Doctoral School of Information and Biomedical Technologies

Polish Academy of Sciences (TIB PAN)

SUBJECT: Increase the precision, accuracy, and reliability of the SLAM algorithm by using the fusion of multiple information sources and deep learning

SUPERVISOR:

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DESCRIPTION:

The aim is to increase the precision, accuracy and reliability of the Simultaneous Localization and Mapping (SLAM) algorithm using the fusion of multiple information sources and deep learning. The fusion of different sources (LiDAR, Camera, IMU, Radar ...) will enable the integration of multiple information sources into one reliable optimization system. For this purpose, the parameters of individual sensors should be determined and experimentally tested to determine the uncertainty of individual measurements. An important stage of the research work will be the development of the SLAM system with new observational equations in mind. An important stage of the research work will be to propose the improvement of individual SLAM workstations with the use of AI, including:

- Find landmarks in an image.
- Loop closure using AI to recognize the place visited.
- Improved the "kidnapped robot" task.
- Remove noise and other dynamic objects from images or 3D scans.
- Recognition of moving objects that change shape (e.g. tree branches bend under the weight of leaves in the spring season, doors in buildings, cars on the streets, pedestrians).

The result of the work will be a new SLAM algorithm characterized by increased precision, accuracy and reliability compared to the set of known algorithms that are the subject of research in the first year of studies.

BIBLIOGRAPHY:

Janusz Będkowski, Large-Scale Simultaneous Localization and Mapping, Springer 2022

Janusz Będkowski, Open source, open hardware hand-held mobile mapping system for large scale surveys, SoftwareX 25, 101618

Gökçe Sena Hocaoğlu, Emrah Benli, "Multiple Objects Localization With Camera-LIDAR Sensor Fusion", *IEEE Sensors Journal*, vol.25, no.7, pp.11892-11905, 2025.

Hiroki Hisatsugu, Hisahiro Koshizuka, Moritoyo Hori, Kenjiro Yamamoto, "Visual-Lidar Odometry with Orientation Correction towards Millimeter-Level Localization for Indoor

Construction Robots", *2025 IEEE/SICE International Symposium on System Integration (SII)*, pp.1484-1490, 2025.

Yisu Fang, Hadyan Hafizh, Muhammad Ateeq, "An Autonomous Irrigation Robot Based on ROS2, YOLOv8 and Distributed ESP32 WMN Architecture", *2024 IEEE International Conference on Smart Internet of Things (SmartIoT)*, pp.384-391, 2024.

Yakup Kayataş, Sanem Kabadayı, "An AI-Assisted Autonomous IoRT Agent for Smart Spaces", *2024 9th International Conference on Computer Science and Engineering (UBMK)*, pp.613-618, 2024.

Jun Luo, Gang Wang, Hongliang Liu, Lang Wu, Tao Huang, Dengyu Xiao, Huayan Pu, Jun Luo, "BE-SLAM: BEV-Enhanced Dynamic Semantic SLAM with Static Object Reconstruction", *2024 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pp.10105-10112, 2024.

Egidio Raimundo Neto, Matheus Ferreira Silva, Arismar Cerqueira Sodré, "Pedestrian Sensing and Positioning System Using 2D-LiDAR Based on Artificial Neural Networks Toward 6G", *IEEE Access*, vol.12, pp.152289-152309, 2024.

Wei He, Bin Shen, ZhiQi Zhang, LongJie Liu, "Magnetometer IMU-based Trolley Mapping and Navigation Optimization on Complex Road Surfaces", *2024 3rd International Conference on Artificial Intelligence and Computer Information Technology (AICIT)*, pp.1-4, 2024.

Yukang Su, Shuo Zhang, Chengning Zhang, Yuyang Wu, "A 3D Lidar Odometry and Mapping Method Based on Clustering-Directed Feature Point", *IEEE Transactions on Vehicular Technology*, vol.73, no.12, pp.18391-18401, 2024.

Hu Xu, Xiaomin Zhang, Ju He, Yang Yu, Yuwei Cheng, "Real-Time Volumetric Perception for Unmanned Surface Vehicles Through Fusion of Radar and Camera", *IEEE Transactions on Instrumentation and Measurement*, vol.73, pp.1-12, 2024.

Xuyin Wang, Fangzheng Gao, Jiacai Huang, Yuan Xue, "UWB/LiDAR Tightly Coupled Positioning Algorithm Based on ISSA Optimized Particle Filter", *IEEE Sensors Journal*, vol.24, no.7, pp.11217-11228, 2024.

Hiroki Hisatsugu, Jiro Hashizume, "Active Search and Relocalization Framework for Position-Lost Recovery Under Limited Number of AMRs", *2024 IEEE/SICE International Symposium on System Integration (SII)*, pp.104-111, 2024.

Claire Nicodeme, "Building Reliable Datasets for Autonomous Vehicles: Data Factory for the Industry and Intelligent Trains", *2023 23rd International Conference on Control, Automation and Systems (ICCAS)*, pp.1479-1483, 2023.