1 prediction performance analysis and application to motion planning

1.1 accuracy analysis

The proposed algorithm was compared with the results from three base algorithms, a path-following model with constant velocity, a path-following model with traffic flow and a CTRV model.

We compare those algorithms according to four sorts of errors, The x position error e_{x,T_p}, y position error e_{y,T_p}, heading error e_{θ,T_p}, and velocity error e_{v,T_p} where T_p denotes time p. These four errors are defined as follows:

$$
\begin{aligned}
e_{x,Tp} =& p_{x,Tp} - \hat{p}_{x,Tp} \\
e_{y,Tp} =& p_{y,Tp} - \hat{p}_{y,Tp} \\
e_{\theta,Tp} =& \theta_{Tp} - \hat{\theta}_{Tp} \\
e_{v,Tp} =& v_{Tp} - \hat{v}_{Tp}
\end{aligned}
$$

The proposed model shows a significantly less prediction errors compare to the based algorithms in terms of mean, standard deviation(STD), and root mean square error(RMSE). Meanwhile, the proposed model exhibits a bell shaped cure with a close to zero mean, which indicates that the proposed algorithm's prediction of human divers' intensions are relatively precise. On the other hand, e_{x,T_p}, e_{y,T_p}, e_{v,T_p} are bounded within reasonable levels. For instant, the three-sigma range of e_{y,T_p} is within the width of a lane. Therefore, the proposed algorithm can be precise and maintain safety simultaneously.

1.2 motion planning application

1.2.1 case study of a multi-lane left turn scenario

The proposed method mimic a human drivers better by simulating a human driver's decision-making process. In a multi-lane left turn scenario, the proposed algorithm correctly predicted the trajectory of a target vehicle even the target vehicle was not following the intersection guide line.

1.2.2 statistical analysis of motion planning application results

The data is analysed from two perspectives, the time ot recognize the in-lane target and the similarity to human driver commands. In most of cases, the proposed algorithm detects the in-line target no late than based algorithm. In addition, the proposed algorithm only recognized cases later than the base algorithm did when the surrounding target vehicles first appeared beyond the sensors' region of interest boundaries. This means that these cases took place sufficiently beyond the safety distance, and had little influence on determining the behavior of the subject vehicle.

In order to compare the similarities between the results form the proposed algorithm and human driving decisions, we introduced another type of error, acceleration error $a_{x,error} = a_{x,human} - a_{x,cmd}$. where $a_{x,human}$ and $a_{x,cmd}$ are the human driver's acceleration history and the command from the proposed algorithm, respectively. The proposed algorithm showed more similar results to human drivers' decisions than did the base algorithms. 91.97% of the acceleration error lies in the region $\pm 1 m/s^2$. Moreover, base algorithm possesses limited ability to respond to different in-lane target behaviors in traffic flow. Hence, the proposed model is efficient and safety.