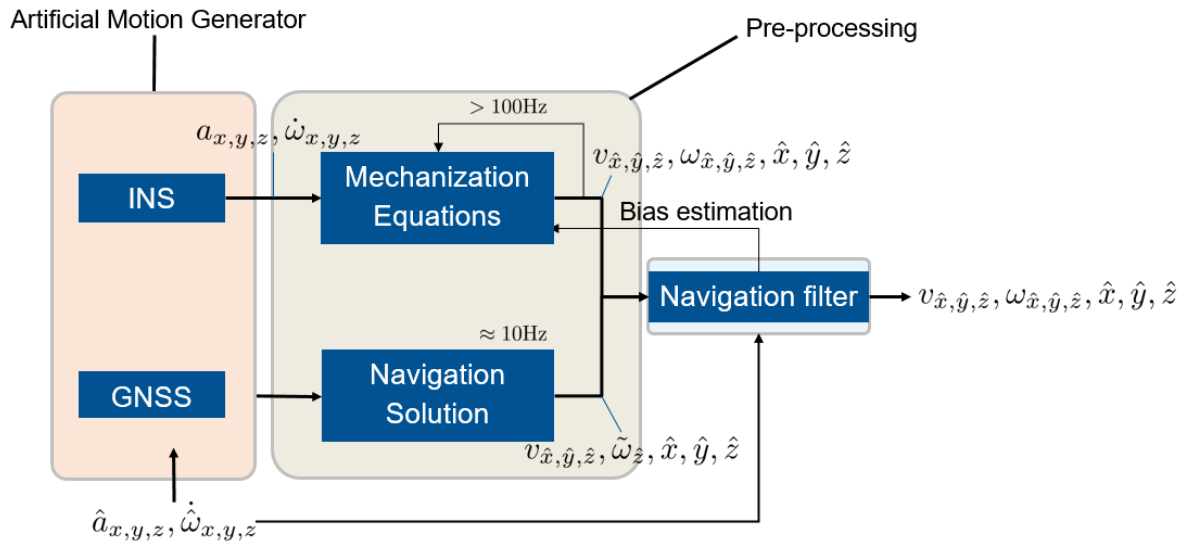
Chair of Agrimechatronics
Technical University of Munich

Characterization of Dynamic Influence on RTK-GNSS/IMU-Based Positioning Using an Artificial Motion Platform

The Chair of Agrimechatronics is currently seeking a motivated Master's student to contribute to ongoing research on improving GNSS/IMU sensor systems for agricultural machinery.



Background

Off-road vehicles such as agricultural machines (e.g., tractors, combine harvesters, and sprayers) operate in unstructured and often featureless environments. Unlike on-road applications, these machines cannot rely solely on visual sensors for localization. Instead, Real-Time Kinematic (RTK) GNSS positioning, in combination with an Inertial Measurement Unit (IMU), represents the state-of-the-art solution. This setup enables centimeter-level position accuracy and reliable orientation estimation.

However, the estimation process faces challenges in low-dynamic scenarios—common in agricultural applications—where sensor fusion performance may degrade. To address these limitations, the chair has developed an artificial motion platform designed to simulate controlled dynamic conditions.

Objective of the Thesis

This thesis aims to utilize the artificial motion platform to systematically characterize the influence of motion dynamics on the performance of RTK-GNSS/IMU-based positioning. The goal is to investigate potential improvements in estimation accuracy through the introduction of artificial motion.

Part A: Prototype Sensor-Fusion implementation (30%)
1. Implementation of state-of-the-art GNSS/IMU fusion algorithm based on available resources
2. Development/Implementation of a data-capturing system to obtain raw-data from the GNSS, IMU and motion platform

Part B: Test Setup Using the Artificial Motion Platform (30%)
1. Development of communication setup with motion-platform control (CAN/UART-based)
2. Characterization and calibration of the utilized sensors
3. Test Case Definition with the Motion Platform (e.g., level of motion, external vibrations, sky view of GNSS receiver)
4. Execution of Test Cases

Part C: Analysis and Improvement of the initial fusion concept (40%)
1. Raw Data Post-Processing (e.g., unit conversions, transformation into the vehicle frame).
2. Data analysis with scope to main frequencies, amplitudes, and variations
3. Evaluation of performance improvements due to artificial motion
4. Formulation (and if feasible) implementation of enhancements to the sensor-fusion structure

General

The theoretical components of the thesis can be completed at your own pace and in your preferred working environment. However, regular meetings with the advisor—either weekly or biweekly—are mandatory to ensure consistent progress and guidance.

For hardware development and prototyping, the chair provides access to a fully equipped electronics lab located in Dürnast (near Weihenstephan, Freising), including various 3D printers for housing fabrication. In-person meetings can also be arranged at the MW building in Garching.

A profound motivation for the topic is the only requirement for working on this thesis. Previous experiences in microcontroller programming, sensor fusion, or statistics will help you but are optional initially. As a benefit, we offer a high degree of freedom during the thesis for your personal preferences and solution strategies. This, in turn, requires structured and independent work. The topic above was sketched for a master's thesis but can also be adapted to fit a semester's thesis.

Interested? Contact us!

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