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Quantification and Mitigation of Errors in the Inertial Measurements of Distance

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Abstract
The accurate measurement of the distance travelled, velocity and acceleration at low velocities to supersonic speeds is an active area of research. The captive flight at Rail Track Rocket Sled (RTRS) facility provides a unique environment for kinematic testing at supersonic speeds. Using RTRS facility, an accurate distance measurement method is developed, tested and experimentally verified. Three accelerometers, with different noise density, identically moving, have been chosen for sensing forward motion. A number of measures such as different mountings, bias correction, capping, digital filtering and position fix have been tried in a practical implementation. To keep the measurement error within tolerable limits a novel method of obtaining position fix is proposed by using a pair of magneto-inductive sensors. The bias correction is applied in the position to derive corrected velocity and acceleration. To know the truthfulness of results and to validate the proposed methods, a system has been developed to generate reference values for computation of error. This reference system has an error of 0.046 % which is much better than reported in previous study. After mitigation of various errors using proposed methods, an error within 1.5 % was attained with one of the sensors used in trials. The proposed work identifies the elements which contribute in errors and quantify the mitigated errors in some cases and highlights the measures which bring about significant improvement in error. It also suggests how to obtain more accurate results using economical MEMS accelerometers.

Keywords
Distance – Velocity – Acceleration – Rocket sled – Sled motion – MEMS accelerometer – Inertial acceleration – Rail measurements