FRAUNHOFER INSTITUTE FOR MANUFACTURING ENGINEERING AND AUTOMATION IPA

AUTONOMOUS NAVIGATION FOR "STR" USED IN THE BMW GROUP'S INTRALOGISTICS

Robot and Assistive Systems

Source: BMW Group

The customer

As one of the largest car and motorcycle manufacturers in the world, the BMW Group has production sites on four continents. BMW's declared goal is to use digitization and Industry 4.0 to ensure optimal production logistics capable of supplying the global production network both punctually and reliably. Innovations such as autonomous transport robots are part of this logistics.

Status quo

In cooperation with the Fraunhofer Institute for Material Flow and Logistics IML, BMW had developed the "Smart Transport Robot" (STR) as a flexibly-applicable transport robot for internal company logistics. In the past, the STR navigated on predefined, fixed tracks and used an ultra-wideband system for robot localization. For this, the robots had to be fitted with sensors and the environment equipped with a close-meshed network of anchors. However, BMW wanted a navigation solution that was even more flexible, autonomous and economical.

Solution

The IPA navigation software was able to achieve this. The software uses the safety laser scanner for navigation which is already built into the STR. This made the solution more economical without having to add extra sensors to the robots or surrounding infrastructure. Methods for dynamic path planning and obstacle avoidance assure the necessary degree of autonomy.

Localization

However, implementing the STR navigation software was not without its challenges. This was mainly due to the low quality and quantity of the sensor data paired with the fact that the robot has to navigate in environments which are sometimes highly-dynamic and highly-variable. In contrast to comparable robots, the STR solely detects its environment using a safety laser scanner with a limited field of view (180° view to the front). Furthermore, robot localization based on laser scanners is made all the more difficult because of the highly-variable environment with hardly any fixed structures, as well as the high dynamics due to forklifts, tugger trains and workers in the production halls. The Longterm SLAM (Simultaneous Localization and Mapping) algorithm developed at IPA ensures reliable robot localization despite these difficult conditions. Based on current sensor information, the algorithm continuously updates the robot's map of the environment and compensates for noise and uncertainties.

Path planning

The software also meets BMW's requirements as far as dynamic path planning is concerned. Here, the dimensions and safety fields of the robot must be taken particularly into account, and these vary depending on the load the STR is carrying and on its speed. Thanks to the software from IPA, the STR is still able to navigate through narrow gaps as well as avoid obstacles, such as vehicles which are parked or crossing in front of it. As a result, the STRs can act more autonomously, get stuck in impasses less frequently and reach their destinations faster.

Commissioning

In addition, the STR with the software can be easily and quickly put into operation in new environments, thus assuring the desired flexibility of use. BMW staff can commission the system themselves in just a few hours. An initial map is recorded by the SLAM module simply by navigating the STR through the new environment with manual control. The user then configures the desired driving behavior, such as observing one-way streets or avoiding prohibited areas, by entering the corresponding zones on the map. The STR is now ready to accept transport requests in the new environment.

Using the Robot Operating System (ROS) in the software, application-specific adaptations or further developments, as well as interfaces to other components such as machine vision or fleet management, can be achieved without great effort.

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