

Integration of a GNSS RTK Module into a ROS2 Based Mobile Robot Platform

Master Project 1

Student



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Definition of Task: This MSE project investigates the integration and verification of a GNSS Real-Time Kinematic (RTK) positioning system into a ROS2-based mobile robotic platform. The task involves integrating the GNSS RTK module into the Husarion Panther unmanned ground vehicle and incorporating it into the ROS2 software stack. The system is intended to acquire GNSS RTK data along with diagnostic metrics to enable reliable outdoor localisation. The project further aims to evaluate the system performance under realistic operating conditions, focusing on horizontal, vertical, and three-dimensional positioning accuracy, RTK correction service availability, and overall system reliability.

Result: The GNSS RTK module and LiDAR sensor are mounted on a centrally located bracket, ensuring unobstructed sky visibility for the GNSS antenna and a clear LiDAR field of view. The bracket allows the precise positioning of the GNSS antenna and offers the possibility to mount a reflecting prism for verification. The interface hatch houses the Raspberry Pi 5 and the GNSS module, provides IP54-rated protection, functions as a heatsink for the electronics, and supports modular connections for the LiDAR and antennas. This design ensures robust operation and minimises EMC interference by physically separating the GNSS module from the robot's high-power electronics. Only two permanent cables are required: the Raspberry Pi power cable and a LAN connection, enabling easy installation of the module.

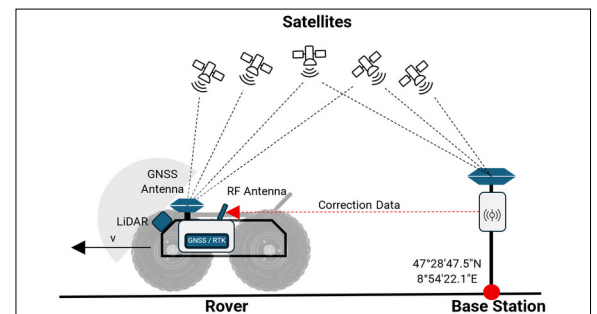
With RTK correction service available, the system achieved consistent centimetre-level horizontal positioning accuracy, with horizontal RMSE values from 7.2 mm to 9.5 mm. Vertical errors were more variable, resulting in three-dimensional RMSE values between 31.1 mm and 41.6 mm. The availability of RTK correction varied across test cases, with fixed RTK coverage ranging from 58.2 % to 96.2 %, directly affecting positioning stability and continuity.

Conclusion: The results demonstrate that GNSS RTK systems can be successfully integrated into mobile robotic platforms and provide high-accuracy localisation when an RTK correction service is available. The achieved horizontal positioning accuracy confirms the suitability of GNSS RTK for outdoor robotic navigation tasks requiring global reference information. However, the sensitivity to correction service continuity, satellite geometry, and environmental conditions highlights the need for robust real-time data validation and handling strategies within the localisation and navigation stack. Continuous monitoring of diagnostic metrics, such as RTK fix status and DOP values, is essential to ensure reliable operation. This master project provides a validated integration and evaluation approach and identifies key aspects for improving robustness and

reliability in real-world GNSS RTK-based robotic applications.

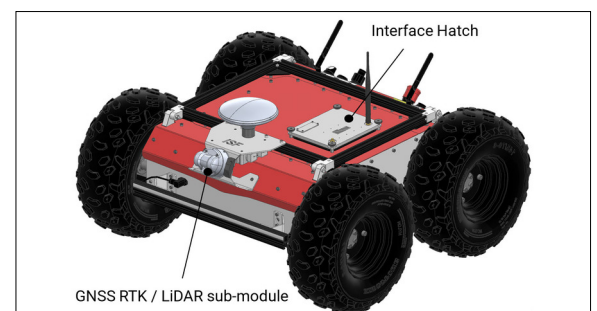
Visualization of High Level Project Scope

Own presentation



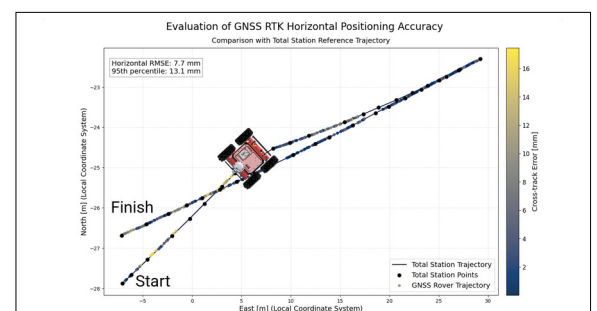
UGV with integrated GNSS RTK / LiDAR sub-module

Own presentation



Horizontal Position Accuracy Evaluation

Own presentation



Advisor

Prof. Dr. Dejan Šeatović

Subject Area
Mechatronics &
Automation