UNIVERSITY OF CRAIOVA
FACULTY OF MECHANICS
SMAT 2008

SECOND INTERNATIONAL CONGRESS
AUTOMOTIVE, SAFETY AND ENVIRONMENT
23 - 25 October, 2008 – Craiova, Romania

USING GPS DEVICES FOR COLLECTING TRAFFIC DATA

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Abstract: *As the traffic volumes are increasing every day, collecting data about traffic is more and more difficult, and requires much expensive equipment. This paper presents a method and a tool for collecting these data based on cheap GPS devices. The GPS devices are currently used for navigation and monitoring vehicle position, and they can be used also to collect points and record tracks, and the data can be converted in information about the dynamic behaviour of the vehicle.*
Keywords: *traffic, GPS, data acquisition, software tool, CAD programming.*

1. INTRODUCTION

The GPS system consists of three pieces: the satellites that transmit the position information, the ground stations that are used to control the satellites and update the information, and finally the receiver [3]. The receiver collects data from satellites and computes its location anywhere in the world based on information it gets from the satellites. The GPS receivers don't send any information to the satellites, they only receive data from satellites, then send the information to a computer or other device, like PNDs.

The GPS receiver sends data in a string or sentence. This might look something like this:

$GPGLL,5330.12,N,00215.31,W,134531,A <CR><LF>

First, there is a NMEA code ($GPGLL), then the latitude, North or South, Longitude, East or West, Time (hhmmss), Data Valid (A), Carriage Return and Line Feed (the Carriage Return and Line Feed may not be visible) [1].

From this data string we need to use the latitude, longitude and time, and sometimes the altitude.

The GPS data are usually saved by the GPS devices and then downloaded on a PC as text files, in various format. The most used is the standardized, XML based format, called GPX [2].

2. EQUIPMENT USED AND DATA FORMAT

Any GPS tracking device can be used to collect geographic data. The tests were done mainly with two device types: HOLUX M-241, a GPS data logger, and Garmin GPSmap 60CSx, a device used for recording tracks and waypoints. Data is recorded in the internal memory of each device and then is exported to a PC using the USB connection.

The first device (Holux) exports data in text files; each line contains data for a recorded point. The sampling rate is given by the number of points recorded by time, or by distance. Holux M-241 record a point at every 5 seconds, as his fast recording possibility.

Example of exported data (each line contains: longitude, latitude, altitude, date and time):

```
25.5957108,45.6437531,578.83,Fri Jun 13 17:00:55 2008
25.5956726,45.6437645,578.38,Fri Jun 13 17:01:00 2008
25.5956078,45.6437683,592.58,Fri Jun 13 17:01:05 2008
25.5956078,45.6437683,601.56,Fri Jun 13 17:01:11 2008
25.5956078,45.6437683,605.48,Fri Jun 13 17:01:16 2008
25.5956078,45.6437683,609.27,Fri Jun 13 17:01:21 2008
25.5956078,45.6437683,611.66,Fri Jun 13 17:01:26 2008
25.5963650,45.6433105,613.45,Fri Jun 13 17:01:31 2008
```

Fig. 1. Data exported by Holux M-241

```
<trk>
<trkseg>
    <trkpt lat="45.620847" lon="23.306938">
        <ele>984.527</ele>
        <time>2008-08-06T15:34:55Z</time>
    </trkpt>
    <trkpt lat="45.620841" lon="23.306921">
        <ele>984.047</ele>
        <time>2008-08-06T15:34:56Z</time>
    </trkpt>
</trkseg>
</trl>
```

Fig. 2. Data exported by GPSmap (GPX format)

Fig. 3. A track viewed in MapSource (MapSource is a mapping software distributed by Garmin)

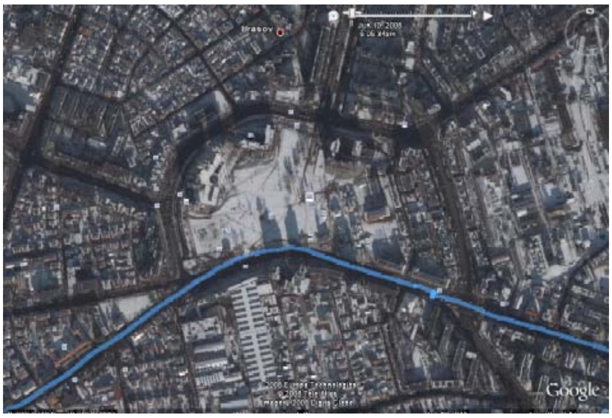

Fig. 4. The same track viewed in Google Earth

The second device (Garmin) exports data in GPX format. The fastest setting for recording tracks is one point at every second.

An example of exported data is shown in figure 2.

A track recorded in a GPX file can be viewed using map programs (fig. 3) or Google Earth (fig. 4). Using this kind of software us useful for viewing the track on a map and identifying the location [4], but no information about the vehicle behaviour is available.

3. SOFTWARE FOR DATA VISUALIZATION AND ANALYSIS

3.1 Presentation of the Program

In order to analyze the data collected from the GPS devices, it was developed a software tool, using AutoCAD as environment. This CAD medium was chosen because it offers many tools to the user and to the programmer (developer), who can focus on the functionality, since the graphic is included by the CAD system. The programming language used is Visual LISP. The advantages of using this language include the quick interactivity with the CAD objects and the speed of development. The goal was not to develop a complete commercial software, but to write some functions and use them for data analysis.

The program support text and GPX file formats, to import data from both Holux and Garmin devices. Since GPX is a standardized format, many other devices may be used.

A track is represented using points and lines. Each of these entities contains some geometric data and properties like colour, line type or layer, needed to manage the geometric data inside the CAD system. In order to manage the GPS data, the new program developed is capable to add custom data to the existing objects. So, the information about latitude, longitude, altitude and time are added to each point. Latitude, longitude and altitude are converted in *x*,*y*,*z* coordinates, then the distance between points is calculated based on the coordinates. From distance and time results the vehicle speed. All this data is added as custom data (*metadata*). The lines drawn between points include also metadata. Some examples of metadata are presented in the figure 5.

The program can then interrogate the drawing objects to obtain custom data like speed, and then use these data for various purposes, like representing the vehicle speed in the drawing.

Point:
(("vxk" . 14.2306) ("type" . "gps_point") ("Time" MAY 13 2008 07:06:05) ("Long" . 25.5987) ("line2" . "128C") ("line1" . "1275") ("Lat" . 45.6448) ("id_traseu" . "1") ("id_point" . 195) ("Alt" . 603.91))

Line:
(("Viteza" . 9.50302) ("VerLen" . -0.79) ("type" . "gps_line") ("TimeSec" . 5) ("p2" . "126C") ("p1" . "1255") ("Length" . 13.1986) ("id_traseu" . "1") ("HorLen" . 13.175))

Fig. 5. Metadata for points and lines in a track

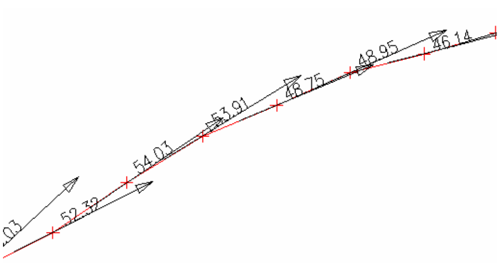

Fig. 6. Vehicle speed represented in AutoCAD

Another function can calculate for example the accelerations, and then represents the values and orientation in the drawing; and same for other dynamic properties of the vehicle.

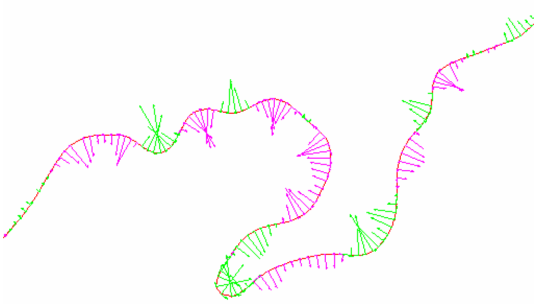

Fig. 7. The lateral acceleration represented on a track

The capabilities of the program include:

- read information from text and GPX files, exported by the GPS devices;
- draw the tracks in the current drawing;
- adding and reading metadata to/from the existing CAD objects;
- calculate vehicle speed and accelerations, and other dynamic data;
- represents the speed and accelerations on the track, in the AutoCAD drawing;
- draw waypoints from GPX files (like those recorded by Garmin GPS devices);
- delete points from a track, if these are considered useless;
- calculate a medium point, based on the coordinates of more points of the track;
- generate a medium track, if more recorded tracks are available for a route;
- split a track in a selected point;
- export a selected track in GPX file;
- export a selected track in Excel file (CSV);
- draw diagrams for speed, acceleration, altitude and others, depending by the travelling time or distance;
- identify a point on a track based on a selected point in the diagram;
- find the highest and lowest points on a track, using the altitude information;
- simulate the vehicle travel by animating his movement on the selected track, taking into account the vehicle speed;
- eliminate the "noise" caused by the GPS device errors when the vehicle is stationary.

3.2 Using the Program for Collecting Traffic Data

In order to record a track, the GPS device should be placed in a vehicle. The vehicle will travel following the route established for traffic analysis. During the travel, the GPS device records data like in the figure 1 or 2, and these data will be exported later on a PC.

Usually, the traffic volumes are measured by counting the vehicles that passes through a point in a given period of time, using manually devices, inductive loops, radars or other similar sensors. The GPS method consists in travelling on the given route, following the traffic flow. Then, after many passes, based on the necessary time for travelling between two points, it can be estimated the number of vehicles passing on that route in the given time. The method is not so accurate like using the radars, but is much affordable.

It can be measured also the time passed for entering into an intersection, or for travelling on a route at rush hours. In these cases the regular methods are not efficient, because of the lower speed of the vehicles.

The steps when using the program are:

- load the program using the AutoLISP native function “*load*”;
- read a data file (*txt* or *gpx*); when reading a *gpx* file, it is possible to read more than one track at the same time;
- draw the track;
- put speeds (the values are already calculated, when the track is drawn);
- calculate and draw the accelerations; calculate also other dynamic data (like rolling resistance);
- make diagrams.

To evaluate an urban cycle, for a given route, the program can draw the diagram of speed depending by the travelled distance (figure 8) or time (figure 9). Both diagrams in the example below are for the same route, at the same time. It is easy to identify the points where the vehicle was stationary (see figure 9).

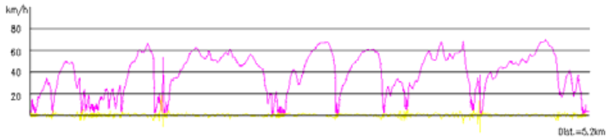

Fig. 8. Diagram of speed depending by travelled distance, on an urban route

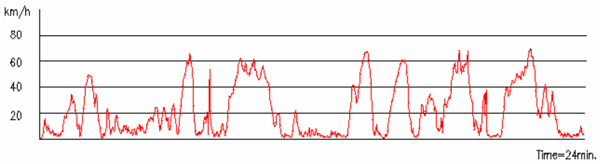

Fig. 9. Diagram of speed depending by travelling time

Using waypoints marked on the GPS device, it is also possible to add extra information that indicate gear shifts or other events. In this case, a second person is required beside the driver, to mark the event’s points during the travel. The shifting points may be added on the diagram and then it is possible to synchronize them with the recorded track. The portions of the plot that correspond to certain gears can be shown with different colours.

4. CONCLUSION

The program developed for analyzing data recorded by the GPS devices is in the development phase, and more features may be added in time. It is a research tool, focused on functionality, not on interface. It uses the geometric and graphical capabilities of AutoCAD, as well as the flexibility of the Visual LISP API. Even if the accuracy of this method is not enough for traffic measuring at normal vehicle speeds or for determining the road profile, there are good results when the traffic flow is too low, for example at rush hours.

Based on the same data it is possible to make more analysis, like the vehicle dynamic behaviour [5].

5. REFERENCES

[1] Garmin International, *Garmin Proprietary NMEA 0183 Sentence Technical Spec. 2006,* http://www.garmin.com.

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[3] Dale DePriest, *A GPS User Manual,* http://www.gpsinformation.org.

[4] *** CEEX X2C25/2006 Project - Saighid, *Advanced Services for drivers and travellers information and guiding, using digital maps.*

[5] Ion Preda, Dinu Covaciu, Gheorghe Ciolan, Dragoş-Sorin Dima, *Vehicle Dynamic Behaviour Analysis Based on GPS Data,* SMAT2008 Intl. Conference, Craiova, 2008.

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