EÖTVÖS LORÁND UNIVERSITY

FACULTY OF INFORMATICS

MASTER THESIS TOPIC DECLARATION FORM

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Training: Full-time

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Information about the internship

Name of the company: Saxion University of Applied Science

Starting date of internship: Jan 15, 2025

Closing date of internship: June 2, 2025

Weekly schedule: full-time

The purpose of the admission declaration is to certify that the student of the MSc in Intelligent Field Robotics System at ELTE Faculty of Informatics may complete the mandatory internship in the selected institution within the framework detailed hereby and in accordance with the learning outcomes required by the program.

LiDAR-Based Mapping Module for Autonomous Navigation

Motivation

Simultaneous Localization and Mapping (SLAM) is a core technology for autonomous robots which enables to generate maps for autonomous navigation and localization. Modern robotic applications demand SLAM solutions to be real-time, robust, and adaptable. The emergence of frameworks such as FAST-LIO (fast, versatile, and robust Lidar Inertial Odometry) and LiDAR SLAM offer a chance to enhance accuracy and efficiency in mapping while reducing computational complexity.

Objective

In this thesis work, we aim to develop a lidar-based SLAM module that efficiently generates maps and enable autonomous navigation. Our added values include adapting FAST-LIO for mapping and reduce relative position errors in revisited areas to produce undistorted representation of environments, evaluating and benchmarking against other SLAM solutions and highlight its advantages and limitations.

Research Questions

1. How can LiDAR-based SLAM generate accurate environmental maps using wheel odometry, IMU, and LiDAR point clouds?
2. What are the comparative advantages of FAST-LIO's raw-point registration approach versus traditional feature extraction methods for map quality?
3. How does loop closure detection optimize the generated map's accuracy?

Method

To generate accurate maps for autonomous navigation, we will use the following technologies, tools and methods.

- **Literature Review**: Conducting a comprehensive literature review to identify existing SLAM solutions and their limitations.
- **Technology:** Implementing SLAM solution using FAST-LIO framework to integrate LiDAR point clouds, wheel odometry and IMU.
- **Mapping**: Raw-point registration of LiDAR points will be used for incremental update.
- **Optimization:** Implementing loop closure detection to reduce position errors in revisited areas and then optimize the improvement along all detected loop closures to generate maps in Global Coordinate System.

Tools

- **ROS 2:** A set of software and libraries for developing robotic applications.
- **C++ programming language:** We will use C++ as the main programming language in the implementation.
- **Gazebo:** Simulation tool for creating virtual environments for testing SLAM solutions.
- **Rviz:** Visualization software for analysing robot perception and map quality.

Keywords: SLAM, Mapping, LiDAR-Inertial Odometry, FAST-LIO, Robust

Encryption of the topic is necessary: **YES**

I ask for the acceptance of my thesis topic.

Budapest, 20./12/2024

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Student

I approve of the suggested topic of the Master's Thesis:

Budapest, 10/.1./2025 .....

ELTE supervisor

I approve of the suggested topic of the internship, and in the name of the institution (organization, company) above I agree, that the named student will carry out his/her internship along the conditions detailed above:

Netherlands, 16/12/2024 .....

Industrial supervisor

The topic of the thesis and internship is approved by the Dean of Faculty of ELTE Informatics

Budapest, …./…./202

Digitally signed by Dr. Kozsik Tamás
Date: 2025.01.15 00:02:50 +01'00'

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Dr. Tamás Kozsik

Dean of Faculty of Informatics