











prediction algorithm needs to be further improved in view of the diversity of traffic flow data and the change of practical application scenarios, it will be our research focus in the future.

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## REFERENCES

- [1] Lv, Y.S., Duan, Y.J., Kang, W.W., Li, Z.X., Wang, F.Y. (2015). Traffic flow prediction with big data: A deep learning approach. *IEEE Transactions on Intelligent Transportation Systems*, 16(2): 865-873. <https://doi.org/10.1109/TITS.2014.2345663>
- [2] Wei, G.Y., Ling, Y., Guo, B.F., Xiao, B., Vasilakos, A.V. (2011). Prediction-based data aggregation in wireless sensor networks: Combining grey model and Kalman Filter. *Computer Communications*, 34(6): 793-802. <https://doi.org/10.1016/j.comcom.2010.10.003>
- [3] Golestan, S., Guerrero, J.M., Vasquez, J.C. (2018). Steady-state linear Kalman filter-based pll for power applications: A second look. *IEEE Transactions on Industrial Electronics*, 65(12), 8331945: 9795-9800. <https://doi.org/10.1109/TIE.2018.2823668>
- [4] Ahmed, S.A., Cook, A.R. (1982). Discrete dynamic models for freeway incident detection systems. *Transportation Planning & Technology*, 7(4): 231-242. <https://doi.org/10.1080/03081068208717226>
- [5] Ghosh, B., Basu, B., O'Mahony, M. (2009). Multivariate short-term traffic flow forecasting using time-series analysis. *IEEE Transactions on Intelligent Transportation Systems*, 10(2): 246-254. <https://doi.org/10.1109/TITS.2009.2021448>
- [6] Yang, Z.S., Bing, Q., Zhou, Q.C., Lin, C.Y., Yang, N., Mei, D. (2014). Research on short-term traffic flow prediction method based on similarity search of time series. *Journal of Transport Information & Safety*, 2014(7): 1-8. <http://dx.doi.org/10.1155/2014/184632>
- [7] Muruganantham, A., Zhao, Y., Gee, S.B., Qiu, X., Tan, K.C. (2013). Dynamic multiobjective optimization using evolutionary algorithm with Kalman filter. *Procedia Computer Science*, 24(1): 66-75. <https://doi.org/10.1016/j.procs.2013.10.028>
- [8] Huang, M.L. (2015). Intersection traffic flow forecasting based on v-GSVR with a new hybrid evolutionary algorithm. *Neurocomputing*, 147(1): 343-349. <https://doi.org/10.1016/j.neucom.2014.06.054>
- [9] Csikós, A., Varga, I., Hangos, K.M. (2018). A hybrid model predictive control for traffic flow stabilization and pollution reduction of freeways. *Transportation Research Part D: Transport and Environment*, 59: 174-191. <https://doi.org/10.1016/j.trd.2018.01.006>
- [10] Iwamura, Y., Tanimoto, J. (2018). Complex traffic flow that allows as well as hampers lane-changing intrinsically contains social-dilemma structures. *Journal of Statistical Mechanics: Theory and Experiment*, 2018(2): 023408. <https://doi.org/10.1088/1742-5468/aaa8ff>
- [11] Kumar, S.V., Vanajakshi, L. (2015). Short-term traffic flow prediction using seasonal ARIMA model with limited input data. *European Transport Research Review*, 7(3): 21-28. <https://doi.org/10.1007/s12544-015-0170-8>
- [12] Jin, S., Wang, D.H., Xu, C., Ma, D.F. (2013). Short-term traffic safety forecasting using Gaussian mixture model and Kalman filter. *Journal of Zhejiang University - Science A: Applied Physics & Engineering*, 14(4): 231-243. <https://doi.org/10.1631/jzus.A1200218>
- [13] Hanifelou, Z., Adibi, P., Monadjemi, S.A., Karshenas, H. (2018). KNN-based multi-label twin support vector machine with priority of labels. *Neurocomputing*, 322: 177-186. <https://doi.org/10.1016/j.neucom.2018.09.044>
- [14] Huan, J. (2015). Research on automobile engine failure recognition technology based on improved PSO-RVM algorithm. *Applied Mechanics and Materials*, 727-728: 757-760. <https://doi.org/10.4028/www.scientific.net/AMM.727-728.757>
- [15] Yao, Z.H., Jiang, Y.S., Han, P., Luo, X.L., Xu, T. (2017). Traffic flow prediction model based on neural network in small time granularity. *Journal of Transportation Systems Engineering & Information Technology*, 17(1): 67-73. <https://doi.org/10.16097/j.cnki.1009-6744.2017.01.011>
- [16] Guo, Y., Lu, L. (2018). Application of a traffic flow prediction model based on neural network in intelligent vehicle management. *International Journal of Pattern Recognition & Artificial Intelligence*, S0218001419590092. <https://doi.org/10.1142/S0218001419590092>
- [17] Othman, S.M., Ba-Alwi, F.M., Alsohybe, N.T., Al-Hashida, A.Y. (2018). Intrusion detection model using machine learning algorithm on Big Data environment. *Journal of Big Data*, 5(1): 34. <https://doi.org/10.1186/s40537-018-0145-4>
- [18] Wu, Y., Tan, H.C., Qin, L.Q., Ran, B., Jiang, Z.X. (2018). A hybrid deep learning-based traffic flow prediction method and its understanding. *Transportation Research Part C Emerging Technologies*, 90: 166-180. <https://doi.org/10.1016/j.trc.2018.03.001>
- [19] Lv, Y.S., Duan, Y.J., Kang, W.W. (2007). Traffic flow prediction with big data: A deep learning approach. *IEEE Transactions on Intelligent Transportation Systems*, 16(2): 865-873. <https://doi.org/10.1109/TITS.2014.2345663>
- [20] Seghouane, A.K., Amari, S.I. (2007). The AIC criterion and symmetrizing the Kullback-Leibler divergence. *IEEE Trans Neural Netw*, 18(1): 97-106. <https://doi.org/10.1109/TNN.2006.882813>
- [21] Kumar, S.V., Vanajakshi, L. (2015). Short-term traffic flow prediction using seasonal ARIMA model with limited input data. *European Transport Research Review*, 7(3): 21-33. <https://doi.org/10.1007/s12544-015-0170-8>