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Title

FRA-GRU: A Deep Learning model for vessel trajectory prediction based on satellite AIS data

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Abstract

The existence of Starlink satellites makes the monitoring of ships at sea ubiquitous. A vital issue is applying satellite Automatic Identification System (AIS) data to monitor vessels effectively. The AIS data is properly employed by marine vessels' trajectory prediction, which improves the quality of service for maritime transport. Recently researchers have applied neural networks driven by AIS data to predict vessel trajectories in some specific scenarios. However, the prediction accuracy is limited by the anomaly of the AIS data set. Meanwhile, the nautical physical differences expressed by the differences in the results in different sea areas need further research and analysis. Thus, this paper proposes a lightweight forward reverse attention-gated recurrent unit model (termed FRA-GRU), which is suitable for dealing with the spatiotemporal characteristics of AIS data. This model consists of three main components: 1) a forward sub-network based on the GRU network to extract the input forward trajectory data, 2) a reverse sub-network applied on the bidirectional GRU network to extract the reverse trajectory data, 3) a fusion layer based on an attention mechanism integrating the weights of the forward and reverse network training results to output the final prediction results. Based on the actual satellite AIS dataset collected by China Maritime Safety Administration, the prediction accuracy of our designed network model is verified through experiments and compared with previous studies. The average prediction accuracy error is less than 0.1% through our method and proved more accurate than other competitors. Furthermore, different AIS data sets show differences in the model prediction performance between sea areas. The reasons for the differences are analyzed based on the shipping characteristics of the corresponding sea areas.

References