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Development of a vehicle tracking system based on MapWindow GIS

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Abstract

Free and Open source software (FOSS) is one of trends of software development in the future. At present, there are many FOSSs in geographic information system (GIS) field such as GeoServer, MapServer, OpenLayer, Mapwindow GIS, Quantum GIS, etc.. These software systems have been widely applied in many fields to deal with particular problems. This paper presents the usage of an FOSS to solve the tracking and monitoring problem in transportation. We develop a software system called "Read Card Global Positioning System" (RCGPS) based on Mapwindow GIS to track and to calculate movement distances of vehicles. Vehicles use a GPS-based monitoring device, which generates and stores data including their coordinates, speed, and status in the memory card. RCGPS then analyzes these data files and displays the routes on the map using MapWindow GIS environment. Simulation results show the high applicability of MapWindow GIS in application development related to digital map.

Keywords: MapWindow GIS; digital map; GPS; tracking system

1. Introduction

GPS (Global Positioning System) is invented by the US military in the 1970s. In the 80s, the US government has allowed to use GPS systems for civil purposes of organizations and individuals people worldwide and is completely free. From up to now, the device GPS applications in the fields of human life flourished and became more popular, especially in advanced countries.

In Vietnam, the application of GPS system is still relatively new especially in the field of life. Applications of GPS can be mentioned here as applications for traffic management, tracking and navigation devices, personal tracking... Another advantage of GPS is that the cost associated with the procurement and installation of equipment has been greatly reduced. Nowadays, users just need only spend a few dozen to a few hundred dollars that can be owned in hand GPS navigation device. But in VietNam, GPS applications mainly focused on navigation devices mounted on cars or integrated into modern mobiphone. However, navigation devices that Vietnamese people are using are imported from abroad, mainly from China. Tan A Chau equipment and automation technology limited Company is a pioneer in the field of research, manufacturing equipment for civilian GPS navigation has brought to market products for the smart black box transportation (IBEE - Intelligent Blackbox Everytime Everywhere). In addition to features such as positioning, tracking information such as speed, direction of travel, information on fuels and lubricants... of vehicles in real time, the device also comes with a removable memory card allows to save all the information about the vehicle journeys. However

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the aggregated data from satellites and devices are encrypted when stored on a memory card. Thus in order to read the data in the memory card needs a specialized software to process and analyze the data encrypted. On the basis of the data has been analyzed roadmap rebuilt vehicles which have been away.

In this paper, we will introduce the development of software applications bundled with hardware devices IBEE allows to analyze of location data and other parameters, which are encrypted and stored in memory card. While illustrating the exploitation and application of effective open source software MapWindow GIS to display results visually on the digital map.

2. Background

2.1 Hardware devices

Tan A Chau Equipment and Automation Technology limited Company has successfully in researched equipment GPS satellite navigation with the name "Black box for vehicle smart move - IBEE". This product has been registered rights and took into market. This device is mounted on the moving vehicles to monitor the journeys, mostly current device is mounted on a car. The basic features similar to the type of navigation device abroad it also has some other advantages features.

Fig.1.IBEE device satellite positioning

Some features of IBEE:
• GPS satellite positioning.
• GPRS connection, data transfer time setting.
• Cost savings, cost only when the device moves.
• Support for the journey to the memory card.
• Built-in temperature sensor, gas, oil, car keys, infrared.
• Supported the output / input, relay control.
• Connect the camera allows taking pictures.
• Have spare battery source, supports charging.

Each device has a unique identifying code, and is mounted on a car. Equipment using energy from the car's battery, in case of need could use a power supply device portable charge. Each device is mounting a telephone sim card, mobile subscribers are registered service GPRS. The main purpose of the installation of the SIM card into the device that is using a GPRS connection in the transmission data sequence obtained from the device and from the satellite on Server.

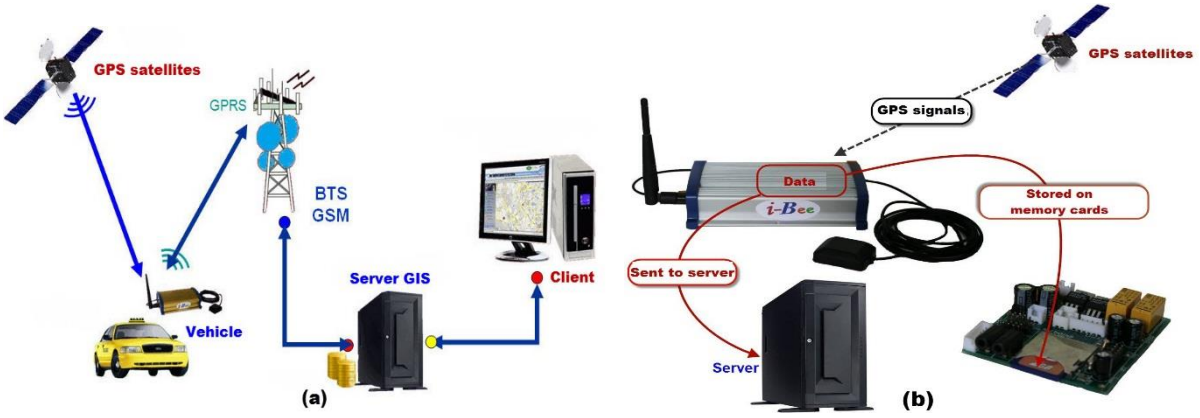

Fig. 2. (a) Operating model IBEE; (b) Data storage method of IBEE

When the device is attached to the automobile, in the process of moving it will auto GPS receiver from the satellite and then synthesize the information of GPS signals obtained in conjunction with the parameters recorded from sensors and conducted encoding parameters constitute a data series from time to time under the set time period (5s, 10s, ...).

- Satellite data includes parameters: longitude, latitude, speed of movement of the automobile, the angle of the vehicle, the time of the satellite signal (hours - minutes - seconds), date signals (day - month - year)
- Data device parameters include: fan status, locked car status, memory card status, emergency status, temperature sensor, infrared, Control roles ...
  After aggregate data into a string of the form as shown below:
  DATA1.NASIA00024.TT00003700.ST001000000.C,030326.000,A,2117.2424,N,10537.9969,E,12.67,230.66,251209,,,A*5
  @STOP.NASIA00025.TT00002800.ST401100000.C,025430.000,A,2004.1284,N,10553.5601,E,0.07,103.19,251209,,,A*670
  @REPO.NASIA00010.TT00003101.ST000000000.C,025100.000,A,2052.5885,N,10534.6512,E,0.20,128.32,251209,,,A*6B104

In each of the above data string will contain the entire parameters of cars at a certain time. Each data series will include the following information: title sequence data indicates the status of the vehicle is running or is stopped, the device ID (each a device only a single identification number), parameters indicate the status SOS (emergency status when there arises automobile accidents), temperature parameters of the equipment, parameters of the infrared port, Control relays, the status of the memory card, business latitude, longitude, speed, angle of rotation of the car at every given moment. Each device has attached a GPRS sim card as stated above, it is responsible for sending data synthesized strings on the Server via GPRS and data simultaneously recorded to a memory card strings attached on the device. Within the scope of this paper we will not cover issues related to the process of transmission and data processing on the server that will focus on the presentation of data stored on the memory card as well as the building of applications analyze this data set.

2.2 Data File

Principles of sequence data stored on the memory card is as follows: The data sequence after synthesis can be saved to a file extension .gis (similar to text file) on each day. The name of the file is placed on the following principles as the opening number of devices and after the day store data. Day data will be saved in each file corresponding to that date.

For example, file named NASIA00031200916 said data file is stored in the device is code 09 NASIA00031va in May 20, 2016.

Currently attached to the device memory card is the popular mobile cards in the market for digital devices fitted as digital cameras ... As calculated with 2GB memory card that can store data of device within 2 years. In case of necessity want to check the data that users can remove the memory card and reads the information stored in the memory card.

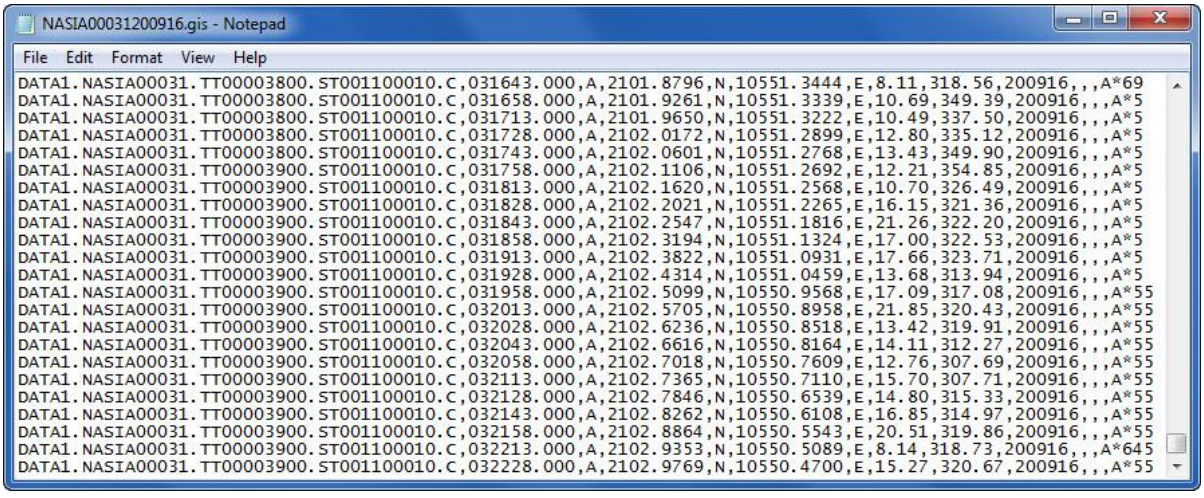

Fig.3. Data stored in the file NASIA00031200916.gis

Each contains a data string of media information in a certain time, suppose the data sequence:
DATA1.NASIA00031.TT00003100.ST000100010.C,003157.000,A,2110.0591,N,10544.5142,E,21.05,137.91,200916,,,A*5
Will be contained the information as shown in Table 1 below:

Table1. The main parameters in a data series

Parameter	Meaning parameters
Header packet (5 characters)	The status of the vehicle
device ID (10 characters)	device ID
Status SOS (2 characters)	Identify emergency
Battery capacity (2 characters)	Determine % current battery equipment
Status MMC (2 characters)	Check the memory card and record the status of the device to the memory card
Status Infrared port (1 character)	Determine the status of the infrared port
Time (10 characters)	Defining the time saved newsletter
Latitude (9 characters)	Determine the latitude of the vehicle at the time of saving newsletter
Longitude (10 characters)	Determine the longitude of the vehicle at the time of saving newsletter
Velocity (5 characters)	Determine the velocity of the vehicle

2.3 MapWindow

One of the requirements is that after decoding the data strings stored in the file on the memory card to move up a roadmap of the future means that based on digitized maps that can observe directly and perform the search function other information. We have studied many open source software involves the manipulation and processing of map data to assist us in the implementation of the above requirements, and open source software is our consistent look MapWindow GIS is selected.

The MapWindow GIS application is a free, extensible GIS that can be used in many ways:

- As an open-source alternative desktop GIS
- To distribute data to others
- To develop and distribute custom spatial data analysis tools

MapWindow GIS is an open source "Programmable Geographic Information System" that supports manipulation, analysis, and viewing of geospatial data and associated attribute data in serveral standard GIS data formats. MapWindow GIS is a mapping tool, a GIS modeling system and a GIS application programming interface (API) all in one convenient redistributable open source solution. MapWindow consists of the main MapWindow application, CoreComponents, and plug-ins.

- Main Mapwindow Application: This is the central interface for MapWindow. From here, the user may view data elements such as Shapefiles and Grids.
- Core Components: These are the components which operate underneath MapWindow. The three main components are MapWinGIS, MapWinInterfaces, and MapWinGeoProc.
- Plug-ins: These are specialized tools written to interact with the main MapWindow application. While MapWindow is mainly a data viewing tool, the real power of MapWindow comes in the form of plug-ins.

MapWindow GIS was developed on the basis of .NET systems, and core software is MapWinGIS, an ActiveX control. Therefore, it allows users to manipulate data on a map layer by writing the code (script) in the programming language C # or VB.NET. A different form of expansion through plug-ins. MapWindows GIS available in a number of plug-in support basin divide.

The information on downloading source MapWindow which can refer http://mapwindown.org site. Currently Mapwindown .NET development platform can use C # or VB.NET.With this system we select VB.NET to build and develop its software.

3. Design and Implementation

3.1 Functional Decomposition Diagram

Based on the requirements of software building, we analyzed the function of the software for the analysis of data files and display analysis results on the digital map. The function of the software is analyzed, designed and described in four main groups as shown in Table 2.

Table 2. Group of software main functions

Groups	Descriptions
System function	Perform the functions as software configuration settings, account management, system sign in and sign out, etc. ...
Mapping function	Perform the functions related to opening, closing maps and mapping manipulation, such as layers management, set the map scale, reference maps, zoom in, zoom out, movement, etc.…
Data analysis function	Perform an analysis of the data file in the memory card to decrypt and display parameters of the vehicle route onto the map background.
Support function	Software introduction and manuals.

1. 3.2 Database Design

Each data series contains a lot of information related to the vehicle at any time, the system will perform the analysis, decode them one by one and save in the database. The entity diagram E-R of the system is given in Figure 4 (a). We choose MS SQL Server as DBMD and design database named DB_CARD includeing 6 table illustrated in Figure 4 (b), where:

- Dbo.tb_card_login: Store information about the system login.
- Dbo.tb_card_Devices: Store information about devices.
- Dbo.tb_card_Users: Store information about device users.
- Dbo.tb_Users_Devices: Store information about relation between users and devices.
- Dbo.tb_card_Device_Date: Store ID devices and date of data storage.
- Dbo.tb_card_Device_Data: Store the analyzed information from the data file in the memory card corresponding to the device and date of data storage.

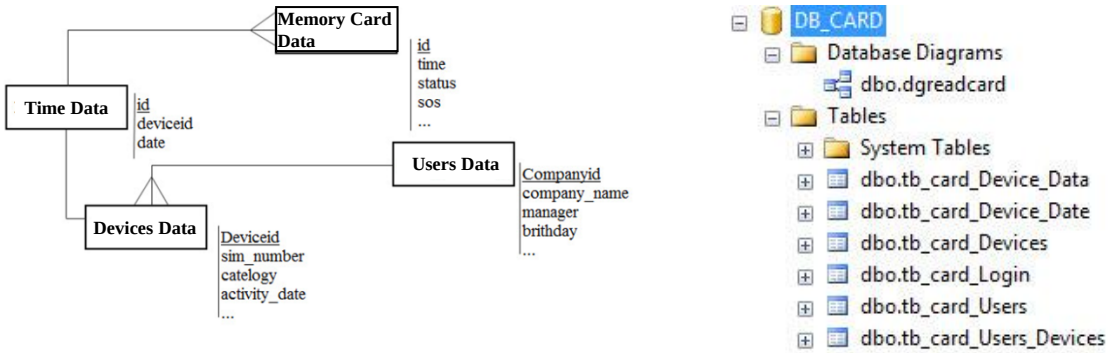

Fig.4. (a) Link entity diagrams; (b) Database in SQL Server;

2. 3.3 Implementation

To build applications, we use MapWindow GIS software with open source, version 4.x Desktop, VB.NET programming language. We use the mapping data processing features and manipulation of digital map of MapWindow GIS software to display the route of the vehicle and determine parameters from time to time as well as calculate the traveled distance by vehicles in a day.

In the group of software main functions as described in section 3.1, we focus on group of data analysis functions with three main modules: Reading data (from memory cards) module; Data analysis module; Data display module. All modules has been tested with different data files, errors edition and processing optimization to ensure operating correctly, meet the technical requirements and user interface. The results of running the software modules are shown in Figure 5 below:

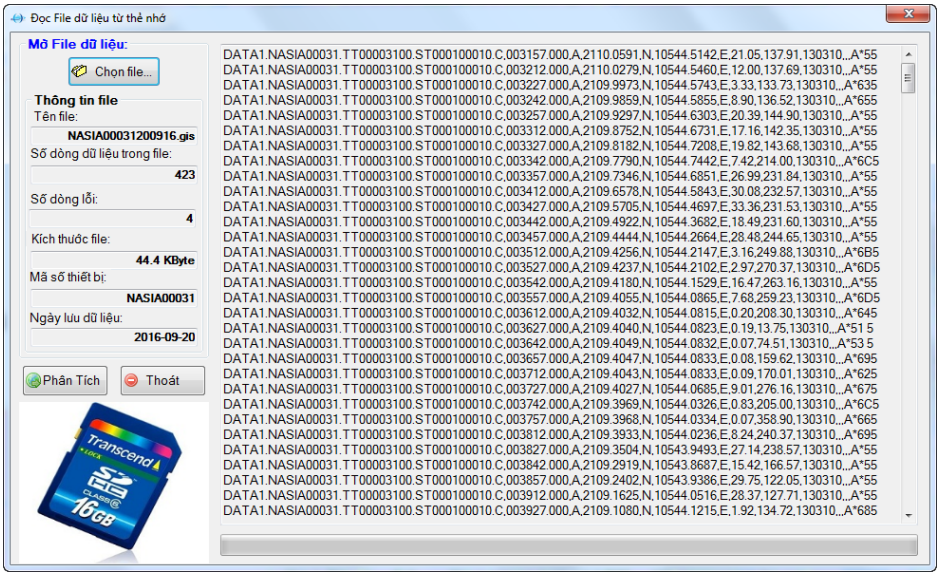

Fig.5. (a) Reading data (from memory cards) module

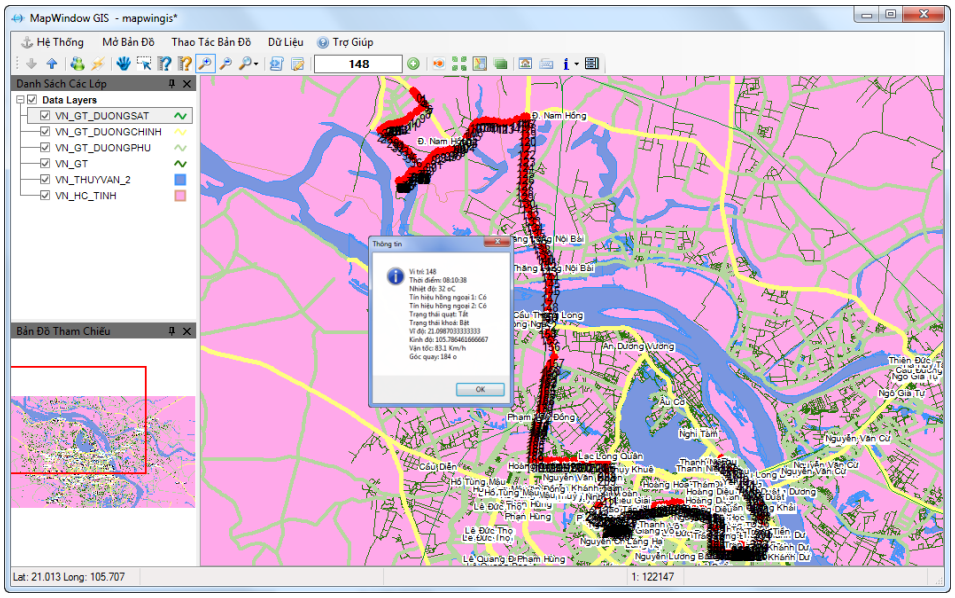

Fig.5. (b) Data display module

4. Conclusions

In this paper, we have presented the development of a vehicle tracking system using with hardware devices to apply the features of the IBEE device; The software has been functionally tested and deployed in several transportation companies.. The software works well, meet the requirements and its graphic user interface is friendly andeasy to use.

Currently, the use of open source systems have become popular. System benefits that open source brings is huge. Users have the right to modify, improve, develop and upgrade with general principles that do not need author's permission, it is not allowed to do with copyrighted software. In our application, we have done the most in using the features of MapWindow GIS open source software by customizing, editing and adding modules to suit the requirements problem.

With the development base on MapWindow GIS, application software allows for the analysis of the data file, decode the series of parameters at any time and display the entire route of the vehicle moving in day on the digital map. Also allow identifying the vehicle information at any time and calculating distance that vehicles has moved.

References

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