Algorithms for Estimation of Vehicle Trajectory during GPS Signal Outages Based on Inertial Sensor Data

[1]Machan Jaroslav , [2]Herda Zdeněk , [3]Pavelková Lenka

The Institute of Information Theory and Automation works with Škoda Auto, a.s. on the joint project under the DAR centre. The main aim of this project is to refine the information about the moving vehicle position obtained from global positioning system (GPS). In the case of signal outage, GPS does not work properly. During this outage, the vehicle position is estimated.

The estimation is based on the principle of the inertial navigation (INS), i.e., the following kinematic relationships are utilized

$$s = \int v(t)\mathrm{d}t; \quad v = \int a(t)\mathrm{d}t; \quad \varphi = \int \omega(t)\mathrm{d}t$$

where t means time, s is travelled distance, v is velocity, a is acceleration, φ is azimuth and ω is angular velocity.

Data required for the estimation are obtained from the following sources: (i) controller-area network (CAN) that provides a data from the vehicle sensors; (ii) external device that provides an acceleration and an angular velocity in the three axes from MEMS sensors; (iii) GPS navigation. All above mentioned devices are tightly connected with the vehicle. Therefore, the INS is called a strap down one.

Using INS data, the position is computed by integration and related computation error continuously grows. It means that the input data have to be very precise. Therefore, the big part of the project deals with processing of measured data and with choice of the most suitable ones from the position estimation point of view.

The vehicle position is estimated using a stochastic state-space model with uniformly distributed noise. The Bayesian approach is applied to obtain position estimates.

The mentioned model utilizes vehicle velocity and azimuth as inputs. The input data are preprocessed by separate pre-processing program. The way of data preprocessing depends on the current driving mode of the vehicle. In the presentation, resulting courses of the used input data are discussed together with estimated vehicle position.

To obtain required data, many rides both on the testing polygon and on the real road were realized. Data from the testing polygon contain no outages. Therefore, simulated outages are used in experiments. On the other side, the real road data were intentionally measured in the area where the GPS signal outage occurs. So, the position estimation could be verified under real condition.

References

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[1]Škoda Auto, a.s., *jaroslav.machan@skoda-auto.cz*
[2]Škoda Auto, a.s., *zdenek.herda@gmail.com*
[3]Institute of Information Theory and Automation, Adaptive Systems Department, *pavelkov@utia.cas.cz*