# PRECISE ABSOLUTE VELOCITY ESTIMATION OF HUMAN SPACE FLIGHT IN LEO USING NAVIC DOPPLER SHIFT MEASUREMENTS

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**Abstract**

The Low Earth Orbit (LEO) is the most significant for diverse applications like imaging, human space flight and scientific observations; the number of satellites in LEO is ever increasing. To estimate the Position and Velocity (PV) conventionally multiple ranging sessions are conducted. It increases burden on the ground support staff and computation delays are introduced. These delays will lead to inaccurate estimation errors. Additionally, propagation errors are introduced into the PV estimation. Also, for human space flight applications, safety is of utmost importance, and hence precise and instantaneous determination of orbital parameters is crucial. This makes autonomous determination of the position and velocity of the satellite a necessity on board. In this study, it is proposed to use indigenously developed NavIC (Navigation by Indian Constellation) by Indian Space Research Organization Doppler shift measurements, for precise kinematic estimation of absolute velocity and receiver's clock bias rate of the human space flight. The novelty of this research work is the usage of the NavIC Doppler shift measurements, for precise kinematic absolute velocity and receiver clock bias rate estimation, for the orbit of the human space flight in LEO, for the first time. This will extend the footprints of indigenously developed navigation technology to space applications. Extensive simulation and analysis is performed to study the Doppler collision at LEO. Thus establishing the suitability of the method, as the LEO will not exhibit Doppler collision unlike on ground. The mean value and Standard Deviation (SD) values of the velocity estimation error are [-0.0027 -0.0001 -0.0045] m/s and [0.1191 0.3550 0.1319] m/s respectively for the best case. The mean and 3-$\sigma$ standard deviation of clock bias rate estimation error are 0.00075 m/s and 0.6 m/s respectively when the number of visible satellites is six. Additionally, simulations are carried out for a highly inclined sun synchronous orbit; with nominal and 50% higher standard deviation receiver noise, in Doppler measurements. The performance of velocity and clock bias rate estimation error is consistent for different orbits. However, the performance degrades with higher receiver noise.

**Keywords**: Navigation by Indian Constellation (NavIC), Indian Regional Navigation Satellite System (IRNSS), Low Earth Orbit (LEO), Kinematic, Kinematic, Navigation, Doppler, Velocity Estimation