Engineering Risk Analysis Group
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MSc thesis/ Study project

Analysis and Prevention of Failure in Perception for Autonomous Racing Vehicles

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Background

A modern Autonomous Driving System (ADS) usually contains perception, prediction, planning, and control. Perception is the first step of an ADS. It receives input from sensors and passes information regarding the surrounding environment to the following modules. The accuracy of the perception output, to a large extent, determines the performance of the following modules. Thus, it is essential to ensure the adequate performance of the perception module. The study focuses on providing a comprehensive reliability analysis of a current state-of-the-art perception module for a racing vehicle and providing performance or robustness improvement methods.

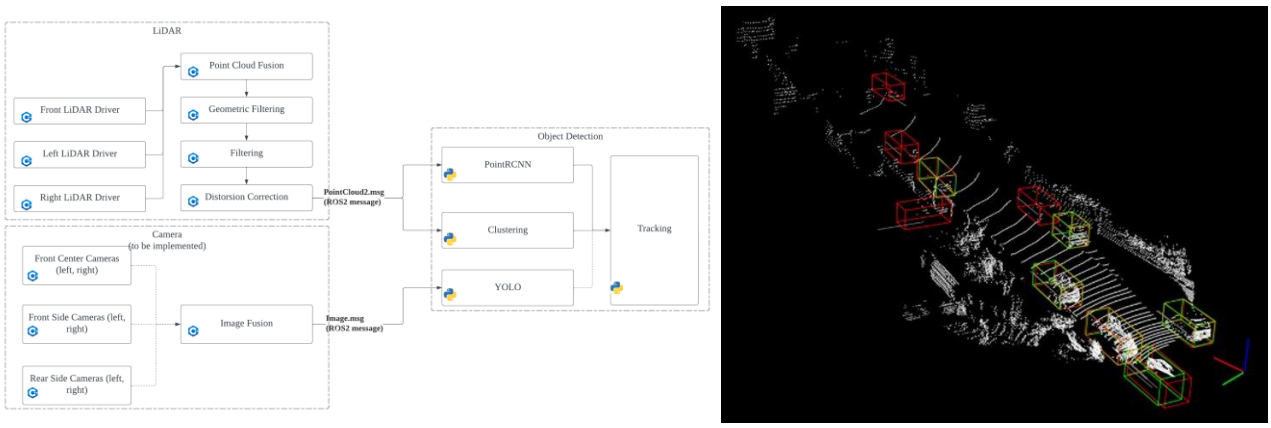

Fig: Structure of a Perception module in an Autonomous Driving System (left) and examples of Type I (false negative) and Type II errors (right).

Methodology

The thesis starts with an introduction to the hardware and the software and existing studies into the causes of error in detection failure. The reliability analysis of a current perception module is then carried out based on 5000 labelled point clouds. The study analyses the accuracy, relative accuracy and Mean Absolute Error (MAE). Causes of detection failure and inaccuracies are examined and methods are developed to improve the overall accuracy of the perception module. Finally, reliability analysis of the improved perception module is carried out using the same data.

Conclusion

For both perception modules: clustering and PointRCNN, considerable improvement can be seen. The accuracy of both modules has increased, the number of Type I and Type II errors has dropped, and relative accuracy, and MAE, have generally improved. The PointRCNN module demonstrates a more significant improvement in the far region, whereas the clustering module demonstrates a larger improvement in the near field. The methods of improvement have proven to be effective.

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