SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Mobile Satellite Communications and Navigation Technology (4)

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THE CLOCK-BASED METHOD FOR GPS RECEIVER POSITIONING UNDER THREE SATELLITES

Abstract

Nowadays, GPS plays an important role in our daily lives. Normally, there must be at least four useful satellites so that the positioning information of GPS receivers can be obtained. However, in certain applications, there are situations wherein the requirement of a minimum of four satellites is not satisfied because of the obstructions to receiver-to-satellite line of sights. In the circumstances, the traditional positioning method cannot be used anymore. How to deal with the ill-conditioned problem so that GPS receivers can provide continuous and reliable positioning results is the main theme of the paper. Aiming at such problem, additional devices such as altimeter and Inertial navigation system may be used to provide additional information. It is also possible to increase the number of useful satellites by combining GPS and Galileo. The above mentioned methods may be useful, but not efficient. In fact, the cost of these methods has great impact on their popularizations. To decrease the cost, it is desired to develop a method through the inner information from GPS receivers. Actually, besides the position information, the receiver clock bias (RCB) is obtained when the function of positioning calculation is implemented normally. When the clock frequency keeps stable, the RCB series can be viewed as one useful satellite, and a prediction model on it can be used for positioning calculation under the conditions of only three satellites. Compared with other auxiliary methods, the clock-based positioning method needs no external equipments, and its advantage is clear. Recently, the theory of time series analysis has been used in many fields and made a great success due to its accuracy and mathematical soundness. One of the primary objectives is to be able to predict the future behavior of a dynamic series on the observations of its past behavior. Accordingly, the RCB series is considered as a time series measured at successive times and spaced at regular intervals, and then we use the theory of time series analysis to predict it. After the RCB prediction model based on the theory of time series analysis is presented, the clock-based positioning method augmented with it is developed. Experiments demonstrate that the prediction model is suitable for predicting the RCB series, and the clock-based positioning method is indeed effective. Equipped with the presented method, the positioning continuity and reliability of GPS receiver can be ensured for a few seconds even if there are only three useful satellites.