HSLU Hochschule Luzern

Technik & Architektur
Mechatronics & Automation

Master‘s Thesis Mechatronics & Automation

System integration of an autopilot box for mobile robots

Fig.1 Modular Autopilot Box

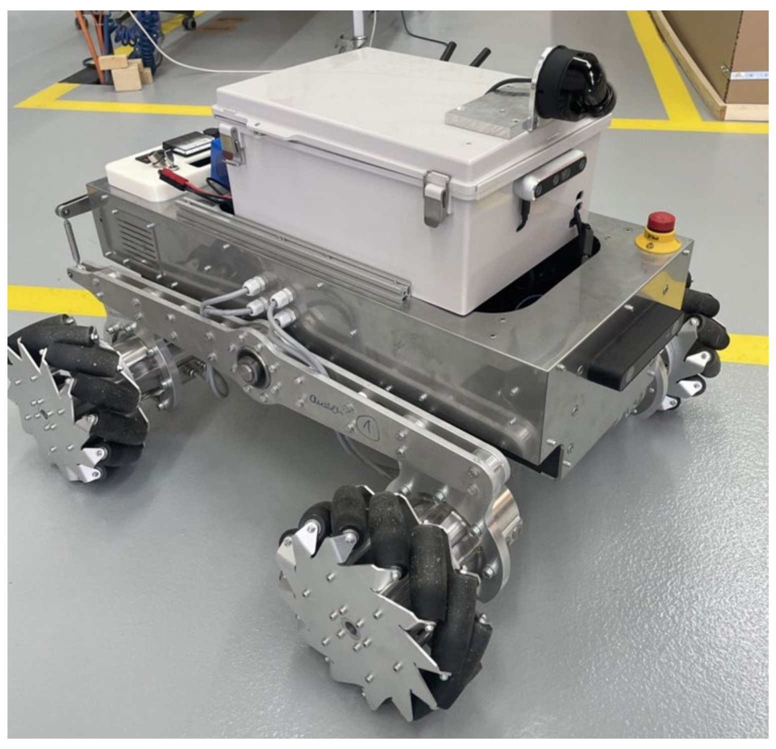

Fig.2 Integration on indoor platform

Fig.3 Integration on outdoor mower

Fig.4 Integration on Rapid Cosmos

Fig.5 Field Test with Rapid Cosmos and attached mulcher

Fig.6 Route Coverage during Field Test

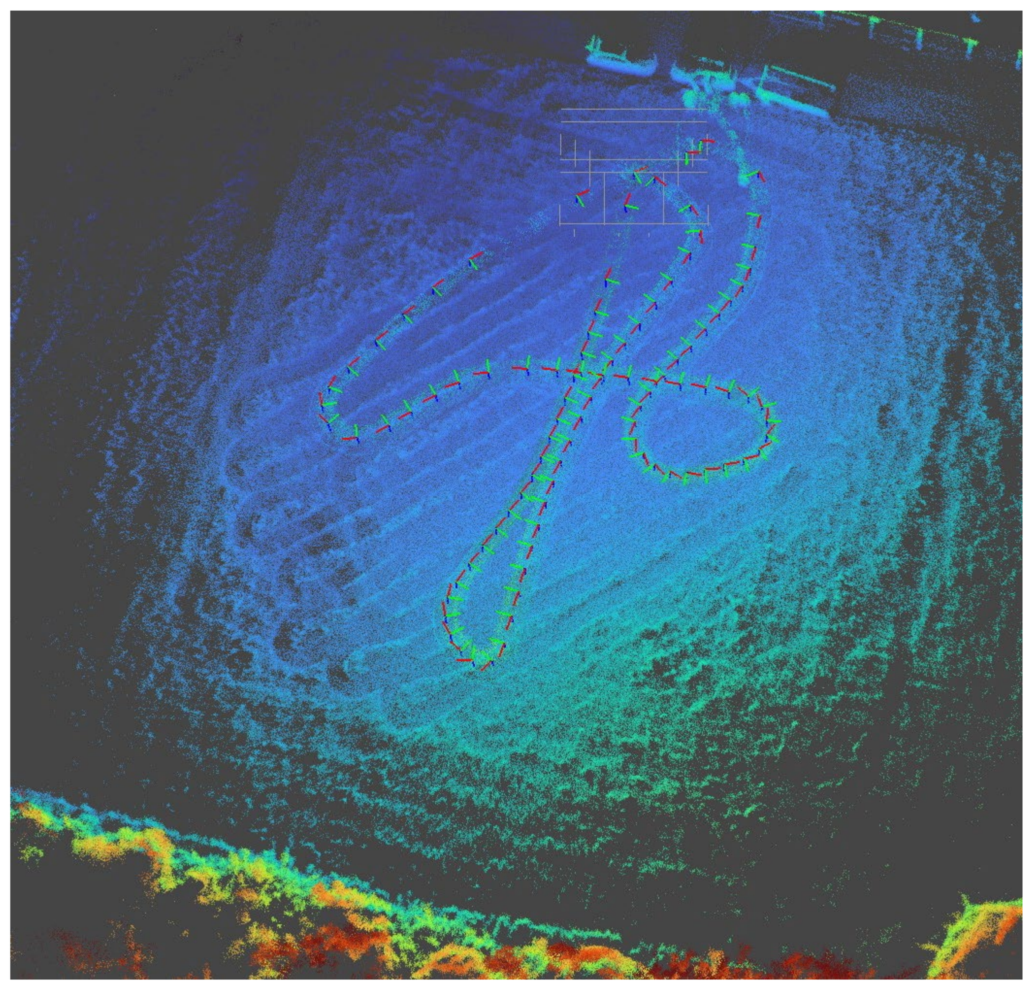

Fig.6 Field mapped with LiDAR-based SLAM

Motivation

The increasing demand for automation in mobile robotics is driven by labour shortages, cost reduction, and the need to improve productivity in different application areas. Mobile platforms in agriculture, intralogistics, service robotics, or outdoor maintenance often have their own specifications and use cases. Nevertheless, they require similar autonomy functions, such as localization, path planning, path following, and obstacle detection. If these functions are developed separately for each platform, the integration effort is repeated. Therefore, this thesis investigates the development and commissioning of a modular autopilot box. This box can be transferred and connected to different mobile robot platforms.

Method

The thesis includes the commissioning of all components, as well as the setup of a reusable ROS2 (Robot Operating System 2) Jazzy software stack. Software packages for localization, navigation, path following, and coverage planning were integrated and tested on an indoor platform and two outdoor platforms.

In addition, launch files with platform profiles were developed. These reduce the manual configuration effort during transfer. For the initial commissioning of the box, the indoor platform was used for software validation.

Results

The outdoor platforms highlighted the importance of platform-specific motion control and communication interfaces. They also demonstrated coverage planning and path following in a real field. The Regulated Pure Pursuit controller has less tuning effort than MPPI. It reached the desired speed with sufficient precision. The Fixposition module worked well as the main outdoor localization source. LiDAR-based odometry showed potential as a redundant localization source. The results show that several parts of the system are reusable. However, motion control interfaces, footprint, kinematics, velocity limits, and localization setup remain platform-specific.

The system is therefore not fully plug-and-play, but it can reduce repeated setup effort and support faster integration of autonomy functions. Further work is required for high grass, rough terrain, complex field shapes, long-term robustness, safety certification, and industrialization.

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