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To cite this article: Hongrui Wang *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **234** 012047

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# Application Development of Moving Target Route Playback Technology in Intelligent Transportation System

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**Abstract:** "The 13th Five-Year Plan" emphasizes the concept of intelligent transport in its major project columns. For scene conflicts and ground accidents, it is extremely important to apply intelligent technologies to post-processing. In order to facilitate post-processing evidence collection, and provide reference for similar conflicts planning or accident prevention. The track playback system of vehicle is constructed by the design of three modules: software based on C# and SQL Server for receiving original positioning data in a positioning receiver of vehicle; time and coordinate conversion in the computer server; Baidu map API combines JavaScript to create track playback web page. The built system can realize the historical record query function of the vehicle, and provide information of time, latitude and longitude for each point in the path.

## 1. Introduction

"The 13th Five-Year Plan for the Development of Modern Comprehensive Transportation System" points out that it is necessary to carry out the intelligent development of information technology throughout the entire chain of transportation construction, operation, service, supervision. The transportation industry should improve the utilization rate of BeiDou Navigation Satellite System. In the transportation construction key section of "The 13th Five-Year Plan", it needs to promote the Internet based transportation tools and operational information, improves operation and maintenance, and promotes operational intelligence. Considering the application of intelligent technology in the transportation industry is of great significance. In order to curb the occurrence of major accidents effectively, it is necessary to strengthen traffic safety supervision and improve emergency support capabilities. However, there are many types of vehicles on the road surface. Different scales of conflicts and collisions cannot be completely avoided. Therefore, it is necessary to provide intelligent solutions. The realization of vehicle track playback is conducive to improving driving quality and provides an important basis for accident handling so that provide reference for conflict prevention.

In recent years, with the mainstream map platform officially announced the opening of the free map API, developers of all social circles have a faster and more convenient choice when developing map-related applications [1]. Baidu Maps API is a set of application interface based on Baidu map and is free for developers. It includes JavaScript and Web services, with a lot of functions such as basic map display, geographic information search, location, route planning [3]. Based on Baidu map API, we design a path track playback system for scene vehicles in actual movement.

## 2. System Design and Key Technologies

First, the first step of the track playback implementation requires the latitude and longitude positioning information of the path. The navigation-positioning signal sent by satellites is an information resource



that can be shared by numerous users. The users need to have a receiving device, which can receive, track, transform and measure the positioning signal in order to use the positioning signal. Chinese self-developed global satellite navigation system is called BeiDou satellite navigation system. As of November 19, 2018, a total of 43 BeiDou navigation satellites has been launched.



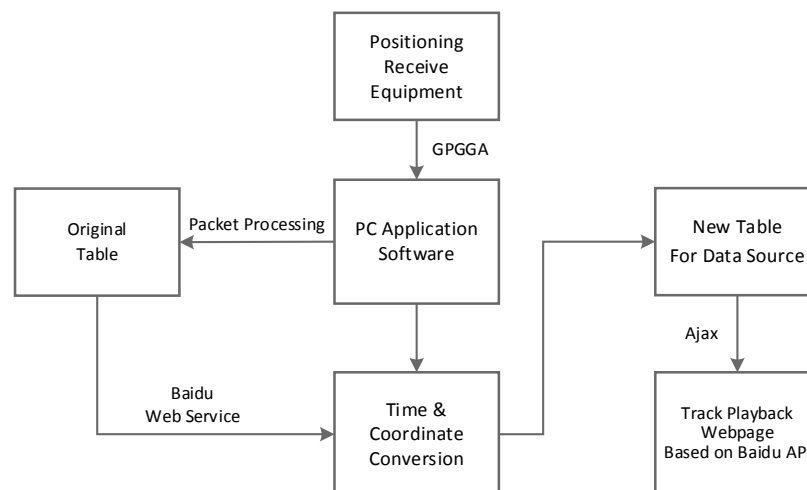
**Figure 1.** Coordinate conversion example

Second, after the original latitude and longitude positioning information is obtained, data processing is required. The international standard of latitude and longitude coordinate is the World Geodetic System 1984. Domestically, the GCS-02 developed by the National Bureau of Surveying is used to encrypt the geographical location, commonly known as the Mars coordinate system. Based on this, Baidu Coordinates carried out BD-09 secondary encryption measures, which further protected personal privacy[12]. The coordinate system of external interface of Baidu is not the real latitude and longitude of GPS acquisition, and it needs to be converted through the coordinate conversion interface. The conversion of coordinates is an indispensable step (Fig. 1 shows an example). Obviously, without convert the original positioning data to Baidu coordinates, the position displayed on Baidu map will be greatly deviated.

The API in Baidu map support two types of coordinate systems, geographic coordinate system and Mercator projection coordinate system. The former unit is degrees and the latter unit is meters. Since the latitude and longitude of the original positioning data output by the receiver used in this study is in the form of degrees and minutes, when converting to Baidu coordinates, the Baidu geographic coordinate system is selected.

The Baidu Map Web Service API provides the developer with an http/https interface. The developer initiates a retrieval request and obtains the retrieved data in the JSON or XML format. Through this service, the non-Baidu coordinate can be converted to Baidu coordinate. According to the web request parameters provided by Baidu and the returned JSON format, the actual purpose of the coordinate transformation is to make the display position based on the original positioning data measured by the receiver more accurate on the Baidu map. In fact, in coordinate transformation of the study, the conversion of latitude and longitude of the positioning information is a crucial part.

At last, a web page is created with calling Baidu map JavaScript API, the location data during the driving of the vehicle is displayed to the map of the webpage. The system block diagram is shown in Fig. 2.



**Figure 2.** System diagram

In the hardware part, we mainly studied a series of technology problems to using satellites receiving equipment based on FX-BD330. The receiver and the receiving antenna are shown in Fig. 3 and Fig. 4. In addition to BeiDou satellite data, the satellites receiving equipment can receive data from GPS, GLONASS, GALILEO satellites [14]. The data can be received separately or simultaneously, and the receiver will select high-quality satellite data for analysis to obtain positioning data[9], and finally output the positioning data of the unified NMEA-0183 standard format[2]. This format has become the unified RTCM standard protocol for positioning navigation devices, and the output data of the receiver is set to the one format of the protocols called GPGGA.



**Figure 3 & 4.** Positioning receiver and antenna

In the software part, the software architecture is divided into display level, business level and data level<sup>[4]</sup>. In the presentation level, HTML5 is used to build the web page layout, and the web behavior layer is completed based on the Baidu JavaScript API. In the business level, using the object-oriented C# language with the Visual Studio 2017 development environment, an .exe application is built to receive the positioning statement from the serial port from the receiving equipment. Whenever a positioning statement is received, the C# program will immediately process it according to the mathematical logic and store the processed data in the database. In the data level, the SQL Server database as a data management system is an essential back-end support.

### 3. Modular Design

#### 3.1 Original Positioning Data Reception

Before receiving original data, a new table need to be created in the database. According to the GPGGA statement format<sup>[5]</sup>, define the corresponding column name, data type and so on. The format statement is as follows:

\$GPGGA,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,M,<10>,M,<11>,<12> \*xx<CR><LF>

The SerialPort class which mainly implements serial data communication is provided in the .NET Framework 2.0. In addition to the code declaration, these controls such as SerialPort can also be set in

the VS designer. For example, properties of the SerialPort class should be set for the object, such as baud rate, parity, data bits, stop bits, etc. Finally the method of the SerialPort object can open/close a new serial port connection.

Through the Thread class, create a new thread with a delegate of type ThreadStart. The idea of the method executed in the thread is as follows[11]:

```

while (true) do
    if Button STOP not pressed then
        the Thread sleep 1ms
        Let i = 0 n = 0
        do{
            read one byte from stream
            store the byte in outByte[i]
            if the Char represented by outByte[i] is $ then
                Let i++
                Let n = i-1
            }
            while the Char represented by outByte[i] is not *;
            convert Array outByte into String outstr
            remove the first and last markers: '$' and '*'
            if the first five char of outstr are GPGGA then
                split outstr by ','
                edit the T-SQL string
                insert the output data into Sql Server

```

### 3.2 Conversion of Coordinate and Time

After the original positioning data is received, the latitude and longitude coordinate information and time information in the data need to be converted. Before the conversion, similar to the original data storage table, a new table used to store the converted positioning data need to be created in the database. Then, Relying on the ADO.NET technology in C#<sup>[8]</sup>, the original positioning data in the database can be processed.

UTC time is used in GPGGA statement. UTC is also called world unified time, while Beijing time is 8 hours faster than UTC time, and the format of the time in the new table is 'datetime'. With the date added, then the content of the time in the original position table needs to be converted. The format of time in the original table is 'hhmmss.sss'. Add the date based on the time in the original table, and then use the AddHours method in the DateTime class in C# to complete the time conversion adjustment.

The format of latitude in the original table is 'ddmm.mmmm' and the longitude is 'dddmm.mmmm'[13]. The 'dd' indicates degrees and the 'mm' indicates minutes, while the default parameter of Baidu coordinate conversion interface is degree only. Therefore, the latitude and longitude received by the receiver need to be preprocessed by the corresponding formula to convert all points into degrees. Taking the longitude 'lng' as an example, the preprocessing code in the software is:

```

int lng1 = (int)(Convert.ToDouble(lng) / 100);
lng = (lng1 + (Convert.ToDouble(lng) - 100 * lng1) /
60).ToString();

```

After the latitude and longitude preprocessing of the original positioning data, when the Baidu Web API interface service is called, the latitude and longitude is transmitted as a parameter, and the

response is obtained by sending a request in the form of 'GET'. The latitude and longitude of the BD09 in the JSON format is returned. An example of the format of the returning data is as follows:

```
{
  "status":0,
  "result":[
    {
      "x":118.17102495551454,
      "y":32.17110945076022
    }
  ]
}
```

The status value of '0' indicates that the service request is recalled normally. 'x' and 'y' respectively represent the longitude and latitude of the data type named 'float' of the successful conversion. After getting the return information, deserializing the JSON text needs to define the format of the object construction. The JSON string obtained above is deserialized into an object by referring to 'Newtonsoft.Json'. Then the latitude and longitude values of the conversion success are obtained by the attributes of the object. When the adjustment of the original data is completed, the new value of the positioning data need to be stored into the new table and used as the data source for path track playback.

### 3.3 Software Operation

The software for serial port reception and data conversion is shown in Figure 5. Firstly, click the button 'OPEN\_PORT', enter the measured path name in the TextBox in the lower left corner, such as line1, nuaa1, etc. Secondly, click the button 'Data Receive Date Storage', the software interface will continuously refresh the positioning information of the GPGGA statement format. The original positioning data will be stored in the database in real time, if the data mapping is completed, click the button 'STOP'; finally, click the button 'WGS84\_TO\_BD09' in the lower right corner to extract the positioning information of the original table of the database for coordinate conversion, and store the converted positioning information into the new table. Through the above operations, the first two modules of the track playback system can be completed.

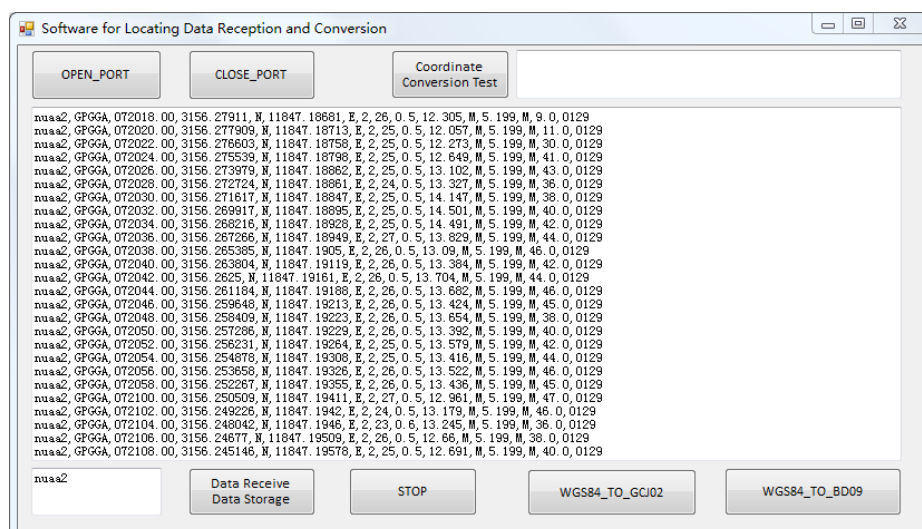


Figure 5. Software operation effect

### 3.4 Web Page

Baidu map JavaScript API supports browser-based map application development on PC and mobile. The JavaScript API is free to invoke and the interface is used without limit. The official website of

Baidu map open platform provides JavaScript API v2.0 class reference. This article uses HTML and JavaScript to build a simple website for track playback [7].

First, a website file with the suffix '.aspx' should be created in VS. Create basic web layouts with HTML[10]. Initialize the map by creating a Baidu map 'BMap' instance, and set the center point coordinates and map level from the 'Bmap' instance.

Second, an interface file with the suffix '.ashx' need to be built, also known as a generic handler. The interface file executes instructions for operating the database, including connecting to the database, and extracting positioning information from the new table. The positioning information such as date and time, Baidu latitude and longitude coordinates and path name need to be serialized into a JSON-formatted string for network transmission.

The website file uses jQuery with Ajax technology to call the interface file so that it can interact with the database and obtain the returned JSON format positioning data. Then the JSON string have to be parsed, and the returned JavaScript value should be assigned to the points object array.

If the point of the Baidu map center changes with the track, it will cause the map to be refreshed continuously, which will cause the web page to be overloaded and even crash. Therefore, the screen of the track playback only uses the first coordinate point returned by the interface as the center point, and displays all the tracks by allowing the map to be enlarged and dragged. The core idea is to present the path in the form of a "point join point". In actual driving, the distance between two adjacent points is very short and can be regarded as a straight line. The assumption above is similar to the differential in mathematics, that is, connecting each adjacent point, thus all points measured in the path are connected into a complete track.

All the positioning points in the database table are sorted according to the time ascending order. Each time, two points are extracted from the array of points objects, and the 'Polyline' class in the overlay class of Baidu map BMAP is quoted to draw map overlays on the map by the vector drawing tool for browsers. With a simple traversal, the connection of tiny straight segments between all adjacent points can be achieved and track playback can be realized.

#### 4. Verification Testing

In order to verify the reliability of the entire system, the software and hardware systems are combined for testing. The Jiangning campus of Nanjing University of Aeronautics and Astronautics was selected as the experimental site, and the campus was used to simulate ground traffic. During the actual driving of the vehicle, the receiver received 938 positioning data successfully. The original data stored in the first 10 rows of the table in the database is shown in Table 1. There are several numeric fields, only the key columns are shown here. When the receiving equipment can receive signals from 4 or more satellites, it can calculate the local 3D coordinates: longitude, latitude, and altitude.

**Table 1.** Primary information of original positioning data.

UTC	latitude	longitude	Number of
071726.00	3156.3418	11847.1207	18
071728.00	3156.3418	11847.1207	18
071730.00	3156.3417	11847.1205	18
071732.00	3156.3417	11847.1203	18
071734.00	3156.3418	11847.1200	18
071736.00	3156.3418	11847.1198	18
071738.00	3156.3420	11847.1196	19
071740.00	3156.3404	11847.1201	18
071742.00	3156.3387	11847.1208	19
071744.00	3156.3373	11847.1210	18

The updated data after the conversion of coordinate and time is stored in the new table successfully. The main contents of the first 10 rows of data in the new table are shown in Table 2. Compared with Table 1, it is found that the time has been successfully converted from UTC time to Chinese standard



time, which is more in line with the domestic identification habit, and the corresponding latitude and longitude has been successfully converted. Till this, the Baidu coordinate data source of the track playback has been successfully obtained.

**Table 2.** Conversion result of time & coordinate.

Chinese standard	latitude	longitude
2018/02/26	31.9433203613396	118.796972702780
2018/02/26	31.9433198066804	118.796971349333
2018/02/26	31.9433192447989	118.796969184025
2018/02/26	31.9433194751846	118.796964583652
2018/02/26	31.9433197079613	118.796960253904
2018/02/26	31.9433213045207	118.796956736879
2018/02/26	31.9433237126000	118.796952949752
2018/02/26	31.9432977508113	118.796962404931
2018/02/26	31.9432682762933	118.796973481584
2018/02/26	31.9432457836941	118.796976444088

The final website realizes the function of track playback through the interaction with the background database. Figure 6 shows part of the interface effect of the track playback.



**Figure 6.** Track playback web page effect.

In practical applications, the actual running time of the vehicle is long. The accident handler will not watch the entire track of the vehicle. Therefore, the website offers the extra function for handlers that they may select the period of time, and speed up the playback. The experiment proves that the function can effectively shorten the time of accident playback and improve the efficiency of the handler. The effect of the function is shown in Figure. 7. In fact, when there are two cars in conflict, instead of spending a lot of time watching the monitored video, the function above can find the conflict location and conflict mode quickly (Fig. 8 shows an example), which is convenient for accident evaluation.





**Figure 7 & 8.** Examples of the segment query and conflict.

## 5. Conclusion

After many field tests, the PC software designed by C# runs well. The program can collect the original positioning data in real time, and realize data storage and conversion based on SQL Server database. Finally, The available data source in database realizes the interaction with the track playback webpage so that the whole system can display the information of time and space of the vehicle.

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