IONOSPHERIC ERROR IN GPS APPLICATIONS

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Abstract:

The need for satellite navigation technology, with its capability to provide real time Differential Global Positioning Systems (DGPS) using Global Navigation Satellite System (GNSS) has increased tremendously over the years. However, the positioning accuracy tends to degrade as the baseline increases. The degradation is due to many errors, amongst which is the ionospheric error in the radio propagation signal. The ionospheric delay is the main problem in achieving millimetre level positioning. It is known that the ionospheric errors in the GPS observations can significantly bias the computed user position when they are not taken care of. The ionosphere affects the electromagnetic waves that pass through it by inducing an additional transmission time delay, under worst case conditions, ionospheric scintillations can rapidly vary amplitude and phase of GPS signal or result to loss of lock on a satellite and if enough satellites are affected, it could result to loss of positioning services. The magnitude of the ionospheric delay is related to the Total electron Content (TEC) along the radio wave path from the GPS satellite to the user antenna on the ground. Using a dual frequency GNSS receiver, the ionospheric errors can be accounted for taking advantage of the ionosphere's dispersive nature. Because of its optimum performance and determining of the up-to-date uncertainties of the estimates for real time quality assessments, the study utilizes the concept of extended Kalman filter (EKF) in reducing the ionospheric effects and measurement noise in real time GPS applications. The study also determined the extent in which the ionosphere can affect the user antenna in real time positioning, using a GPS constellation. During the field tests, measurements were taken when there were ionospheric scintillations and when the ionospheric activity was low, two stations observations were used. The first is the observations collected from the vicinity of a permanent GPS station using an Ashtech z-extreme receiver, while the second observation is from the user's Ashtech z-extreme GPS receiver. With the aid of radio link, data from the user station was sent to an independent computer which is connected to the permanent station. Both observations from the permanent GPS station and the user's station were processed simultaneously implementing double differencing method and the LAMBDA method to correct the integer ambiguities in the carrier phase, the tests were processed using ionospheric weight technique. The formulated algorithms and data were processed using Matlab and the end result yields a millimetre level positioning.