PARADISE

Precise and Robust Navigation enabling Applications in Disturbed Signal Environments

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About

The primary objective of the PARADISE project is to develop innovative signal processing and navigation algorithms bringing precise GNSS positioning and IMU attitude available to applications where to date GNSS could not be adopted due to prohibitively bad signal conditions, such as urban canyon and forest environment. These new PARADISE algorithms will be validated using a newly developed 'Proof-of-Concept' breadboard. Furthermore several user applications will be demonstrated with a prototype receiver within the scope of the project.

The PARADISE project will focus on the following four applications (with first three also demonstrated), with the clear aim to increase the overall efficiency of the work flow of these applications by introducing GNSS based positioning:

- Cadastral surveying inside and near forests
- Mapping of underground lines in construction work in urban canyons
- Navigation of forestry machines (harvester/forwarder)
- Mapping of boundary stone inside forests

Those applications generally demand high accuracies to e.g. allow a survey to be accepted by the state offices, to locate a certain tree to be harvested or to allow a reasonable overlay of underground power lines onto a camera image. But they face the problem of a limited or distorted visibility to the GNSS satellites. Currently available GNSS solutions can not adequately cope with this problem resulting in unacceptable positioning errors of several meters. Also using a compass (as being integrated in nearly all mobile phones or tables) for attitude determination results in heading errors of up to 45°-90° in case of nearby metal objects (e.g. vehicles). Thus PARADISE targets the development and demonstration of

- Algorithms (signal processing and RTK/PPP) for GPS/Galileo dual-frequency based navigation positioning with a horizontal error below 2 m to 5 cm
- Algorithms for MEMS integration for attitude determination that provides attitude as yaw, pitch, roll with an error < 1°
- Development of a 'Proof-of-Concept' receiver to validate the capability of the algorithms to meet the requirements, driven by the user applications
- Demonstration of the user applications using a mobile 'prototype' receiver adapted to the different user demonstrations needs
- Usage of a design enabling later cost efficient production as a precondition to penetrate the target markets

under degraded signal conditions. This enables new applications and improves existing applications in forest and urban canyons.

The PARADISE receiver realizes the robust and precise positioning and attitude solution by a combination of improved GNSS signal processing together with an adapted and highly performing real-time-kinematic (RTK) or precise-point-positioning (PPP) algorithm. In particular synthetic aperture GNSS processing is applied to obtain precise code/carrier pseudoranges and precise user velocity estimates in degraded environments. Those observations are used to update a GNSS/INS Kalman integration filter. Stand-alone (without RTK or PPP) positioning will be at the 1 m level already exceeding today's existing commercial solutions. In combination with a PPP algorithm, that will reliable correct remaining cycle slips in the carrier phases, centimeter accurate positioning will be obtained. The inertial measurement unit (IMU) is a cost efficient MEMS unit and provides the 3-dimionsinal orientation. By using the GNSS/INS Kalman filter, the IMU is constantly calibrated. The IMU also allows to bridge complete GNSS outages of short (10-20 s) duration.

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