Demonstration of real-time sensor-based decision support for forest machine operators

Advanced Virtual Aptitude and Training Application in Real Time

Objectives:

Quantifying the operational environment, machine positioning and visualization

Developing methods for capturing and describing environmental data including the stand, ground vegetation and terrain, and the visualization of this data

Project Partners:

UNIVERSITÄT GÖTTINGEN

IFADO

NIBIO
NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH

OPTEA

skogforsk

SKOGKURS

Landesbetrieb Wald und Holz Nordrhein-Westfalen

The objective of AVATAR – Advanced Virtual Aptitude and Training Application in Real Time – is to complement the already existing mentoring programs, through the development of quantitative support tools. These tools would analyze harvester and forwarder operator's pre- and post-training work through machine control systems and sensor technology, and compile directed feedback to guide the operator towards more balanced working methods and techniques. During the field trial, the proof-of-concept of AVATAR were demonstrated with a system in operational conditions, focusing on the data collection, analysis, and visualization.

Multiple methods were developed in the frame of the project to capture, describe, and visualize environmental data, based on LIDAR, IMU, and GNSS data. A novel simultaneous localization and mapping (SLAM) algorithm utilized the sensor information to produce a unified point cloud and localize the machine even in GNSS denied environments. The point cloud was segmented to identify environmental features, distinguishing the ground, tree stems, and canopy, furthermore, provides the position and size of the surrounding trees. Localization of the harvester aggregate was also achieved from the LIDAR measurement using by deployment of a state-of-the-art image processing and machine learning algorithm.

The solution was integrated into *HarvestSense*, a manufacturer independent prototype sensor platform developed by NIBIO. *HarvestSense* was continuously improved throughout the project to optimize sensor configuration, ensure that the sensor platform was operating in different conditions (rain, snow, warm weather (+30 °C), and cold conditions (-15 °C). The sensor platform was tested for extended periods of operational work on two different harvesters.

The sensor platform was integrated with Optea's Head Up Display (HUD). The information was transmitted to the operator via the HUD and showed a map of the operating range of the crane, location of the harvester aggregate, and the surrounding trees (relative location to the machine and scaled cross-sectional size).

The field trial verified the applicability of the developed algorithms, methods, and sensor platform, furthermore, showed how complex information can be presented to the operator in real time. Most of the relevant information could be collected and processed independently from the machine type. However, real-time access to machine related properties raised significant challenges since access to the CAN-bus was challenging.

The results suggests that the environmental information can be efficiently collected and analyzed via the add-on system. Overlapping the previously, on-site available stand information with real-time sensor information could provide benefits in monitoring the performance and the execution of the whole operation.

The developed system during the field trial in Arnsberg, Germany

Authors: Csongor M. Horváth, Weria Khaksar, Rasmus Astrup

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