Chair of Agrimechatronics
Technical University of Munich

Investigation of Relative Positioning Between Collaborative Agricultural Machines Using GNSS and Moving-Base RTK

The Chair of Agrimechatronics is currently seeking a motivated Master's student to contribute to ongoing research on improving robust relative positioning for collaborative agricultural machines.

Background

In collaborative agricultural scenarios, multiple machines often operate in close proximity to perform coordinated tasks. However, not all machines may have access to correction services (e.g., RTK base stations or NTRIP), especially in rural or infrastructure-limited regions. To address this, moving-base RTK offers a promising solution by enabling one machine to act as a mobile reference station for others.

This thesis focuses on investigating the feasibility, accuracy, and reliability of relative positioning between machines using GNSS and moving-base RTK. The communication between machines is assumed to be handled via a Wi-Fi-based system. The core objective is to evaluate the achievable accuracy, fix reliability, and coordinate system considerations in a real-world proof-of-concept setup. For a master-thesis, the additional topics on spoofing effects and mitigation and/or detection can be included to the scope of the topic.

Objective of the Thesis

The goal of this thesis is to develop and evaluate a relative positioning system for multiple machines using GNSS and moving-base RTK, with a focus on accuracy analysis, fix stability, and coordinate transformations.

Part A: System Setup and Integration (30%)

1. Configure GNSS receivers for moving-base RTK operation.
2. Establish a basic data logging and synchronization setup for relative positioning data.
3. Define a suitable coordinate system for relative positioning and transformation between global and local frames.

Part B: Experimental Evaluation (30%)

1. Design and conduct experiments to evaluate relative positioning accuracy under various conditions (e.g., distance, motion, satellite visibility).
2. Analyze fix reliability and convergence behavior in dynamic and static scenarios.
3. Compare results with expected performance metrics from literature or manufacturer specifications.

Part C: Proof of Concept and Analysis (40%)

1. Implement a basic proof-of-concept demonstration with two or more machines.
2. Evaluate the system's performance in terms of relative accuracy, latency, and robustness.

3. Document findings and provide recommendations for future integration into collaborative machine systems.

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 GNSS systems 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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