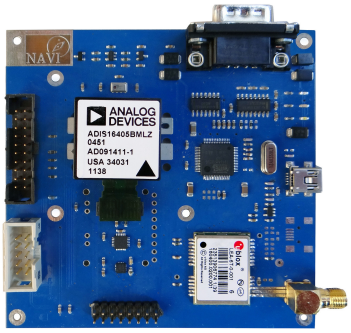
Amir Melzer

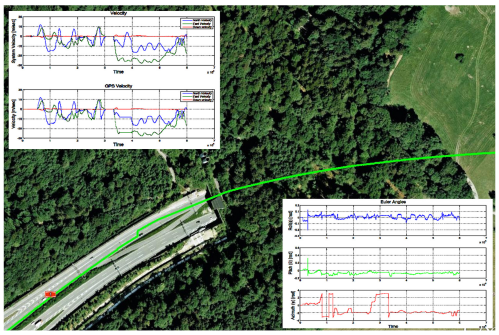
Graduate Candidate	Amir Melzer
Examiner	Prof. Dr. Markus Kottmann
Co-Examiner	Dr. Markus A. Müller, Frei Patentanwaltsbüro, Zollikon, Zürich
Subject Area	Sensor, Actuator and Communication Systems

MEMS based Navigation System

Design, implementation and evaluation of MEMS based inertial navigation system with GPS and magnetometer integration



Prototype unit

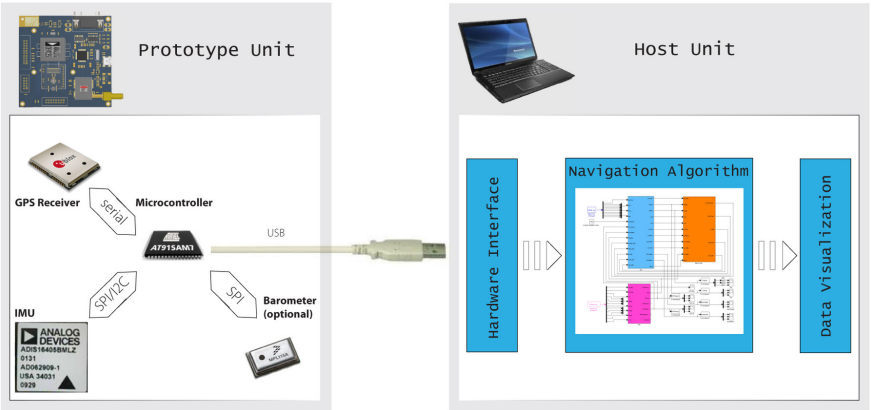


Graphical user interface

Introduction: Inertial measurement units (IMUs) based on micro-electro-mechanical systems (MEMS) offer a cost-effective, low power and small size solution for navigation applications. Nevertheless, the MEMS based IMUs are subject to substantial imprecision since their sensors suffer from noise, drift and inaccuracy. A GNSS based navigation system offers a precise source for positioning and velocity. But it suffers from reliability problems owing to dependency on signal reception conditions and slow navigation solution throughput. A hybridization of the MEMS based IMU with a GNSS receiver however provides accurate and cost-efficient navigation results. Furthermore this fusion can cover situations where an accurate satellite navigation solution is not available owing to lack or inadequacy of GNSS signal.

Approach/Technologies: This study investigates and develops a strapdown navigation solution based on the fusion of a MEMS based IMU with a GNSS receiver and a magnetometer. The integrated navigation solution is realized by using an extended Kalman filter (EKF) algorithm. The navigation solution includes the development of a custom designed prototype unit based on ARM technology. The unit allows synchronized acquisition of the data from the IMU, the GNSS receiver, a three-axis magnetometer and a barometer. This was followed by the realization of a post-processing environment which implements the integrated navigation solution, facilitates the tuning process and visualizes the navigation results.

Result: Numerous performance tests and EKF tunings ultimately led to a reliable and accurate navigation solution. Repeated tests have shown that even under GPS outage conditions of up to 60 seconds over a travel distance of 1.5 km, the system presents a position error of no more than a few dozen meters.



System block diagram