STEERING ANGLE DECISION AND CONTROL FOR LKAS USING NEURAL NETWORKS

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EXTENDED ABSTRACT

Lane keeping Assistance Systems (LKAS) have been developed mostly by using model based prediction control or multi-rate Kalman filters for lane keeping functions of the advanced driver assistance systems (ADAS).[1-3] These kinds of approaches have limitations in that precise dynamic models are required and they are highly nonlinear and complicated and thus the control design based on the mathematical model is difficult. Also, control parameter tunings should be performed according to the change in driving environment as well as vehicle model changes.

In order to solve the problem, fuzzy logic or neural networks have been employed to LKAS since these methods are not model-based approaches. However, these does not consider time information but only the current states from the vision sensor. The control systems like the car driving should make use of the time series information since it is a highly dynamic. Thus, in this paper long short-term memory (LSTM) recurrent neural networks (RNN) are employed for computing of the steering angle for the lane keeping of a passenger vehicle.[4,5]

The LSTM neural networks (LSTM-RNNs) are applied to estimate an appropriate steering angle as shown in figure 1. In general, the update rate of the vision sensor is slower than those of the other sensors like the motion sensors. This non-uniformity causes time delay which is difficult to handle in controller design phase. The LSTM RNN prediction model is one of the artificial intelligence techniques that incorporate the time series without having to use the complicated vehicle model.[6,7] The prediction model of LSTM-RNN is connected in series to the fully-connected (FC) multilayer perceptron (MLP) models.

The input values of LSTM-RNN are the road coefficients of clothoid road model obtained by processing the data from the vision camera and the Inertial Measurement Units (IMUs) sensor data respectively based on the time series. The output of the network is the vehicle steering angle and its target values are obtained during the real road driving by human drivers. The implicit relation between road coefficients of the road model and the IMU sensor data and the steering angle is trained over time. We implemented the LSTM-RNN prediction model with TensorFlow and confirmed by using the model designed with Tensorboard. The vision sensor data and IMU sensor data the obtained from the vehicle were divided into learning data and test data. After learning the LSRM-RNN prediction model designed with learning data, we confirmed the steering angle prediction performance by inputting test data to the learned model.

The acquired steering angle is provided as a reference output to the steering control system. Then, the actual driving through the neural network output is tested on simulation tool like a SimCar.

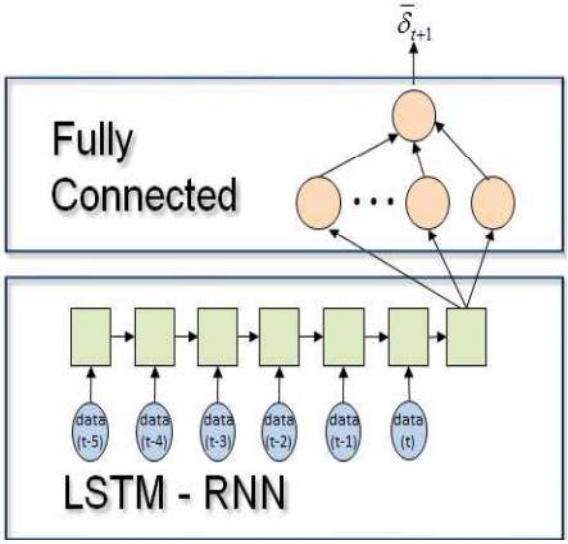


Figure 1 LSTM RNN model for prediction of steering angle

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