1 Introduction

This report outlines the key activities carried out by **TEAM COSS** during the preparation for **the Bosch Future Mobility Challenge**, including team collaboration efforts, changes encountered during the project, and the progress made.

Particular Activities

AI Based Lane Detection: The detection accuracy using **LaneNet** is superior to OpenCV-based methods, leading to a **model transition** for better performance.
Develop Driving Algorithm in a Simulator: We designed the decision making and control method using Pure Pursuit class and SMACH along with localization.
Traffic sign Recognition: We focused on traffic sign recognition using various data augmentation techniques along with existing pedestrian detection.

Team Spirit

Team members conducted development by setting up an appropriate development environment that suited their roles and situations.

Changes

- Using Jetson Orin Nano and RealSense 455, we can see improved process speed and accuracy compared to the environment consisting of RPi5 and Picamera.

These activities and the spirit of collaboration played a crucial role in achieving the initial project goals. The team responded to challenges with flexibility and a proactive approach, ensuring steady progress.

2 Planned activities

1) Developing Lane Keeping Algorithm
Supplemented to minimize noise and ensure stable driving in the center of the lane
2) Developing driving algorithm based on global planning
Drive a route planned based on a GraphML file
3) Traffic sign Recognition
Recognize the given traffic signal using YOLO

3 Status of planned activities

1) Developing Lane Keeping Algorithm
Details Task:

- **AI based Lane Detection:** Our team optimized the LaneNet algorithm's memory usage from 2.4 GB to 300 MB for real-time use in embedded environments. We were able to make the existing method lighter by replacing it with Depthwise Separable Convolutions and SEBlock.
- **Developing Sliding Window Technique:** Based on the lane detection results, an ROI was formed, and the appropriate lane was estimated using the pixels detected by lane tracking through a window.

Outcome: More precise Lane Keeping is possible than the existing OpenCV method due to optimized AI-based technology and algorithm improvements.

2) Developing Driving Algorithm in a Simulator
Details Task:

- **High-Precision Odometry Development:** We implemented VIO for motion estimation, but faced drift and high memory usage. On the other hand, sensor fusion of wheel encoder and IMU data allowed us to estimate more accurate real-time motion.
- **Control on the global path:** Pure Pursuit class is used to pass through the main nodes of the provided GraphML. The ideal decision result is passed through the Control server to execute the action, thereby completing the control process.

Outcome: Localization allows us to estimate more accurate locations and expects to drive the optimal path from a clear decision making.

3) YOLO-Based Traffic sign Recognigion

Details Task:

- **Optimization and Deployment of Traffic Sign Detection:** We generated 1,140 training images and 270 validation images using various data augmentation techniques such as random rotation. We used YOLOv5m.pt for training and chose the optimal model resolution of 640x640.

Outcome: The HW change improved the inference speed by about 10x and showed improved real-time detection performance by maintaining a confidence score above 0.5 in various environments.

4 General status of the project

We are checking various functions through development in real environments and simulations. Currently, our team is capable of autonomous driving in simple sections through the developed algorithm.

AI based Lane Keeping: The LaneNet-based optimization algorithm was verified on an embedded system, and lane tracking is possible through sliding window technology.
Localization using sensor fusion data: We demonstrate that a reasonable odometry can be estimated by using fusion data from an ideal wheel encoder and IMU in a simulator environment.
Object Detection: Custom dataset creation and data augmentation successfully completed. Optimization and training of YOLO-based object detection completed.

5 Upcoming activities

The next report period aims to complete stable driving through the prepared functions. We plan to transfer the test in the simulation to the real environment to ensure stable completion of the track.

1) Development of a robust localization algorithm

Objective: Based on the provided map, we plan to develop an occupancy grid-based location estimation method without GPS data.
Detailed Tasks: In addition to optimizing sensor fusion data, we will test BEV-based pixel matching methods for correspondence between local and global maps.

2) Decision Making

Objective: We will develop decision and control logic to drive the planned route stably.
Detailed Tasks: The FSM-based SMACH algorithm is applied to enable the vehicle to judge a given situation.

3) Advancement and optimization of existing algorithms

Objective: Strengthening the algorithm through lane and object recognition under various conditions such as lighting
Details: Improve performance through lightweighting and reduce variables related to external light through additional training.