Integrated high precision kinematic positioning using GPS and EGNOS observations[1]

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Abstract

Satellite positioning using GPS and to a limited extent GLONASS is now widespread within the civilian community. The main observable used for high precision position determination is the carrier phase. Carrier phase measurements are very precise but ambiguous because the whole number of cycles between the receiver antenna and the satellite is unknown and must be determined. Measurements from GPS satellites have been used for high precision position determination in real time in certain environments. However, for some applications, such as position determination in harsh engineering environments, there are disadvantages in just using data from GPS satellites alone. An example of this is due to obstruction of satellites. Using fewer satellites and the poor geometry of the remaining visible satellites, can severely limit the performance of the system, e.g. integer ambiguities cannot be resolved quickly enough, and the accuracy, reliability, integrity and availability of the solution are reduced. A solution to this problem is to use additional data from other sources.

This research assesses the potential of using of both GPS and EGNOS (European Geostationary Navigation Overlay Service) carrier phase data, transmitted as part of the EGNOS System Test Bed (ESTB). Various issues involved in the integration of data from the two systems including computation of satellite coordinates and clock offset estimation are addressed. This is followed by a detailed discussion of an approach for the generation of double difference observables, ionospheric error estimation as applicable for the single-frequency observations transmitted by the EGNOS satellites, and the determination of integer ambiguities.

Ambiguity determination and ionospheric error parameterization for medium (< 100 km) and short-range (< 1km) baseline lengths represent the core of the research presented in this thesis. Different algorithms have been implemented and successfully tested with simulated and real data. The real data was captured using a set of Novatel Millennium/WAAS receivers. The algorithms for the Kalman filter based ionospheric error processing engine to determine a near real-time local ionospheric error model based on the dual frequency GPS data are described in detail. The final ionospheric error parameterization is based on a new approach using a modified weighted biharmonic spline interpolation to take into account small-scale local and temporal changes in the ionosphere .

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The final results show a by 5-10 % increase in the availability of reliable ambiguity determination and position determination accuracy in difficult environments, when GPS and EGNOS data is combined.