

Design and Implementation of Positioning Software System based on Non-navigation Satellites

A Dissertation Submitted for the Degree of Master

Candidate: Sun Guiyu

Supervisor: Prof. Qin Honglei

School of Electronic and Information Engineering

Beihang University, Beijing, China

ABSTRACT

With the development of technology and the increase in demand, people have become more dependent on position services. Although many Global Navigation Satellite Systems (GNSS) that have been built and been able to provide accurate Position, Velocity and Time (PVT) information, the fragile satellite navigation signals are susceptible to multipath effects, occlusion, and other complex situations. Other positioning technologies have broad prospects as GNSS backup systems. Among them, non-navigation satellite signals have the advantages of wide coverage, high signal strength and strong anti-interference. Based on the existing satellite resources, only a small amount of capital investment can provide useful positioning services.

At present, the basic algorithm for positioning based on non-navigation satellites has basically been verified, but due to a series of problems such as data processing and orbit prediction, the algorithm has low execution efficiency, a large number of manual assistance operations and other problems. As a result, it cannot realize automatic and real-time positioning based on non-navigation satellite signals. In view of the above-mentioned many problems, designing and developing a set of non-navigation satellites positioning software system has important theoretical significance and application value.

This subject has completed the design and development of a positioning software system based on non-navigation satellites. The research content includes the following points:

(1) The realization of the key technology of Doppler extraction and processing. The system first preprocesses the collected digital signal according to the characteristics of the digital signal, and then uses the maximum likelihood estimation method (MLE) to obtain the time and Doppler information of the satellite signal, and finally assigns the Doppler information of different satellites according to the characteristics of the timing. The clustering is completed.

(2) The implement of the orbit prediction and satellite number recognition. This

system uses the TLE file and the SGP4 orbit model to achieve the prediction of the position and speed of the satellite, and fulfills the function of automatically matching the above-mentioned Doppler information with the satellite number one by one.

(3) The accomplishment of key technology based on non-navigation satellite signal positioning. According to the Doppler information and the characteristics of the satellite distribution, the system independently selects the appropriate distributed epoch information to realize the instantaneous Doppler positioning, and uses the output information to monitor self-integrity.

(4) Corresponding software interface has been developed for the whole set of positioning system, which is easy for users to operate. At the same time, the Doppler information and positioning results can be displayed visually during processing.

(5) Tested and analyzed key positioning indicators such as the Time to First Fix(TTFF) of the system, and predicted the application and prospects of the system.

The experimental results show that the combination of the software platform designed in this paper can completely autonomously realize the positioning function with an accuracy better than 200 meters associated with the hardware platform. In summary, this article has fulfilled the design and development of a software system based on non-navigation satellite signal positioning, verified the validity and feasibility of instantaneous Doppler positioning, and tested and analyzed the key indicators of the system to prove that the system can provide good positioning services on the basis of existing non-navigation satellite signals and has great development prospects.

Keywords: Non-navigation satellite; Positioning software; Instantaneous Doppler positioning; Time to first fix;