Design and Development of GPS Navigation and Positioning System based on AutoCAD Platform

Jichao Cui[1] and Feng Zhang[2]

[1]School of Intelligent Engineering, Henan Institute of Technology, Xinxiang Henan, 453003, China, jichaocui@126.com
[2]School of Intelligent Engineering, Henan Institute of Technology, Xinxiang Henan, 453003, China,

zhfeng_opt@126.com

Corresponding author: Jichao Cui, jichaocui@126.com

Abstract. According to the design of the software system, the positioning chip configured in the positioning terminal can be GPS, or a hybrid positioning system, plus optional position differential function, which ensures the positioning accuracy and maintains data security at the same time. Software system using cloud computing technology and C/S, B/S hybrid architecture for development, the system can be deployed on an ordinary PC to achieve greater capacity and higher performance, companies or individuals only need to be equipped with positioning terminals can directly use the system, but also according to their own needs to further modify the system realized in this paper customized. This greatly reduces the development and maintenance costs of the system and is beneficial to the promotion and use of the system. The satellite positioning information is received from the positioning terminal, decoded according to the present decoding algorithm, and sent to the database server for storage; remote control commands are received from the terminal administrator, processed, and sent to the positioning terminal. Web server, which provides access service to the user's operation platform. Service server, which provides service support for business logic to the user operation platform. The user operation platform is divided into the ordinary user operation platform and the terminal administrator operation platform.

Keywords: AutoCAD platform; GPS; navigation and positioning systems; design and development.
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1 INTRODUCTION

A satellite positioning information management system refers to a software system developed based on global navigation satellite systems (GNSS), embedded device development technology, mobile communication technology, database technology, and geographic information systems (GIS). A satellite positioning terminal is an embedded device with a built-in satellite positioning chip and a mobile communication module [1]. The satellite positioning information management system receives the satellite positioning information sent by the satellite positioning terminal using mobile communication technology, and then carries out data analysis, storage and later statistical analysis, and realizes the positioning management of the person or thing configured with the satellite positioning terminal with the visualization display of geographic information systems, such as real-time positioning and historical track view [2]. GNSS is the most widely used navigation and positioning system, which provides high-precision navigation and positioning services for global customers after receiving signals from positioning satellites and making calculations [3]. At present, many countries or regions in the world have their navigation satellite systems and are developing rapidly [4]. Computer-aided design is the use of computer powerful computing functions and efficient graphics processing capabilities, is the urgent need of modern engineering design, in product and engineering design, the computer can help designers to undertake information storage, calculation, mapping, and other tasks. In the design, the computer is usually used to carry out a lot of calculation, comparison, and analysis of different programs, and finally, the best program must be selected: all kinds of design information, whether graphic, text or digital, can be stored in the computer's memory or hard disk and other storage media, and can be easily and quickly retrieved: designers are generally divided into these steps to design: design, calculation, checking, sketching Modified and determined into a working drawing. If there is a computer can quickly replace the manual completion of these boring and repetitive work: through the computer-aided calculation of the design results, you can quickly, accurately, the real sense of graphic display, so that designers can judge the design of timely transformation: for complex graphic design in the editing, zooming, shrinking, panning, rotation and other routine work can be easily given to the computer, through its auxiliary design system to complete.

GPS, the primary satellite navigation system, was built with investment from the U.S. Department of Defense and can be made freely available to users around the world. Even for civilian applications, GPS has a positioning accuracy of about 10 meters [5]. GPS is a worldwide and all-weather navigation system that ensures that six to nine satellites, or even up to 11 satellites, can be observed at any time and place on Earth. The GPS navigation orbit is a quasi-synchronous orbit that orbits the Earth in 11 hours 58 points, with unlimited user device capacity [6]. However, the GPS positioning system does not have the function of communication. PS navigation system can be said to be the all-weather, worldwide, real-time, continuous, space-based to achieve high precision radio navigation system, in the sea, land and air military with a full range of real-time navigation and positioning capabilities. On this basis, El-Ashmawy proposed the C/S model of satellite navigation and positioning system: using GSM as a communication module, the GPS information of the vehicle navigation equipment is sent to the supervision center for storage and real-time display of positioning information, and the communication function between the supervision center and the vehicle terminal can be achieved through the GSM module [7]. Today, Hasicic has proposed a common platform technology for satellite navigation and monitoring system, which is a cloud computing platform technology [8]. Based on cloud computing to build a highly concurrent and cloud-based architecture, Vaiana divided into interaction layer, business layer, and physical layer, the interaction layer provides an operating platform for users to use, users can easily use the system under the guidance of the visualization and navigation; business layer to achieve equipment information management, a navigation system, positioning system, and other functions; physical layer using the mobile network and other communication technologies and terminal interconnection [9]. Currie proposed a carrier smoothing pseudodistance method for single-frequency receivers that eliminates the influence of atmospheric ionospheric dispersion on the measurement results, resulting in a further improvement in the accuracy of differential correction numbers [10]. Chen differential positioning methods, where the moving station only needs to stay at one point for a few moments to obtain a centimeter-level accuracy solution, and then perform the same positioning operation at the next location to be measured, this stop-and-go measurement method has some of the characteristics of dynamic measurements [11]. By using this system to locate the construction of water transport projects, it greatly improves the precision and efficiency of construction, ensures the construction quality of water transport construction projects, controls the construction progress and funding of water transport projects in real-time, improves the management level of the project, optimizes the use of funds, and shortens the construction cycle, which is conducive to further enhance the management level and work efficiency of the Authority for water transport construction projects.

2 THE DESIGN AND DEVELOPMENT OF GPS NAVIGATION AND POSITIONING SYSTEM ON AUTOCAD PLATFORM

2.1 AutoCAD Platform for Positioning System Design

AutoCAD platform, GPS navigation and positioning system are developed for efficient, accurate and fast construction and positioning in the marine engineering, its purpose is to introduce the GPS signal into the AUTOCAD system platform, through the Gaussian projection solution to form the Beijing coordinate system, the position of the construction vessel directly in the electronic version of the construction plan display, guide the vessel construction operations, effectively avoid dredging, reef bombing and other construction of the missed dredging. The system can greatly reduce the project work loss and rework, save project investment, reduce construction cost, improve construction efficiency, and further improve project management, and can scientifically assist construction schedule arrangement by combining with the predicted operating conditions such as weather and sea conditions. The system requirements analysis is conducted by using the Unified Modeling Language (UML) to describe the functional requirements of the system, and the use case model is constructed through Use Case Analysis. The use case diagram describes the interaction between the system actors and the system, which consists of actors, use cases, system boundaries, and associations.

In the system analysis phase, the entities (or objects) in the problem space and their interrelationships are used to build a logical model of the system to describe the system requirements and architecture more naturally. Since the objects in the problem space are relatively stable, even if there are changes, they usually only affect the system locally or localize the changes in the system requirements, thus giving the system a relatively stable structure. System design and system implementation is a refinement or instantiation of the logic model obtained in the analysis phase. The objects in the logic model eventually appear in the design and implementation model in the form of code, making the analysis and design seamlessly connected and the system easy to test and maintain. The process of system development is the refinement of a series of models, such as system requirements, analysis, design, implementation, and testing, which can effectively solve system complexity problems. At the same time, the object, as the basic unit of the system, can be designed as a software component with a standard interface, so that it has a certain degree of reconfigurability, laying the foundation for the scale of software development and industrialization. The system can be divided into two parts according to the different needs of the access system for positioning terminal and user operation platform. The positioning terminal needs high concurrent access and real-time bi-directional communication of data. For cost consideration, the positioning terminal is only responsible for collecting and uploading data without performing calculations, and the server system needs to assume the responsibility of receiving and processing data, so C/S architecture is chosen. The positioning terminal is developed in the C language and uses the GPRS network to establish a connection with the communication server of the system through the socket, the communication server is developed in the Java language, and uses the JDBC interface to access the data to the database server after processing the data. User operation platform concurrency is not large, and the user operating platform equipment has certain computing power, using the B / S architecture. The web version of the user operation page by the user to access the website through the browser to obtain, WeChat app version of the mobile phone from the WeChat terminal click to use. The business server uses JavaScript and PHP language to develop, and then uses PHP to access the data from the database server, and then re-render the webpage after getting the data. Then, through the demand analysis of the system, design the topology of the system for the system service platform and user operation platform, the system service platform is divided into the database server, communication server, website server, and business server; user operation platform is divided into ordinary user web page operation platform, ordinary user WeChat small program operation platform and terminal administrator web page operation platform. After the workflow of functional requirements is clarified, the system architecture is designed hierarchically, and the system is divided into three layers: user perception layer, functional module layer, and the data layer. Finally, according to the characteristics of positioning terminal connection and communication with the system, the connection between the positioning terminal and the system adopts C/S architecture; according to the access characteristics of the user operation platform, it adopts B/S architecture. Then, according to the working characteristics of each module, the technical architecture design, coding language, and software selection is carried out. According to the system requirements analysis, the database server needs to provide safe storage and efficient read and write functions. Database server to store the account information of the positioning terminal, satellite positioning information, operation 8 logs and the account information of the terminal administrator, as the bearer of the positioning terminal and the terminal administrator's login verification operation information carrier, the requirements of the database server must be able to exist to a certain extent of security, to protect the information security of the system. As the working frequency of the positioning, the terminal is up to 1 second/time, and the positioning terminal is in the state of long-time continuous working, the amount of satellite positioning data gradually increases with the working hours of the equipment, which requires the database server to successfully undertake the highly concurrent writing task. Therefore, it is necessary to focus on the safe and stable storage and efficient and correct read and write two aspects of the database server design.

2.2 Design and Development of GPS Navigation and Positioning System

The communication server is mainly responsible for the communication tasks between the positioning terminal and the terminal administrator in the system, and the interface and function module that the communication server needs to provide can be obtained from the analysis of the workflow of the positioning terminal and the terminal administrator to communicate with it. Considering that the number of positioning terminals in the access system will increase greatly according to the expansion of the scale of the system; the positioning terminal will be in the state of continuous long time, long time and high-frequency transmission of satellite positioning information; the terminal administrator needs to control the positioning terminal remotely through the communication server. For these requirements, the communication interface of the communication server needs to meet the following conditions: high concurrent connection; long connection; high concurrency while ensuring system stability. The interface for concurrent access is designed using thread pooling technology, as shown in Figure 1.

The main thread of the communication server listens to the network port and maintains a certain number of threads in the thread pool (core pool) during initialization. When a terminal or terminal administrator sends a connection request to the communication server, there is no need to create a thread temporarily. Can effectively save the overhead of creating and destroying threads. And the thread pool can be expanded and reduced according to the situation, can effectively deal with high concurrency.

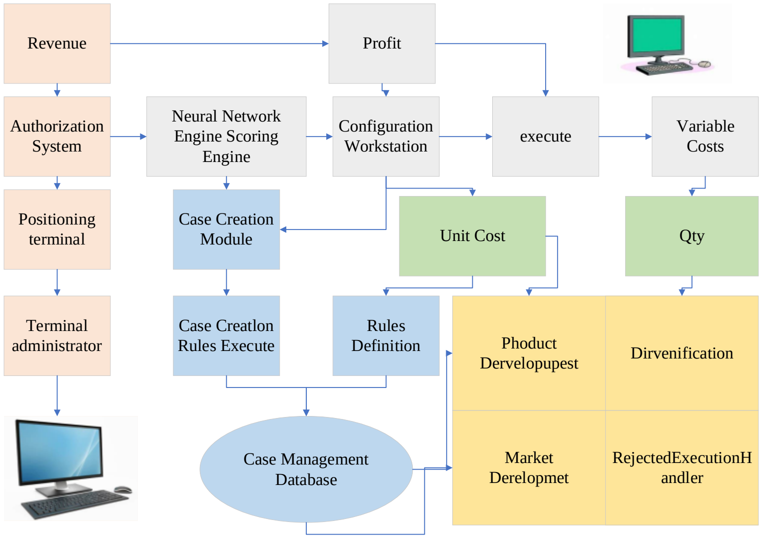

Figure 1: Concurrent access process for communication servers.

Because the positioning terminal to send satellite positioning information to the communication server at a rate of one per second, so the communication server has an intensive database I/O tasks. The database I/O generally occupy many software system resources and running time, so the design of the database interaction is critical. Design database interaction using database connection pooling technology. System initialization, database connection pool administrator to create several databases to establish a connection pool of resources, when the system has a database interaction tasks, from the database connection pool, and then in the CRUD operation, the release of the connection back to the database connection pool, waiting for the next use. This greatly saves the resource overhead and time of frequently creating and destroying database connections. Get Login Authentication Message: Identify and locate the first message sent by the terminal or terminal administrator to establish a connection with the communication server as a login authentication message. Extract login authentication type: Extract login authentication type from the header of the login authentication message, it can be TERMINAL and MANAGER. Extract IMEI and password: When it is determined that the login authentication type is TERMINAL and the system recognizes it as the login of a positioning terminal, the IMEI and password of the positioning terminal are extracted, and the IMEI is used as the keyword of the password of the corresponding positioning terminal in the query database of the communication server, and the password is used for comparison. Extract user name and password: When the login authentication type is MANAGER and the system identifies it as terminal administrator login, then extract the user name and password of the terminal administrator, with the user name as the keyword of the corresponding terminal administrator password in the query database of the communication server, and the password is used for comparison. Get satellite positioning information: When the positioning terminal successfully logs into the system, the system determines that the positioning terminal is sending satellite positioning information to the communication server continuously. Get remote control command: When the terminal administrator successfully logs in the system, the system determines that the terminal administrator is in the state of occasionally sending remote control commands to the communication server to control the positioning terminal. Satellite positioning information decoding and reorganization: the satellite positioning information sent by the positioning terminal is in the format that the terminal parses and processes, the communication server needs to decode it and reorganize it into the designed location table format, then the communication server will store it into the database. Remote control command decoding:

The remote-control commands sent by the terminal administrator are decoded and forwarded to the specified location terminal. If the location terminal or the terminal administrator disconnects from the communication server due to poor network signal, and the communication server cannot identify and disconnect the connection in time, the thread resources will be in a persistent waiting and blocking state, wasting system resources. Therefore, when the communication server receives data information, it is designed to perform a 30-second timeout judgment, and when there is no incoming data within 30 seconds, it determines that the other party is offline, disconnects actively, and recovers system resources. This not only can improve system resource utilization and system efficiency but also can improve system security and prevent system crash due to attack to some extent. After the user clicks the Track button, the History Track function menu will be opened. Click the drop-down selection box of vehicle selection, check the positioning terminal which you want to view the history track, click the drop-down selection box of track icon, check the icon style which you want to view the history track, then select the time interval through the selection box, click the Show Track button if there is track data in the time interval, the history track will be displayed in the map, and then you can use the animated cruiser to simulate the positioning terminal. Run, you can see the details of positioning points on the track by mouse movement: time, speed, direction. At the same time, the animation control progress menu is expanded and can be clicked. If there is no positioning information in this time interval, there will be a popup box to indicate that there is no positioning data in this time interval. When you need to turn off the function of the historical track, click Clear Track.

3 ANALYSIS OF RESULTS

3.1 Analysis of Functional Test Results

Through the analysis of the functional requirements of the system, this paper is oriented to the system use case diagram and the functional items to be realized after the system design, and relevant test cases are designed to execute the test. To verify the data processing results of the navigation system in this paper, the system navigation and positioning data are collected on the terminal equipment for analysis and confirmation. Figure 2 shows the latitude and longitude data received by the navigation system. At the same time, using other more accurate instruments in the laboratory to test, the coordinates are 22.3131799 latitude north, 113.5609388 longitudes east, which is consistent with the longitude and latitude data received by the navigation system. The data processing program of the terminal machine is normal, and it can receive and analyze the navigation positioning data obtained by BD/GPS normally, and the longitude and latitude information are complete. From the test results above, the positioning accuracy of the terminal is consistent with the test results of laboratory instruments, and the positioning accuracy of the system meets the requirements. The positioning time of the system is the same as the GPS single-mode time, but it is better than the single-mode positioning time. Also, it can be seen from the system search quantity display chart that the number of system search stars reaches 10, which meets the design requirements. It can be concluded that the terminal system meets the design requirements, can collect GPS/BD satellite positioning signals, can accurately locate, and the time required for locating is within the required range, the number of search stars is much higher than the set requirements, and has the basic functions of the car navigation system.

Also, the relevant tests on the terminal, the results show that the designed terminal can pass various performance tests. The car navigation positioning system designed in this paper has accomplished the predetermined design goal, the designed positioning module can run normally, and the accuracy of information such as positioning and star search can be verified on the built car navigation terminal equipment. Compared with the single-mode or single-mode GPS positioning, positioning time, performance, positioning accuracy, the number of star search, etc. have been effectively improved, as shown in Figure 3.

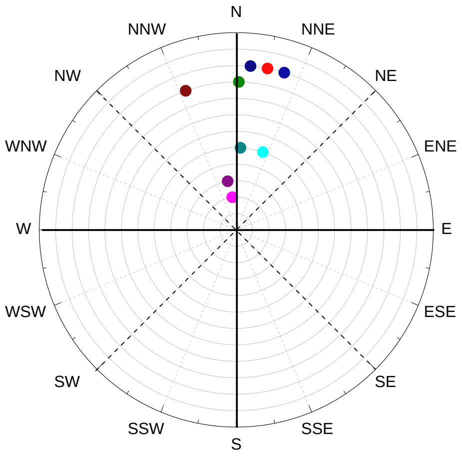

Figure 2: Navigation satellite distribution map.

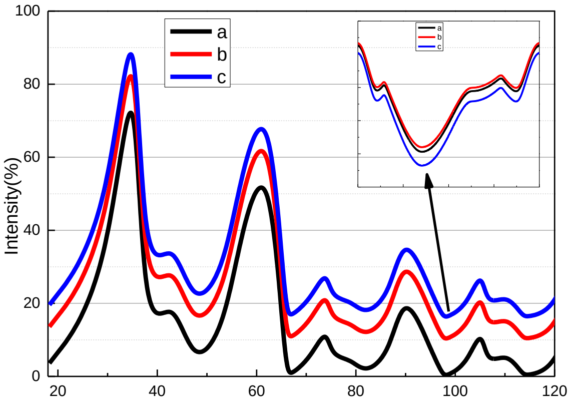

Figure 3: Pure inertial navigation and combined navigation bit error.

By Figure 3 can be seen from the hand down are northeast of the lack of a directional position error, experimental data processing by the figure shows that after 500s pure inertial guidance system in the three directions h position deviation will reach about 10m, while the red line indicated by the combination of navigation systems: time during the work of the position error straight in front of fluctuations in the maximum range of position error in about 3m, from which it can be seen that the combination of navigation positioning accuracy higher. The maximum speed deviation is less than 2m/S. The maximum speed error in the three directions is 1.73m/s, 0.69m/s and 0.51m/s. During the car experiment, because of the initialization of the system, there are a few tens of seconds of star search time, because the experiment is to start the combined navigation system under the driving condition. Therefore, the initialization time of the combined system is slightly longer than the initialization time of the static car experiment, but considering that the general vehicle is in a static state before the combined navigation system is turned on to complete the initialization of the system, it can be seen that the initialization of the combined navigation system this time does not have a great impact on the movement of the vehicle. The speed error of the vehicle in the moving state is also small. The speed measurement value of the combined navigation system mainly measures the speed of the vehicle in the three directions, and the cumulative error is about 1m/s. The speed error of the normal running vehicle is about lm/s, which does not have much influence on the user's identification, as shown in Figure 4.

The positioning accuracy of combined navigation is always in fluctuation state, and the position error of the 2500s shows convergence state, and the maximum position deviation is 4.35m in the sky direction, while the deviation in the northeast direction is relatively small. The maximum position deviation is 4.35m, 2.96m, and 2.75m in the northeast and sky directions respectively. The position error of combined navigation is also the data collection when the vehicle is running, so it is necessary to consider the evaluation of the system positioning performance for the initialization of the system.

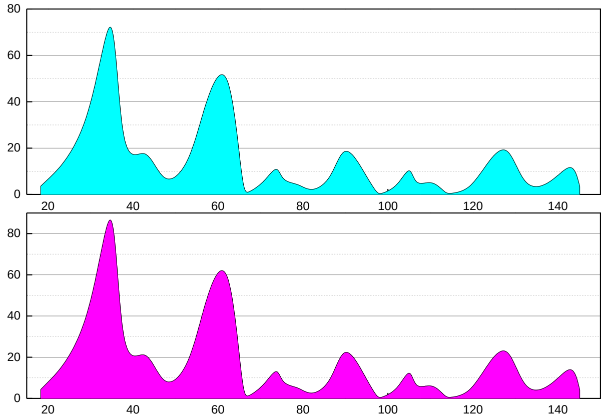

Figure 4: Combined navigation position error.

3.2 Analysis of Accuracy Rating Results

The RMS values of the combined navigation and positioning system in the stationary state are obtained by comparing the data received from the static vehicle education experiment with the coordinates of known points after the fusion of GPS navigation and SINS inertial navigation system through the Kalman recorder, as shown in Figure 5.

The average value of RMS in X, Y direction in 7 periods under the stationary condition of positioning terminal is 1.14m and 1.12m respectively, which has quite a high positioning accuracy, higher than the positioning accuracy of other combined navigation systems. The combined navigation system in the stationary state has a high positioning accuracy, which is higher than the positioning accuracy of other combined navigation systems. Because the measurement error of GPS is very small, it has little influence on the positioning accuracy of the combined navigation system as the initial value, and its positioning accuracy is high, which can meet the precision requirements of users for the stationary state of the vehicle.

Combined navigation general performance inspection includes the inspection of combined navigation positioning system signal blocking convergence time and blocking situation, lake reflection system of the inspection of the positioning performance, through the experiment when the record, including the vehicle to the lake time, the car both in the shade blocking period. Corresponding road conditions, corresponding period, corresponding positioning data for sampling. Check the accuracy of the plot as shown in Figure 6.

Figure 6 is the vehicle into the lake section of the positioning accuracy map, the maximum error in its positioning in 1.5m, the lake on the combined navigation positioning system positioning accuracy of the small impact, and Figure 7 is the vehicle into the shade section of the combined navigation positioning accuracy.

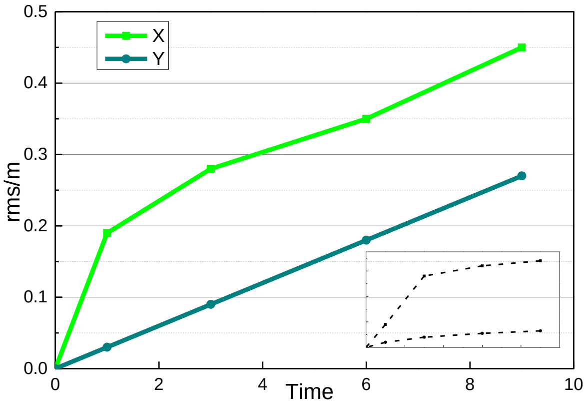

Figure 5: RMS values for each period.

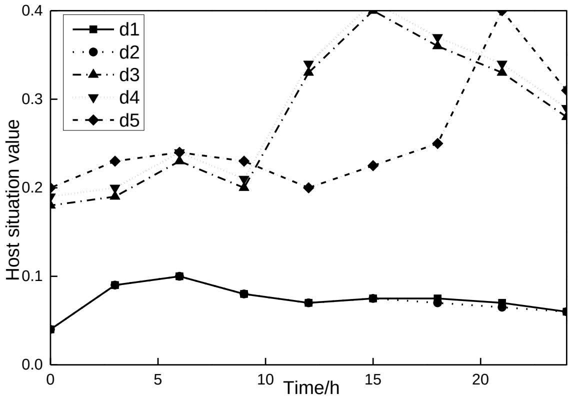

Figure 6: Section positioning accuracy.

Can be seen from the figure in 2120 seconds when the positioning error suddenly increases, but the maximum positioning error of 2.7m, and in the continuous positioning accuracy gradually converge, from Figure 7 can be seen in the shade of the map matching effect is still good, to meet the positioning accuracy requirements of car navigation. The convergence time of each experiment is averaged over the repeated switch-on and switch-off of the positioning terminal to check the convergence time of the combined navigation system as the positioning recovery performance standard. In the process of the experiment, we tested the positioning recovery performance of the positioning terminal in the signal blocking situation, simulated the signal blocking environment, and obtained the data processing after the experiment, after the signal blocking, the positioning data showed precision jump, but a few seconds later showed convergence state, the average time of several experiments is 4.5s, as shown in Figure 7.

The comparison of positioning accuracy between pure inertial guidance system and combined navigation system, the positioning performance of combined navigation system in the stationary state, the positioning accuracy in the case of dynamic vehicle experiment, the map matching of positioning data, and other aspects were tested respectively. Through the data performance comparison and performance evaluation, on the whole, the positioning accuracy of the combined navigation positioning system is better than the pure inertial guidance system and single GPS positioning performance, not only the positioning accuracy is higher than another individual positioning system, in the system's anti-interference ability is better than other positioning systems. And its anti-jamming ability of the combined navigation system has been tested. The simulated blocking environment system can complete the convergence of positioning state in the average time of 4.5s, and can reach the error of about 2.7m positioning accuracy, by this chapter on the combined navigation performance of some tests can make the following conclusions, the combined navigation is better than other positioning systems, and has a strong anti-interference ability. The key coordinate system unification of the combined navigation system was studied, GPS uses the WGS84 coordinate system, the inertial navigation system uses the carrier coordinate system, and the electronic map uses the navigation coordinate system.

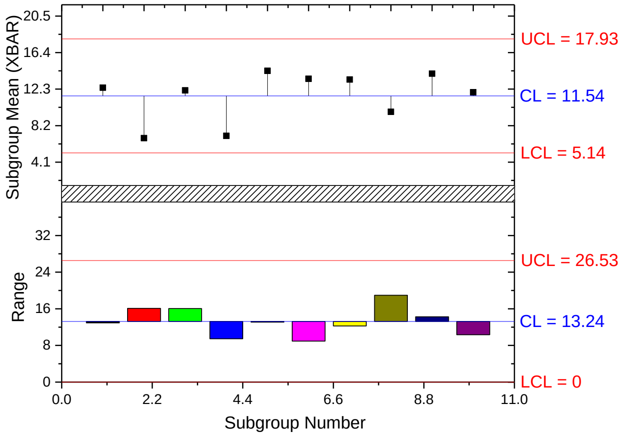

Figure 7: Segment positioning accuracy.

In the paper, the method of converting these two types of coordinate systems to the navigation coordinate system is studied, and the formula for the conversion is deduced to solve the problem of the unity of the coordinate system in the combined navigation system, and finally, after the coordinate system conversion are converted to the navigation coordinate system adapted to the electronic map. One of the key technologies of combined navigation is the integration of two navigation systems. The paper starts with the type of GPS and inertial navigation system fusion, combined with the actual car navigation system project, to study a class of methods suitable for the car combined positioning system fusion, position, speed combination model which is - a kind of pine combination model. This kind of model double system data fusion fast, low cost, simple model establishment, easy to overhaul, as shown in Figure 8.

In this paper, the application direction of the combined navigation system is the vehicle, and the operating system is more oriented to the user operation. In combination with the experiments in Chapter 5, this method is verified to have a good effect. In the experimental part, dynamic vehicle experiments and static vehicle experiments are designed, and the design route has complicated large area lake, shade road, high building road, and so on, as well as long-distance normal unshaded road. But on average after 4.5s will form a convergent posture, and match well in map matching to lane and match. The experimental results show that the positioning performance of the combined navigation system is better than the pure inertial guidance system and the single GPS, and the stability and positioning accuracy of the system is higher than the other two types of navigation systems to meet the engineering requirements of vehicle navigation.

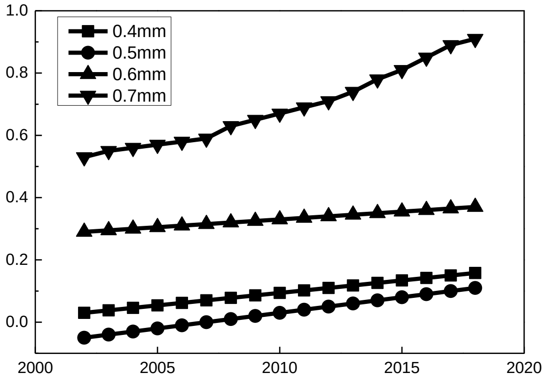

Figure 8: Antenna axis ratio relationship.

4 CONCLUSION

In this paper, the requirements analysis, system design, and implementation of GPS navigation and positioning system on the AutoCAD platform are carried out. From system function, this paper is mainly reflected in the development and design of guiding ship construction operation, greatly reducing engineering errors and rework, saving project investment, reducing construction cost, improving construction efficiency, improving project management and so on; from software development design, this paper is mainly reflected in the analysis of system requirements, selection of system technology, overall system architecture design, system module design, and implementation. The function design and specific module programming are elaborated in detail, and the overall design thinking on multilingual invocation and mixed programming is carried out. Also, we have designed various forms of warning function and intelligent interrupt collection restriction for signal abnormality and adopted a very targeted module design, which maximally eliminates the possibility of mis operation in the field complex working environment and eliminates unnecessary demands, making the system more efficient, more accurate positioning, and more convenient and feasible maintenance. At the same time, the efficiency of the system will be improved and the interface will be more friendly and user-friendly.

5 ACKNOWLEDGEMENTS

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Jichao Cui, https://orcid.org/0000-0002-9304-4568
Feng Zhang, https://orcid.org/0000-0003-0728-1848

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