LH-CDC

TECHNICAL REPORT #2

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Date January 20, 2025

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ASPIRE TO LEAD

1 Introduce

This report summarizes the technical progress of the LH - CDC team in the Bosch Future Mobility Challenge 2025 as of January 20, 2025. In particular, the activities planned from December 18 to January 20 and the current situation as well as upcoming activities are briefly described.

2 Planned Activities

The activities planned during the above mentioned period, in addition to the team members in charge of each activity are shown below:

- Perception
  - Lane detection and algorithm optimization
    @Cuong & Phong
  - Detect obstacles
    @ Huy
- Control
  - AI LLM Algorithm Makes Decisions to Assist in Driving and Maneuvering [Early Deployment]
    @Phong & Cuong
- Working tools
  - Track design and test design of track models for model racing
    @ Huy

3 Planned operations status

3.1 Lane detection and algorithm optimization [Finished]

3.1.1 Target

- Developing algorithms to detect two lanes faster and more accurately
- Improved algorithm to recognize curved and dashed lanes while ensuring stable FPS performance.

3.1.2 Perform

State-of-the-art methods largely treat lane detection as a pixel segmentation problem, struggling to deal with challenging scenarios and speeds. Inspired by human perception, lane

recognition in severe congestion and harsh lighting conditions relies heavily on contextual and global information.

We treat lane detection as a row-based selection problem, leveraging global features. This approach allows us to significantly reduce the computational cost. The use of a wide receptive field of global features allows us to handle complex situations efficiently. In addition, we developed a structural loss function to explicitly model the structure of the lane, optimizing the detection process. Extensive experiments on benchmark lane detection datasets demonstrate that our method delivers excellent performance in both speed and accuracy, reaching the state-of-the-art in this field.

3.1.3 Problem

During lane recognition, the system generally performs well in detecting lanes and processing control commands. However, when the input data or video conditions change, such as lighting, frame rate, or camera angle, the recognition module often experiences drift problems, resulting in inaccurate lane detection. Despite repeated adjustments and optimizations, the system performance only improves slightly for certain road conditions.

The biggest challenge right now is that the track is not yet fully built and the car kits are still waiting to be delivered, making it difficult to optimize the algorithm and fine-tune the model for maximum performance.

To address these issues, we will prioritize improving the track infrastructure and upgrading the detection algorithm. At the same time, we will focus on enhancing the system's ability to handle adverse conditions, ensuring outstanding stability and reliability, meeting real-world challenges.

3.2 Detect obstacles [Done]

3.2.1 Target

We have developed a system based on image processing cameras to create thresholds and safety zones in front of the vehicle. This system performs object recognition and sets limits for each specific case.

When an object crosses the set safety limit, the system triggers appropriate actions depending on the type of object detected. These actions may include warning the driver, slowing down, or stopping the vehicle, ensuring the safety of the driver and surrounding vehicles.

3.2.2 Perform

1. Initial Deployment
   - To overcome the misrecognition and reduce noise, we expanded the training dataset and applied data augmentation techniques to improve the model's learning ability.
   - The image processing process is designed to include three main stages: pre-processing, noise filtering, and feature extraction. The data after going through these steps will be fed into the recognition model to create the final result, helping to increase the accuracy and stability of the system.

3.2.3 Problems encountered

1. Recognition performance is not stable:
   - In low light conditions, narrow viewing angles or low quality video data, the recognition model tends to lose accuracy.
2. Noise from external environment:
   - Noise from bright lights, shadows, or sudden changes in frame rates affect the quality of the input, making it difficult for the model to distinguish objects.
3. Generalizability of the model:

- Despite data augmentation, the model still struggles to handle unusual cases or data that was never encountered during training, such as rare objects or unusual road conditions.

3.3 Active in [Development]

1. Lane Detection and Algorithm Optimization: Develop algorithms to detect two lanes faster and more accurately.
2. Obstacle detection: the camera processes images to create thresholds and safety zones in front of the vehicle
3. LLM AI Algorithm Makes Decisions to Assist in Driving and Maneuvering [Early Deployment: Collecting Safe Driving Data and Driver Handling Situations in Simulator
4. Track design and test track design for model racing cars: Create tracks with diverse features and test durability under various conditions.

4 General status of the project

In summary, we have successfully completed the lane detection and traffic sign recognition modules, and accelerated the speed of lane recognition, laying the foundation for integrating these features into the vehicle's decision-making process. All functions have been tested using data from the competition and the vehicle kit retained from BFMC-2024.

In addition, the ROS environment has been set up on the team members' PCs to support development and testing. Currently, we are working on developing a powerful End-To-End algorithm designed to enhance the vehicle's autonomous navigation and inference capabilities and safety.

5 Upcoming Activities

Upcoming activities from January 21, 2025 to February 17, 2025 are as follows:

- Cognitive integration
  - Detect intersections and determine next destination [Simulation and completion]
  - Obstacle Detection and Tracking [Simulation and Perfection]
- Control
  - Deploying intersection navigation upgrades
  - Implement automatic handling of dangerous and unrecognized situations on the lane.
  - Implement full data collection for AI training