Indoor and Outdoor Precision Positioning System Based on Beidou Difference and UWB

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Abstract. Although the map services given priority to baidu map or Google map have met the most people for outdoor location information for navigation and position requirements, however, as the rapid development of areas such as automatic drive, Internet of Vehicles, the demand for indoor and outdoor high-precision position becomes more and more urgent. The 3d visualization technology based on virtual reality (VR) has been widely used in various fields of social life, such as environment, transportation and construction of digital city. This paper mainly introduces the following three key technologies: (1)The acquisition and application of outdoor high-precision location; (2)The design and implementation of indoor 3d virtual interactive system; (3)Seamless switching technology between indoor and outdoor maps.

1. Introduction

In 2018, the beidou satellite navigation system developed and built by China has also entered a new stage of development: system performance, satellite life and service accuracy are greatly improved, and the area providing services is more extensive [1]. Satellite navigation and location service industry is a rapidly emerging industry in the global information technology wave. At present, mobile maps are widely used in the market, and users need to simply operate the phone to view their current positioning and various location services based on geographic information [2].

The civilian accuracy of GPS reaches 10 meters. Yet with the rapid development of automatic drive, internet of vehicles, unmanned aerial vehicle(UAV),internet agriculture and other special areas, people's demand for higher position precision is also increasingly urgent. Therefore, this paper will introduce the key technologies for obtain and apply outdoor high-precision location.

On the other hand, virtual reality technology is widely used in many fields, which brings a real experience of immersion [3]. This paper also introduces the realization process and key technology of indoor 3d virtual interactive system based on indoor 3d scene roaming, indoor precise positioning display and location navigation service. The system is by building indoor 3d virtual environment, realization of indoor roaming interactive display, getting users understand the architectural interior space, and combinating of UWB (Ultra Wideband) short-range wireless location technology realize the dynamic real-time display of the personnel in the indoor [4]. UWB has the advantages of high transmission speed, low transmission power and large instantaneous bandwidth [5]. By using ultrashort pulse, the positioning accuracy can reach the centimeter level [6].
2. System Design

2.1. The Design of Overall Architecture of the System.

The block diagram of overall design of the system as shown in figure 1, first on the basis of by using high-precision positioning integration equipment and using beidou/GPS differential positioning technology [7] won the high precision position, integrating the baidu map SDK and baidu speech SDK. And then, building the indoor 3d virtual interactive scene. Finally, by realizing the seamless switch of indoor and outdoor maps, the two systems are integrated to realize a map service APP that can perfectly integrate the indoor and outdoor high-precision positioning.

![Figure 1. The overall design block diagram of the system.](image)

2.2. The Design of Outdoor High-Precision Positioning APP.

Software function design mainly includes the display of live traffic, urban heat map, baidu satellite map, moving the center of map and changing the zoom level, POI (Point of things) search, line planning, biking/walking navigation, recommend searches, historical records, launching the baidu map APP, voice navigation and other necessary functions.

2.3. The Design of Indoor 3d Virtual Interactive System.

This study based on the electromechanical information building of the University of Science and Technology Beijing(USTB), after building the electromechanical information building BIM (Building Information Modeling) 3d Building model by Autodesk Revit 2016 software, the BIM will be built to IFC (Industry Foundation Classes) format into Unity3d developing interactive features, as shown in figure 2. In the scene of Unity3D, a game object in 3D space realizes 3D coordinate transformation through matrix operation, which can be easily translated, scaled and rotated [8]. Finally, the BIM model is uploaded to the Apache server to realize real-time dynamic downloading of model resources, even indoor location data.

![Figure 2. The design block diagram of indoor 3d virtual interactive system.](image)
3. Key Technologies and Algorithms

3.1. Key Technologies For Obtain and Apply Outdoor High-Precision Locations.
This study uses m-level positioning (RTD) service provided by beidou partner M1 high-precision positioning integrated terminal product made by Beijing oLinkStar Co., Ltd. As shown in Figure 3, users need to upload original location data (GGA data) collected by data acquisition terminal equipment supported GNSS difference service to Qianxun server, and the server returns RTCM data, which is difference data, used to correct the original data and improve accuracy.

Figure 3. The realization process of the high-precision locating service based on Qianxun server.

3.2. Key Technologies for Design and Implementation of Indoor 3d Virtual Interaction System.

3.2.1. 3d BIM model constructs and scenes generate. In this study, a hierarchical modeling method based on tree structure was used to construct a simplified model. The model is mainly composed of ceilings, floors, walls, doors and windows, and the entity modeling in the scene is organized according to the tree structure. The structure block diagram of the indoor 3d virtual scene modelling is shown in the figure 4, and the completed electromechanical information building BIM model is shown in the figure 5. Each floor corresponds to a separate scene, so that the dynamic loading of the scene can be realized according to the current elevation value of the user, and switch floors automatically.

Figure 4. BIM modeling hierarchy.
3.2.2. Obtain indoor personnel location data in real time. Saving the indoor location data in the .txt file, obtaining the location information by reading the file in unity and displaying it in real time. The application retrieves the location data from the Apache server and updates the location information in the text in real time.

3.2.3. Load resources dynamically. For the reason of the BIM model requires a large amount of memory, to reduce the local memory overhead, you need to implement a method that can dynamically load the BIM files from the server. first, the BIM model file in the unity3d need to set as prefab and is packaged as assetbundle, and then upload it to the Apache server. Downloading the assetbundle of model files is encapsulated in the terminal to realize the dynamic resource loading of the BIM model.

3.3. Realization of Seamless Switch Between Indoor and Outdoor Maps.
Indoor and outdoor map seamlessly switch design process as shown in figure 6. By clicking on a POI on the baidu map, it will show a pop-up information window whether to switch to the indoor map if the POI has BIM model, users can switch to the corresponding indoor map automatically by clicking on the information window.

![Figure 5. BIM of electromechanical information building.](image)

![Figure 6. The design flow chart of seamless switch between indoor and outdoor maps](image)
4. System Testing and Analyzing

4.1. Test of Indoor and Outdoor High-Precision Positioning System.

The outdoor system test result is fine, and all the preset functions in the system software function design are realized. Limited to the current outdoor high-precision positioning technology, the accuracy of the meter-level positioning can only reach 3 to 4 meters. And the indoor 3d virtual interactive system realizes move and rotate, free interactive roaming, path hunting and roaming Automatically, indoor positioning, distance measurement, preview, scenes dynamic switching, mini-map and so on. The human-computer interaction(HCI) interface is fine.

4.2. Test of Seamless Switch between Indoor and Outdoor Maps.

As shown in figure 7, users can automatically switch to the corresponding indoor map by clicking the POI point with the operation is simple and the system can switch smoothly.

![Figure 7. Seamless switch between indoor and outdoor maps.](image)

5. Conclusion

The system this research developed is based on beidou difference and UWB short-range wireless location technology, relied on the secondary development and application of the baidu map API as well. Not only improved the positioning accuracy, but also realized the seamless switching between indoor and outdoor map. The map service can perfectly integrate indoor and outdoor high-precision positioning is undoubtedly one of the important development direction of future map service industry. This paper focuses on three key techniques to provide reference for the application of VR in complex indoor environment and the application of high precision positioning technology, with great significance for the research of indoor and outdoor high-precision positioning.

6. Acknowledgments

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