University of Peradeniya

Enhancing End-to-end Autonomous Driving with Trajectory-Guided Control Prediction

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Abstract- Trajectory Guided Control Prediction (TCP) framework, is a state-of-the-art end-to-end learning model for autonomous driving. This research introduces innovative enhancements by proposing two key methodologies to address specific limitations in TCP's performance.

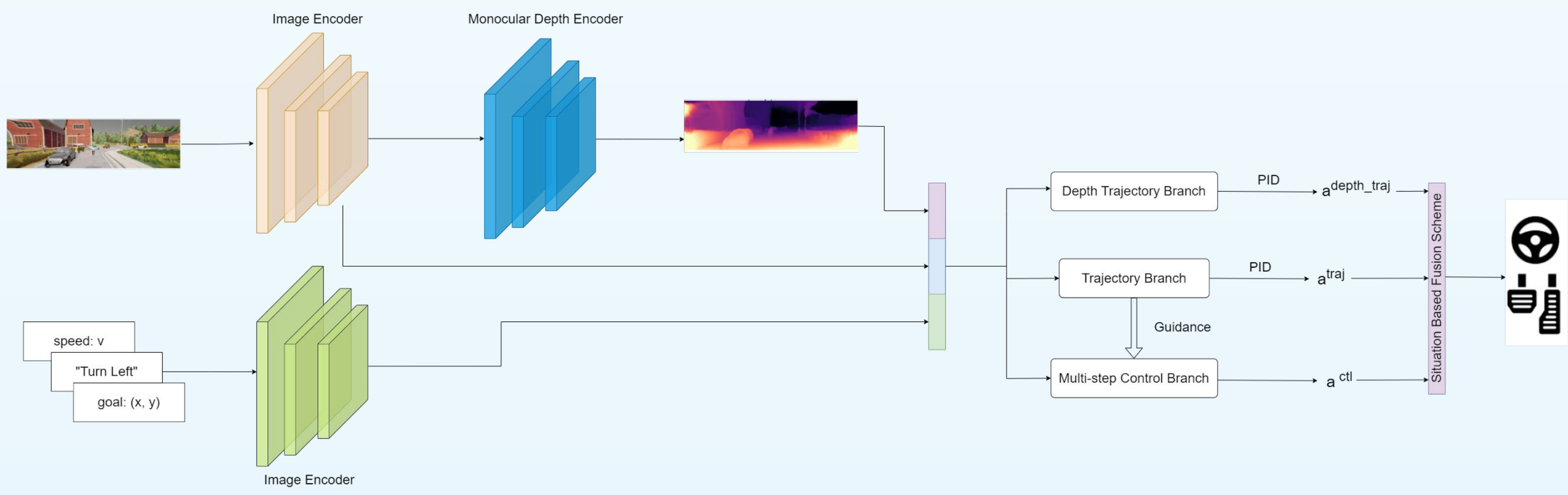


Figure 01: Improved TCP framework with the monocular depth branch

Aim : To improve the performance of the Trajectory Guided Control Prediction framework by incorporating guidance from depth-based disparity features and improving the control component by replacing the PID controllers in the original framework with MPC controllers.

From a single camera input to controlling a vehicle

- Model takes a monocular camera image, velocity, high-level control command, and the destination as inputs.
- A depth map is predicted using Monodepth2.
- Predicts the trajectory and controls simultaneously.
- Depending on the situation the control command predictions or trajectory predictions are chosen.
- Trajectory Predictions are converted to control commands using model predictive control.

How to evaluate

- Route completion: Percentage of the route distance completed by an agent.
- Infraction Penalty - Agents start with an ideal 1.0 base score, which is reduced by each type of infraction committed.
- Driving Score - Route completion x Infraction Penalty

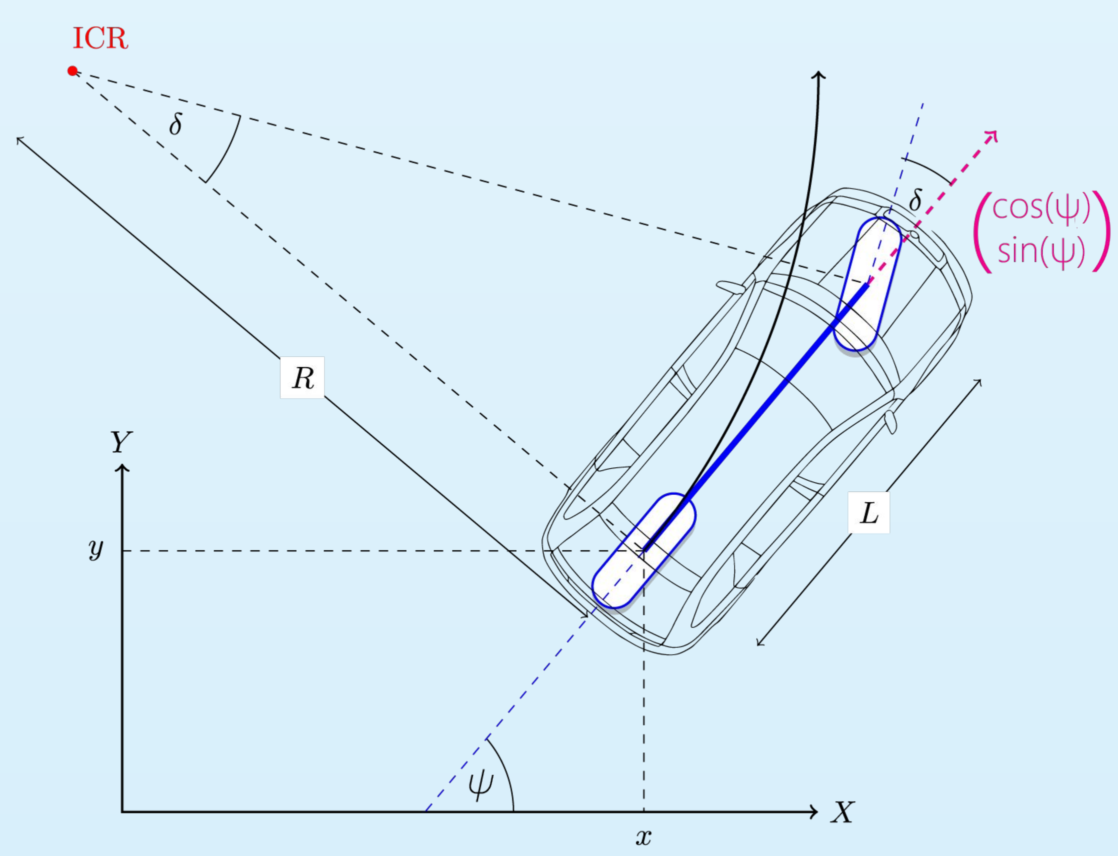
	Route Completion (%)	Infraction Penalty	Score Composed (%)
Depth Attention	89.610365	0.7963287951	70.25550424
TCP	66.50126694	0.7826396398	50.2746211

Table 01: Results compared to the TCP model

Model Predictive Controler

States

- Position x (x)
- Position y (y)
- Heading (ψ)
- Velocity (v)
- Cross-track error (cte)
- Heading error ($e\psi$)



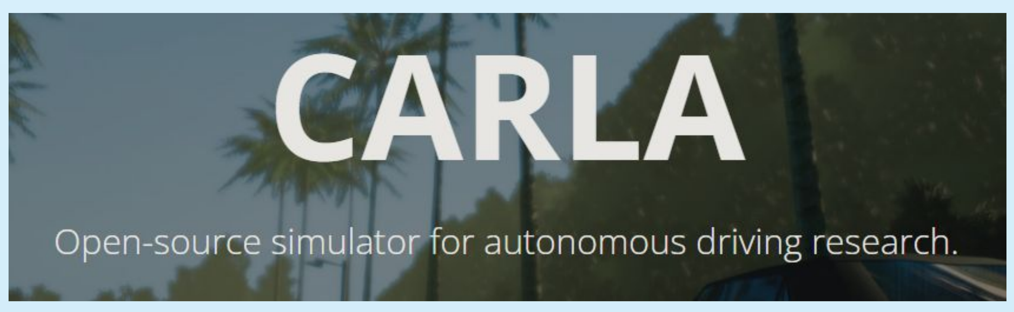


Figure 02: Tested using CARLA simulator

Future Improvements

- Use a complex model for the MPC. (kinematic bicycle model was used)
- Make the MPC parameters trainable.

Economic Advantages

- Expensive equipment like LiDAR, or thermal cameras are not needed.
- Could be implemented with a minimum cost.

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