GPS Positioning of Mobile Communication Equipment Based on Android Platform

Zhang Yali[1,*] *Wang Xiaokan*[2]

[1]Henan Mechanical and Electrical Vocational College,Zhengzhou,451191

[2]Henan Mechanical and Electrical Vocational College,Zhengzhou,451191

Abstract. With the rapid development of computer technology and network communication technology, the demand for convenient and quick access to location information is becoming stronger. The GPS positioning system of mobile communication equipment of Android platform has been favored by most users due to its unique convenience and rapidness as well as the superior system stability. Through the research and analysis of the application of Android platform to build the GPS positioning system on mobile communication equipment, this paper [1]makes details description on how to improve the precision of the GPS positioning data and foresees the broad development prospect of the GPS positioning system. GPS positioning technology provides users with the initial location information, making it better for users to experience the location-based services such as AutoNavi, Baidu map, car navigation, etc., which greatly facilitate people's lives.

Keywords: Android Platform; GPS; A-GPS;Mobile Communication

1 Introduction

The Android system is an advanced mobile platform, which mainly relies on the Linux kernel and whose biggest advantage is the application of open source code. It is widely recognized and very stable, always taking up the leading position in China's mobile operating system. The core of the Android system is Dalvik, which is a Java virtual machine designed by Google and a special support for the Android platform. Dalvik has been optimized and improved by s series of methods, such as improving the efficiency of the processor, reducing the share of system memory, and increasing utilization, making the virtual machine applied in a variety of small platforms, like mobile phones and tablets. The software is running in the Android system with the help of a large number of standard Java function libraries which are usually encrypted, and the program source code can be analyzed and identified only by the Dalvik. Other unique Android functions are also provided by the system, making it more convenient for the operator to directly positioning, communicate and so on. Though the initial location

[1]Corresponding author: zhang20021026@163.com wxkbbg@163.com

information provided by GPS positioning technology, users can better experience the location-based services applications such as AMAP, Baidu map, car navigation, etc., which greatly facilitate people's lives.

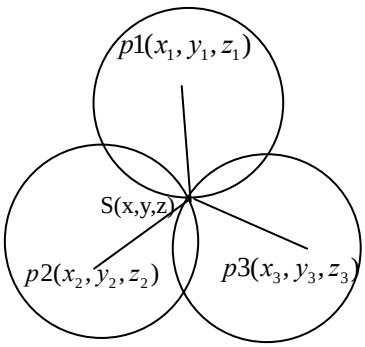
2 GPS positioning technology and its implementation in Android system

2.1 Composition of GPS positioning system

The GPS positioning function for the Android-based mobile communications equipment mentioned in this paper works mainly through the GPS system, which respectively consists of an artificial satellite, a receiver and a ground control system. At present, the number of artificial satellites is 24 (with 3 back-up satellites), which are evenly distributed on the six earth-centered orbits. These satellites can send two radios of different frequencies to the earth, providing the positioning information for the receiver. The ground control system is to monitor the running status of these satellites with four tracking stations and one master station, which takes the responsibility to analyze the received data as well as correct the errors, and finally feedback the date to the satellites, so as to ensure its accuracy. At the same time, each receiving end has a receiver to dock the position of satellite antenna, thus the positioning is completed.

2.2 GPS positioning principle

When mobile users want to experience location-based services, users can start the ordinary GPS module first, and search for the visible GPS satellite. When the visible GPS satellite is fixed, the mobile user's location information can be successfully y calculated by the satellite signal. After the initialization is completed, the location information is supplied to the interface. As shown in Figure 2-1, p1, p2 and p3 respectively, the three GPS satellites in the air, S for the position of the receiver and its position coordinates (x, y, z) need to be obtained. According to the side intersection positioning principle shown in formula (1), as long as you know the location of the P1, P2, P3 and the respective distance to S the position of S can be figured out.



$$d_n = \sqrt{(x_n - x)^2 + (y_n - y)^2 + (z_n - z)^2} \quad (1)$$

Fig.1. Schematic diagram of GPS principle

It generally takes minutes to search for satellites only by relying on the mobile phones of ordinary GPS modules, and it is easily affected by the location of the environment. However, it only takes a few seconds for A-GPS first positioning, and simultaneously, receiving satellite radio frequency signals and the auxiliary positioning information from GPRS. Combined GPS satellite positioning and the new network-assisted positioning technology made by wireless stitching, it effectively increases the positioning accuracy.

Table 1. Comparison of ordinary GPS module positioning with A-GPS positioning

	ordinary GPS module positioning	**A-GPS positioning**
positioning system	GPS positioning system	A-GPS positioning system
locate information	Satellite RF signal	Satellite RF signals and auxiliary positioning information from GPRS
Positioning mode	GPS positioning	Connection location server and GPS location
Positioning speed	Slow	Faster
positioning accuracy	Lower	Higher, optimization of up to 5m
Cost	Free	Charge

2.3 GPS positioning technology

To achieve the positioning of a user's mobile phone, firstly it is necessary to open its GPRS connection module. Then, the SOCKET module (also known as the socket) and the background server will reach a network connection, so that the communication channels can be established. The positioning information will be received from the satellites through the phone's built-in GPS module. Later, the latitude, longitude, direction, time, speed and other aspects of positioning information can be also analyzed by the GPS analysis module. Eventually, the data is packaged in the specific format and then transmitted to the background server for data processing. After that, it will be fed back to the mobile terminal, and then a user's mobile phone can be positioned.

In the Android system, when the application layer application requests positioning, GPS positioning can be achieved in the procedures of: start the framework of the Location Manager class, call the Location Manager Service function, select the appropriate GPS Location Provider according to the system or artificially provided Criteria, and complete the GPS HAL call through the JNI to achieve interoperability of application framework layer and local code.

2.4 The main technical code to achieve GPS positioning module

The main technical code to achieve GPS positioning module can be accessed through the software, and the following codes listed by the Create Vieware statement are relatively simple.

```
Public void  on  Create  View()
{GPS View=new GPS View (this);}
```

This method simply calls the construction method of the GPS View object. The similar representations of GPS View are as following:

```
Public class GPS View extends View
{ My Locate ovedord;
    Public Gps  View(Loeate Me pCtx)
    {super ( pCtx);
    Ovedolord=pCtx;}
    public oid  on  Draw(Canvas canvs)
    {Paintp=new Paint();
    String Strlat=”Latitude:”+over lord. Get Lat();
    String StrLon=”longitude:”+over lord.  getLOn();
    Canvs.  Draw  Text(StrLat,  32,  32,  p);
    Canvs.  Draw  Text(StrLon,  32,  44,  p);}
}
```

Through those program codes in the text format, GPS View can calculate and analyze the relevant data of latitude and longitude positioning, which can also be visually presented on the screen with the on Draw method. In the GPS positioning module, the Activity class is the core program of its application software, and another aspect of which is the on Draw method, whose purpose is to analyze the positioning data. It can call the function libraries by the means of calling the super class construction.

3 Experimental data analysis of GPS positioning in Android system

The mobile communication equipment mentioned on the present market is mostly the Android smart-phones, which have been implanted in GPS positioning system. When the software in the phone starts, the module will send a signal to the GPS satellite. After receiving the signal, it will feed back the related position information to the phone's GPS software.

3.1 The identification of abnormal data

As a result of some unexpected circumstances, such as weather and other factors, there will be some errors that are called abnormal data in the position information received from the GPS positioning system. In general, there are three methods to deal with abnormal data, which are the density method, deviation method and time series method.The most commonly used method of error analysis is the time series method, which is mainly applied to the error analysis of GPS positioning in Android mobile phone, and $x_0$is a way of prediction bade on the data of time series. 3^{σ} (GPS positioning analyzes the changeable range of data) can be used as a judgment standard to identify whether the sequence variance exceeds this range. The measured value is approximately the actual one , which is abnormal when it exceeds the $3^{\sigma} \pm x_0$.The followings are recurrence formula for calculating the average value and variance of GPS data:

$$\bar{x}_n = \bar{x}_{n-1} + \frac{\bar{x}_n - \bar{x}_{n-1}}{n} \tag{2}$$

$$\sigma_{\mathrm{n}}^2 = \frac{n-2}{n-1}\sigma_{\mathrm{n-1}}^2 + \frac{(x_n - \bar{x}_{n-1})^2}{n} \tag{3}$$

In these formulas, $\bar{x}_n$ as the average value, σ_{n}^2 as the variance,and as the measured value, new average value and variance of data can be calculated through the formula $|x_n - \bar{x}_n| > 3\sigma^2$. If the is beyond the normal range, another measured value is able to be analyzed and identified in the second round reusing the way of 3^{σ}.Finally, do the integrity analysis, thereby reducing the deviation of the data.

3.2 The treatment in missing the positioning data of GPS

Put the Huawei glory 8 installed with independent development of "GPS measurement and coordinate conversion," on the position of known coordinates. This location is away from the high-rise, with the ideal observation environment and no other interference factors. After the phone is initialized for 10 seconds, observe the GPS Module positioning and A-GPS positioning respectively for 30 minutes, and the positioning results are shown in Figure 2 and Figure 3. It can be seen that GPS module positioning experimental accuracy is ideal, 55% of the points fell within 3 meters, 78% of the points fell within 5 meters, the positioning results are more discrete; in comparison, A-GPS positioning results

are more stable and reliable, the points within 3 meters are more intensive, which actually reached 79%, which is almost equal to the number of GPS module positioning accuracy in 5 meters, 98% of the points fell within 5 meters, positioning accuracy was significantly higher than the GPS module positioning.

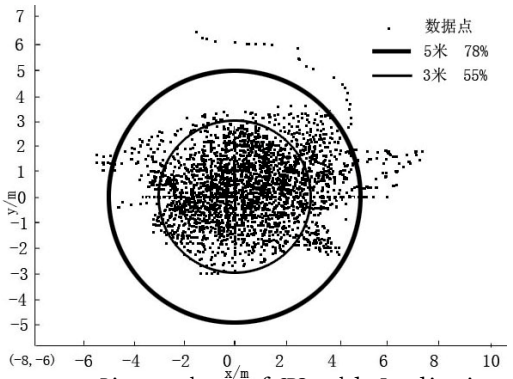


Fig.2. Discrete degree of GPS module Localization

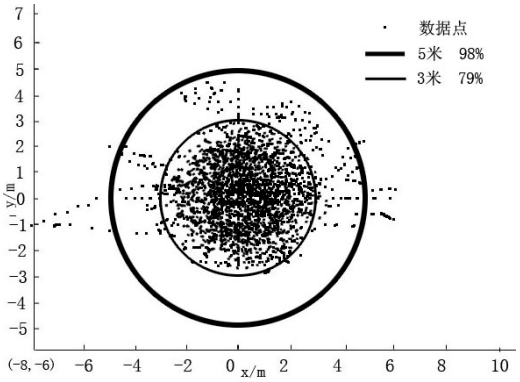


Fig.3. Discrete degree of A-GPS module Localization

In order to achieve high accuracy of real-time positioning service, the GPS positioning system in Android Smart-phones should have a clean, transparent observation data as a support. While it is absolutely not enough to achieve this high-precision only depending on the natural environment (climate, temperature, moisture, sunlight, etc.), it should go through a series analysis and judgment of GPS data, thus the positioning errors can be reduced to the minimum. Only by overcoming the data missing of GPS positioning can the positioning accuracy of GPS in smart-pones be really improved.

4 Conclusion

This paper analyzes the hierarchical structure of Android system and its superiority in similar products, discusses the GPS positioning technology in Android system, and expounds the principle and influence factors of GPS positioning system from the aspects of GPS system constitution, technology, service, realization conditions and experimental data analysis. Finally, put the Android system and GPS positioning system together to discuss the analysis and solutions of abnormal data as well as further improve accuracy through data analysis. With the coming of 4G era, the application of GPS in Android system will have a broader space for development.

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