Recursive Filters and Positioning Algorithms of Carrier Phase Differential GPS

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This thesis addresses the application of recursive filters to the Global Positioning System (GPS). Especially to the so-called carrier phase differential GPS, using the H∞filter that is one of the robust filtering technique, the positioning algorithms and their performance are studied by comparing with those of the ordinary least squares or the Kalman filtering techniques. Several experiments are carried out by using real receiver data.

Firstly, a brief review of the H∞filtering method, and the analysis of relations between the H∞ and the Kalman filters are presented. Also the properties of the H∞ filter in a stochastic setting are provided.

Secondly, with restricting to the static positioning and regarding the unknown integer parameter included in the measurable quantity as real numbers, the positioning algorithms that utilize the H∞filter are derived. Since the H∞ filter performance strongly depends on the design parameter,γ, of the H∞ filter and it is difficult to give an appropriate value toγin nonlinear system such as GPS, a simple but useful method to determine theγvalue is proposed. In the algorithm, although a new parameter must be prescribed, it is easier than giving theγdirectly because the existence of the H∞filter is always guaranteed. The experimental results show the applicability of the algorithm. Furthermore the results show the robustness of the H∞filter against uncertainties in system models. Then some existing techniques that can estimate the integer parameters as exactly integers are applied to the positioning algorithm using the H∞filter. And the performance and the effects of the H∞filter in estimating the integer parameters are examined.

Finally, as an extension of the proposed algorithm, variations of the visible satellites and the kinematic positioning, namely, the positioning while the receiver is in motion is considered.