Coordinate and velocity perturbations for the determination of geopotential from space geodetic measurements

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Although space geodetic observing systems have been advanced recently to such a revolutionary level that low earth orbiting satellites can now be tracked almost continuously and at the unprecedented high accuracy, none of the three basic methods for mapping the Earth's gravity field, namely, Kaula linear perturbation, the variational equation approach and the orbit energy-based method, could meet the demand of these challenging data. Little theoretical progress has been achieved in establishing comparable mathematical modellings for these measurements. In order to best exploit the almost continuity and unprecedented high accuracy provided by modern space observing technology for the determination of the Earth's gravity field, we propose using satellite-based orbits to derive the corresponding coordinate and velocity perturbations. The perturbations derived are quasi-linear, linear and of second-order approximation. Unlike conventional perturbation techniques

which are only valid in the vicinity of reference mean values, the proposed

coordinate and velocity perturbations are mathematically valid through a whole orbital arc of any length. In particular, the derived coordinate and velocity

perturbations are free of singularity due to the critical inclination and resonance inherent in the solution of artificial satellite motion by using various types of orbital elements. We then transform the coordinate and velocity perturbations into those of the six Keplerian orbital elements. For completeness, we also briefly outline how to use the derived coordinate and velocity perturbations to establish observation equations of space geodetic measurements for the determination of geopotential.