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A Study on LSTM Traffic Flow Model using Naturalistic Traffic Flow Data

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Currently, many studies have been conducted on models that can reproduce traffic flow. In order to reproduce the traffic flow, a suitable vehicle following model is required. Mathematical models that calculate acceleration based on data relative to the preceding vehicle, such as IDM and the Gazi-HermanRothery model, are widely used in traffic simulation platforms such as VISSM, AIMSUN, and PARAMICS because of their low computational complexity and excellent reproducibility of driving conditions. However, the mathematical model is not suitable for the complex real-world environment. Data-driven models are superior in reproducing complex driving conditions of real environments in detail . Therefore we constructed a vehicle following model using Long Short-Term Memory (LSTM), which is superior to data-driven models in handling long-term time-series data. We use the US-101 dataset provided by Next Generation Simulation (NGSIM) for our experiments in order to construct the model using the naturalistic traffic flow data. The NGSIM data was very noisy because of the processing of the video acquired from the camera. The Savitzky-Golay method was applied to remove noise. After filtering, the noise was reduced as shown in Figure 1. We divided 90% of the data into training data and 10% into test data. Compared to other machine learning models, LSTM is a model that can learn long-term time series data. Therefore, LSTM was used in many vehicle trajectory prediction and traffic flow models, and this study used LSTM for constracting the traffic flow mode using the naturalistic data. The experimental method was to show that LSTM was superior in reproducing the real environment by comparing the prediction with the IDM model which was currently widely used in traffic flow simulation platforms. Figure 2 showed the relationship between the acceleration error and the Percentage of acceleration error in all data.The x-axis showed the acceleration error, which was the difference between the actual measured acceleration and the acceleration output by the LSTM or IDM. The y-axis shows the percentage of error in the acceleration shown on the x-axis for all data. A small error and a high error ratio indicate a highly accurate model. The acceleration error in the LSTM was evaluated up to 4.5m/s^2 because the acceleration error measured until 4.5m/s^2 in LSTM model. In the IDM model, approximately 95% of all acceleration error data showed the acceleration error of 4.5m/s^2 or less, and the remaining approximately 5% showed the acceleration error was grater than 4.5m/s^2. For the LSTM, the acceleration error was 0.18m/s^2 for 95% of all acceleration errors. These results indicated that the LSTM model was more accurate than the IDM model for constracting the naturalistic traffic flow model. Since errors were also observed in the prediction results of the LSTM model, we analyzed the prediction results and the training data to confirm when the errors occurred. As a result, it was found that the NGSIM data set used by this study did not contain enough data with large absolute values of acceleration. In the future, it is necessary to construct models in various environments.

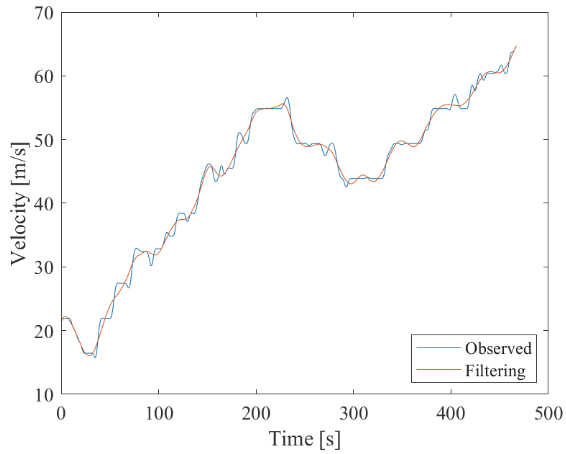

Fig.1 Filtering Data

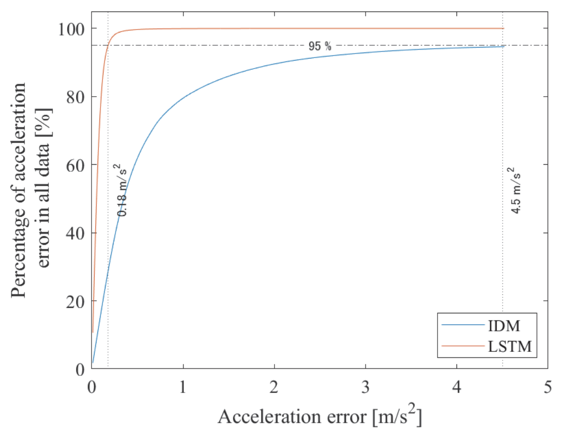

Fig.2 Percentage of Error Acceleration

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