such as transportation, harbors, petroleum industry and so on. Ordinary people could use their needed legal information by registering in sites and payment relevant cost.

In IRAN, currently, the police center could be informed by using this system after checking the vehicle number with fuel card (by RFID[2]) if violation occurred.

In this article, different structures and layer needed for implementing such systems are studied and a number of them are discussed.

It could be said, in this paper, main materials are about sending data from vehicles to receiver to trace vehicle in electronic maps.

First, we explain about the methods that could implement such system. Then available data in IRAN and the methods of providing digital map in the world and the comparison between methods used in other countries used in IRAN would be researched.

In continue, the different methods of mapping needed in IRAN and the world to display the points of inside the map are explained and then two well-known systems LAMBERT and UTM are discussed.

Finally, the method of sending coordinate conversion from the vehicle able to show coordinate in IRAN or world map are discussed, and required results are explained.

According to this material, the conclusions based on the importance of transportation and management by using these systems are explained to reduce goods and service costs.

II. Design and Implementation of This System in Global Layer

In this system (AVL[3]), the information exist in two parts, vehicle and central computer. The device set on vehicle including three parts, GPS, electronic board and device sending. First different information from satellite are received by GPS apparatus set on vehicle (generally, 24 GPS satellite cover all position on the earth) and are taken by electronic board to sender in order to send information to the central computer.

Device sending information placed on vehicle could use GSM[4] or RF[5] band with or satellite or combination of those as much as needed to send information to the central computer. All equipments explained exist in IRAN and it can be used to transfer information to the central computer. Then we could display information entered in the central computer by two approaches in map.

If primary cost is important and project is limited, application and database could be designed and implemented in one computer as the central computer (the computer could be placed in one company). This approach is called single AVL system. In this case, user must be where the central computer is and gets vehicles information by giving vehicles

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[1] - Global Position System
[2] - Radio Frequency Identifier
[3] - Automatic Vehicle System
[4] - global system
[5] - radio frequency

code or license plate number. You can use so simple software to implement this system in the case such as windows XP operating system and SQL Server as DBMS[6] [10].

The other approach is called Web based AVL system. A big company should support this case, because of more cost needed for starting. But it has grate ROI[7] for company which has financed because it could be seller of vehicles information in all over the world. Information must be transferred between client and server. The clients can see vehicles locations just by clicking a point on the map showed in all explorers like Netscape, Muzila or etc. Big E-Commerce Company uses this approach to sell vehicles, buses, and tracks information in their sites or by using SMS in telephones. E-Commerce companies could use this project to earn a little more money in the world by selling more information to ordinary people. If E-Commerce Company wants to use this approach, it could use different program languages like ASP.net[8], PHP[9], JSP[10] and so on.

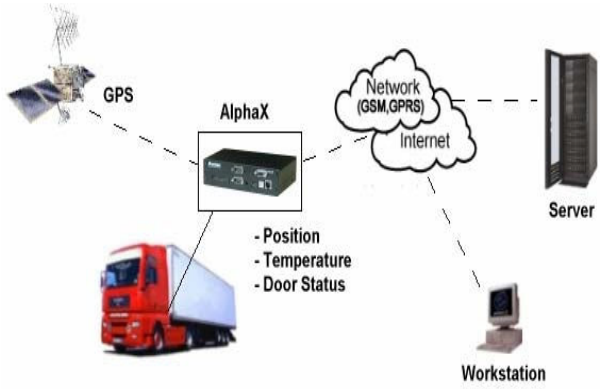

Fig. 1 information transferred by Web Base model

II. Information Exist to Implementation AVL System in IRAN

The being information based on Iranian equipment, tools and organization view used in this article have very differences rather than technologically developed countries. The authors first have researched in companies which had claimed of implementing this system in IRAN. For instance MASIR[11] corporations explained that to implement this system, first of all, you should buy last version of a map as paper. Then you should scan this image using a power full scanner. After that, you should just compare information sent by GPS and digital points to find car location and showing it on the map. In continue, this claim will be rejected by authors' explanations.

In the world, generally there are two approaches to make a digital map. First approach is called aerographic and the second approach is called chorography [9].

[6] - Data Base Management System
[7] - Reverse of Investment
[8] - Active Server Page
[9] - Personal Home Page
[10] - Java Server Page
[11] - P14-SARBEDARAN AVEN.-TEHRAN-IRAN

In the first approach, all points in the land must be taken picture by satellite surveying and be projected this pictures on chess pages to calculate some cell coordinates. This project terminologically called mapping. The other point's locations are calculated using these locations and digital map will be produced. It is called GIS[12]. Such cases are used in developed countries because of advanced equipment needed [3].

Second approach used while taking pictures in extended space of land isn't needed.

An airplane could be used to make images and then continue similar steps with first approach. The other approach done by a number of people trained in computer, some GPS and laptop devices. They should move on all the ways and put all coordinates GPS given in some files in laptop named by geographical ways coordinates. Finally the digital map will be made by such coordinate. So digital map not to make by information given by one paper map scanned by powerful scanner 'MASIR corporation said'.

Currently, converters like RS-USB-RT is used for GPS installation on all types of vehicles and some of software's as HyperTerminal that works on Windows XP OS[13] used to show information sent by GPS. Following picture illustrates such subject.

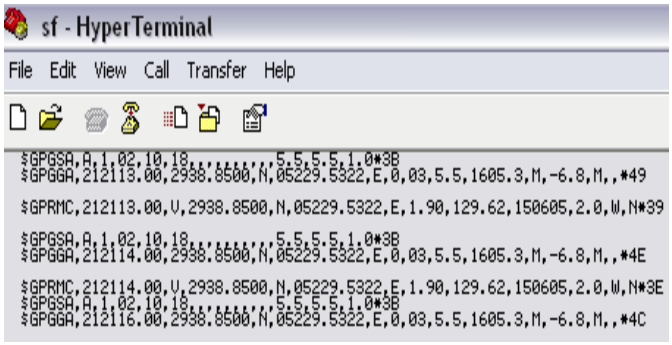

Fig. 2 information has sent by GPS model RFG2k, and shows the information on HyperTerminal software

GIS maps contain layers depended on information required by relevant organizations. For instance, transportation organizations that produce digital maps with information board on the ways, the ways quality, and etc. Urban transportation and traffic organization makes digital maps depends on relevant requirements such as traffic lights or street positions. Also municipalities control and manage something such as bus stations, subway lines, mono rails, and etc., and establish a GIS research department handling. The other organizations such as gas, electricity, water and telecommunication offices work as concentrating on such systems for which department is devoted again.

II. Projection Systems in IRAN and World

Because of the elliptical and dimensional shape of the earth, obtained coordinate could not be projected on two dimensional (x-y) maps. The projection is defined as different method to convert three to two dimensional positions and

[12] - Geographical Information System
[13] - Operating System

propose different ways to image the earth such as MERCAT, AZIMUTHAL, CYLINDRICAL, GRARDUS, LAMBERT, UTM [5].
Among them UTM and LAMBERT are more important and applicable. In LAMBERT approach, the earth is located in funnel such as one of semi-spheres is covered completely. As seen in figure 3, the funnel should be opened to project the map as two dimensional phases.

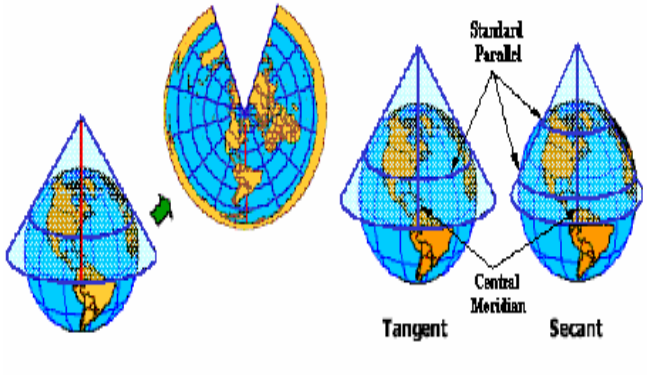

Fig. 3 the projection of the earth by LAMBERT approach [4]

In such method, by moving from equator to poles, latitude will be changed. So, to show points sent from GPS in digital map, that coordinate should be multiplied to a number, well known impressing coefficient. Such approach is useful for countries located in north semi-sphere, and IRAN for instance has used this approach so far [6].
In the UTM approach, the earth is located in cylinder such that equator line completely contacts to the earth.

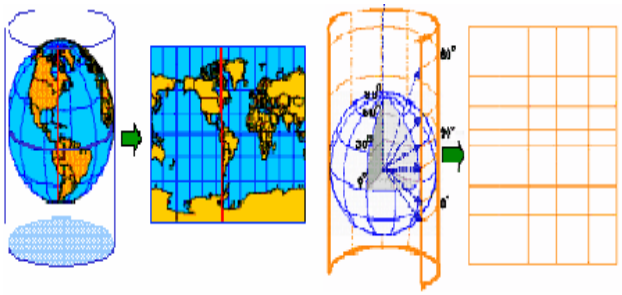

Fig. 4 projection of the earth by UTM approach [4]

Then each part of the earth is projected on an assumed cylinder with different magnifying coefficients, and finally cylinder should be opened as two dimensional images.
Approach UTM has some advantages rather than LAMBERT to make this approach more common place in current world [2]. For instance, one of which could be discussed as following:

According to the figure 3, the whole of the earth is imaged by a projection and so because of preventing negative coordinate, the point (0, 0) isn't be as center.

In other word, point coordinates is summed with (500000, 3000000).it means the coordinate of the earth center is (500000, 3000000). Another advantage of such approach is less dependency to arguments (magnifying coefficient) in converting three to two dimensional points. So, using such approach could have less calculations rather than LAMBERT approach for whole locations in the world. [1]

III. Points Coordinate Conversion Algorithms

Based on previous comments, the only remained action is that central computer receives quantity sent from GPS and shows its corresponding point in two dimensional space of computer displayer digital map. To apply this stage, already provided digital map is required in order to test points and to adapt them sent from GPS with inner points of the map Data Base (for instance, shiraz city avenue map). All of the maps prepared by different organizations in IRAN so far, have used LAMBERT projection system. So to implement AVL system in IRAN country, the usage of formulations including LAMBERT system for converting coordinate must be applied. To perform the conversions, based on data sent from GPS (figure No.1), as one float number longitude, latitude and altitude could be calculated. For instance, the number 5247.861 converts to 52 degree, 47 minute and 51.66 second. Now obtained latitude and longitude should be converted to two amounts PHY (latitude) and LAMBDA (longitude) with following formulation written with MATLAB software [7].

```
clear all
clc
format long g
phi=input('phi=');
Lambda=input('Lambda=');
Deg_phi=fix(phi/100);
Min_phi=fix(phi-Deg_phi*100);
Sec_phi=((phi-Deg_phi*100-Min_phi)*60);
phi=[Deg_phi Min_phi Sec_phi];
Deg_Lambda=fix(Lambda/100);
Min_Lambda=fix(Lambda-Deg_Lambda*100);
Sec_Lambda=((Lambda-Deg_Lambda*100-
Min_Lambda)*60);
Lambda=[Deg_Lambda Min_Lambda Sec_Lambda];
phy=(phi(1,1)+phi(1,2)/60+phi(1,3)/3600)*pi/180;
lambda=(Lambda(1,1)+Lambda(1,2)/60+Lambda(1,3)/3600)*
pi/180;
```

After calculating the amount of PHY and LAMBDA and obtaining that of Central parallel, Standard_parallel_1 and Standard_parallel_2, which are different for every country (refer to figure 2), the relevant amounts are put in next formulation, written with MATLAB software, and the final amounts of X and Y viewable in two dimensional coordinate are calculated and displayed.

```
f = 1/298.257223563 ;
a = 6378137;
b = a*(1-f);
e = sqrt(1-(b/a)^2) ;
%====================
phy1= Standard_parallel_1*pi/180;
phy2= Standard_parallel_2*pi/180;
phy0= Central_parallel*pi/180;
%====================
```

```
E=exp(1);
N1=a/(sqrt(1-(e*sin(phy1))^2)) ;
N2=a/(sqrt(1-(e*sin(phy2))^2)) ;
N0=a/(sqrt(1-(e*sin(phy0))^2)) ;
r0=N0*cot(phy0);
q1=log(tan(pi/4+phy1/2)*((1-
e*sin(phy1))/(1+e*sin(phy1))^e/2));
q2=log(tan(pi/4+phy2/2)*((1-
e*sin(phy2))/(1+e*sin(phy2))^e/2));
l=(log(N1)+log(cos(phy1))-log(N2)-log(cos(phy2)))/((q2-
q1));
K=N1*cos(phy1)/(l*E^(-l*q1));
q=log(tan(pi/4+phy/2)*((1-e*sin(phy))/(1+e*sin(phy))^e/2));
N=a/(sqrt(1-(e*sin(phy))^2)) ;
r=K*E^(-l*q);
X=(r*sin(l*lambda));
Y=(r0-r*cos(l*lambda));
```

There are also other notes in implementation on such system that are excluded from the material of this paper. For instance, the calculating of bias and matching of points sent including errors to points in Data Base could be pointed. To revise and implement the biases, artificial intelligent algorithms like neural network and phase's logic could be used [8].

IV. Market prediction and cost design

Since information needed of transportation situation in road, parcels tracking and so on are increasing day to day, make tracking systems obviously be required. On the other hand, due to this product isn't completely produced in IRAN, all of it's technologies will be handled by it's designer and also the designers could use this technology monopolistic. After manufacturing, system quality could be improved and also adding many peripheral components could be implemented of software view. Cost assessment shows that making an experimental device of such system needs to approximately investigation cost as much as 534000000 RLS. It's clearly that mass production make the cost decreases and after testing and launching the system, key segments like GPS and etc. could be bought with discounting and be bought by installation.

The above calculation (TABLEI) could be applied in IRAN assumed for supporting devices for five hundred thousand truck vehicles. Based on IRAN information, the above table is made according to the assumption of devices supporting for 500000 heavy vehicles. It is of important that the whole of costs exception rows one through four is needed to make an experimental one. In other words, just once these cots are performed and for providing the other devices, the costs aren't repeated. Also it's noted that, device manufacturing cost could hide in design calculation with 50 percent benefit.

In other words, if the design has 40 percent benefit instead of 50 percent and 10 percent remained is considered for device manufacturing cost, such quantities could be obtained with out change.

V. Conclusion

In this article two different method of computer implementation, single and web base, are discussed to display the vehicle location in the digital map. Then notes are explained about different methods being in the world to convert points coordinate from three to two dimensional coordinate. In continue, LAMBERT method already been used in IRAN is discussed and then it's result that LAMBERT method, for testing points and making a ready Data Base to match points coordinate sent, should be used. After that, formulation and quantity for converting points sent to match able points in Data Base required, is discussed and approximately analyzed.

According to the cases mentioned using web base, all people could be able to use of AVL system through internet network and connection to the relevant E-Commerce sites from all over the world.

So, in IRAN, according to the current facilities and possibility of general use in all zones of the world (Because, there is online sell possibility of the E-Commerce devices to other people in other countries through web) implementation of above method is proposed. Investors interested in E-Commerce which have limited investment to implement such system could used single method in tracking of their own corporation vehicles (specially provinces which have important role in transferring of fuel and other exporting and importing goods from harbors to distant place in the country). The advantages of the UTM projection system is much more than lambert projection system, so digital maps must be designed and implemented based on UTM system. To implement such design different organizations could divide country to various regions and each organization provides digital map based on information needed using UTM system.

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