Precise and robust GPS / INS based outdoor localisation

Student

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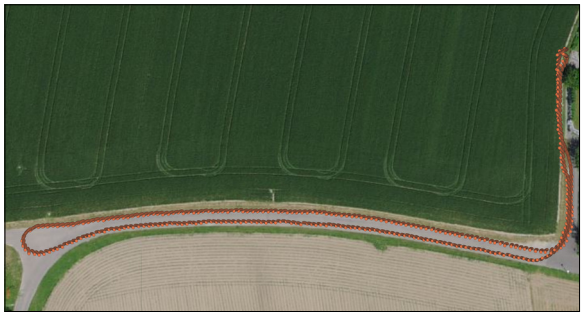
Introduction: In the upcoming field of outdoor robotics, a precise and robust localisation referenced to the earth is becoming more and more important. Integrating GPS and IMU measurements provides a long-term stable dead reckoning localisation solution. Using Differential GPS, the accuracy of localisation can be increased to centimeter level.

Approach: An offline AHRS localisation framework is proposed based on inertial navigation techniques and GPS localisation to fulfil the requirements of precise and robust localisation on or near earth's surface.
A loosely coupled INS/GPS integration based on a Kalman Filter solves a reliable AHRS Attitude Height Referencing System. The IMU and GPS data are fused together to estimate IMU errors, which allows dead reckoning while no GPS data is available.

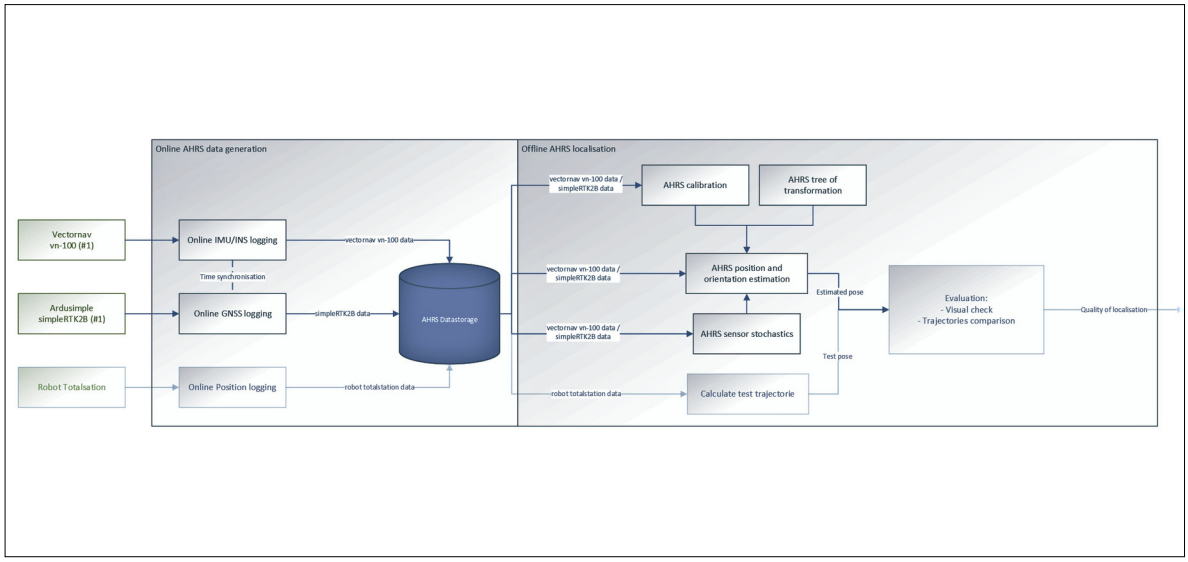
Result: The localisation algorithm is applied on an own captured dataset of approximately 7 minutes. The sensor system is placed on the ground to generate static measurements to solve the initialisation problem. After that, the sensor system is carried around to generate a dynamic trajectory (pedestrian test).
The position and velocity RMSE of the INS prediction to the GPS measurements is computed. An RMSE in the ENU frame of 0.363 m in north-direction, 0.357 m in east-direction and 0.110 m in up-direction is achieved.
A high process noise on position and velocity is needed to force the integration filter to converge. The localisation algorithm does not fit the real process perfectly. Analysing the error covariances of the error state over time indicates a bad orientation error estimate. The yaw angle is not properly converging over time and therefore influences the prediction accuracy of east and north velocity errors.
Reasons for this are evaluated and optimisations are formulated.

GPS trajectory
Own presentment

Corrected INS trajectory
Own presentment



AHRS localisation framework
Own presentment



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Subject Area
Mechatronics and Automation, Sensor, Actuator and Communication Systems, Software and Systems