

Abstract

Modern satellite navigation is the basis for many road traffic applications. These applications cover fleet management systems for logistics, transport or public authorities as well as trip based road tolling or insurance fees and tracking of valuable or dangerous goods. Especially global availability and low user costs are the reasons, why nearly all modern logistic and monitoring systems use satellite navigation.

Nevertheless, satellite navigation systems are limited by the weak signal power. Driving in tunnels, under bridges or in dense urban areas can already lead to outages in position estimation. While these short time disturbances are no case stoppers for car navigation, tracking of valuable or dangerous goods and tolling need a high continuity and availability. Another drawback of the low signal power is the high vulnerability by jamming or spoofing signals. Even if jammers are illegal, the low costs and easy manufacturing hold a high risk.

This work presents a low cost concept for secured positioning of road vehicles, which is able to detect and mitigate short-term outages of satellite navigation. It combines a mass market low cost satellite navigation receiver, standard built-in vehicle sensors and a low cost inertial measurement unit. The special coupling of the sensors allows the estimation of the sensors' systematic and stochastic noise processes and an automatic detection of single sensor outages. In case of satellite navigation outages, the system also distinguishes between environmental blockings (by tunnels, bridges etc.) and jamming. External manipulation of satellite navigation signals by spoofing or meaconing can be detected by parallel internal sensor data comparison.

Subsequent to the description of the used components, the developed and implemented algorithms and methods of data processing are shown. Thereby, the concept of sensor fusion and fault detection as well as the state machine concept are described in context of a real time capable demonstrator implementation. The applicability and performance of the developed system are tested in faultless and defective scenarios with simulated and real data.

The overall system presents an effective real time capable concept for extremely robust and secured road navigation. It uses low cost mass market sensors, which are standard built-in for the most part of road vehicles.