Literature Review (Draft Proposal)

Implementing Machine Learning Tools or Techniques to Predict Traffic Accidents

1. Outline

The number of deaths, according to the World Health Organisation's (WHO) Global Status Report on Road Safety in 2018, highlights the severity of the number of traffic-related deaths each year. It is estimated that 1.35 million people died in 2016 (World Health Organisation, 2018), with most accidents involving vulnerable road users such as pedestrians, cyclists, or motorcyclists. Research shows that stringent traffic policies help reduce traffic accidents but do not cater to mechanical failures in vehicles, which are not currently used in traffic prediction models. This literature review is designed to gain a deeper understanding of integrating machine learning with improved driver safety in the modern world. The technological landscape in the modern era is paving the way for the Internet of Things (IoT) and driverless cars and there is a need to consider the impact on traffic accidents and importantly how technology can help to prevent such accidents.

The safest roads are those that do not have people behind the wheel. Moreover, nowhere is this trend better seen than in the move toward driverless cars. This technology must use machine learning and artificial intelligence for the vehicle (or other interactions) to better understand its surroundings. However, unless vehicles obtain a level of sentience and can autonomously navigate vehicles regardless of road conditions, people will still be involved in moving goods and people from place to place.

The literature review shall consult academic journals and books from various sources such as Scopus, Google Scholar, the Essex University Online library, and Web of Science. The scope of articles is limited to articles dealing with the use of artificial intelligence and machine learning in predicting traffic accidents, human factors that contribute to accidents, technologies such as Vehicle-to-everything (V2X[1]) technology (Tong et al., 2019), and the

[1] V2X technology is new, with a substantial portion of academic research appearing from 2009 onwards

types of neural networks used in traffic prevention and their failings. Lastly, the review attempts to identify any existing gaps related to traffic prevention machine learning tools and their implementations. The literature review does not consider privacy concerns related to data used in machine learning datasets, models, roadside infrastructure, or other information systems. Also not considered is the history of machine learning, deep learning or neural networks and relevant regulations related to accident prediction.

A proposed outline is given below.

2. Existing literature

Researchers have considered the use of Electroencephalogram (EEG) (Wu et al., 2004; Lin et al., 2005), real-time accident prevention using deep learning (Kabir and Roy, 2022), vehicle-to-everything protocol (Kotte et al., 2017; Liu et al., 2020; Xu et al., 2019; Zhao et al., 2022), models for predicting accidents (Xie et al., 2007; Gianfranco et al., 2018), using 3D tracking (Hu et al., 2004), models for predicting traffic flow (Kashyap et al., 2022), the impact of drowsiness (Sayed and Eskandarian, 2001; Hayashi et al., 2005), detecting risky driving behaviour using machine learning (Yuksel and Atmaca, 2021), using image processing for incident detection (Ikeda et al., 2005), predicting vehicle trajectory using computer vision (Harris et al, 2021; Wang, 2018).

3. Variables(?) for Prediction

To make accurate predictions that help improve driver safety, there are several categories that must be addressed

- motion patterns to predict positions and the likely occurrence of a collision.

4. Implementing In-vehicle technology

Literature review related to accident prediction (or avoidance) being developed for use in vehicles.

For example, considerations are for use of 5G, the Internet of Things, computer vision (road signs, other road users) and any edge-computing limitations found in the literature related to implanting in-vehicle machine learning technology.

The initial search is leaning towards Vehicle-to-Everything (V2X) technology and vehicle networks.

5. Implementing Infrastructure technology

Literature review related to accident prediction (or avoidance) being developed that is external to drivers and their vehicles.

For example, considerations are any literature related to roadside sensors or highway cameras (computer vision, data analytics, possibly even searching for emergency services data too.

The initial search is a bit sparse in this regard so this section might be light.

6. Implementing Government regulations

Literature review related to accident prediction (or avoidance) machine learning regulations that are being considered, discussed, or reviewed by governments around the world.

Initial search indicates that a lot of research arises out of China and who are looking into traffic safety. A reasonable expectation is that literature will point to their influence in highlighting the need for regulating accident-prevent machine learning tools. Although, this is just a speculative assumption about the literature.

7. Conclusion and further research

I wrap up the literature review and summarise the ease (or difficulty) faced with implementing machine learning technology, and any pitfalls or possible areas of research not yet identified in the existing literature in the previous sections.

I am mindful that section 1 and section 2 together contain about 500 words, and I need to make up about 300 words per remaining section. Challenging and perhaps unrealistic?

References

Gianfranco, F., Soddu, S. & Fadda, P. (2018). An accident prediction model for urban road networks. *Journal of Transportation Safety & Security*, 10(4):387-405.

Haris, M., Moin, M.A., Rehman, F.A. & Farhan, M. (2021). Vehicle crash prediction using vision. *In 2021 55th Annual Conference on Information Sciences and Systems (CISS):*1-5.

Hayashi, K., Ishihara, K., Hashimoto, H. & Oguri, K. (2005). Individualized drowsiness detection during driving by pulse wave analysis with neural network. *IEEE Intelligent Transportation Systems, 2005*. pp. 901-906.

Hu, W., Xiao, X., Xie, D., Tan, T. & Maybank, S. (2004). Traffic accident prediction using 3-D model-based vehicle tracking. IEEE transactions on vehicular technology, 53(3):677-694.

Ikeda, H., Kaneko, Y., Matsuo, T. & Tsuji, K. (1999). Abnormal incident detection system employing image processing technology. *In Proceedings 199 IEEE/IEEJ/JSAI International Conference on Intelligent Transportation Systems* (Cat. No. 99TH8383) (pp. 748-752).

Kabir, M.F. & Roy, S. (2022). Real-Time Vehicular Accident Prevention System Using Deep Learning Architecture. *Expert Systems with Applications*, p.117837.

Kashyap, A.A., Raviraj, S., Devarakonda, A., Nayak K, S.R., KV, S. & Bhat, S.J. (2022). Traffic flow prediction models–A review of deep learning techniques. Cogent Engineering, 9(1):2010510.

Kotte, J., Schmeichel, C., Zlocki, A., Gathmann, H. & Eckstein, L. (2017). Concept of an enhanced V2X pedestrian collision avoidance system with a cost function–based pedestrian model. Traffic injury prevention, 18(sup1): S37-S43.

Lin, C.T., Chen, Y.C., Wu, R.C., Liang, S.F. & Huang, T.Y. (2005). Assessment of driver's driving performance and alertness using EEG-based fuzzy neural networks. *In 2005 IEEE International Symposium on Circuits and Systems (ISCAS):*152-155. IEEE.

Liu, Z., Lee, H., Khyam, M.O., He, J., Pesch, D., Moessner, K., Saad, W. & Poor, H.V., (2020). 6G for vehicle-to-everything (V2X) communications: Enabling technologies, challenges, and opportunities. *arXiv preprint:2012.07753*.

Sayed, R. & Eskandarian, A. (2001). Unobtrusive drowsiness detection by neural network learning of driver steering. *Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering*, 215(9):969-975.

Tong, W., Hussain, A., Bo, W.X. & Maharjan, S. (2019). Artificial intelligence for vehicle-to-everything: A survey. IEEE Access, 7:10823-10843.

Wang, Y. (2018). A Novel Vehicle Tracking Algorithm Using Video Image Processing. *In 2018 International Conference on Virtual Reality and Intelligent Systems (ICVRIS):*5-8). IEEE.

World Health Organization, (2018). *Global Status Report on Road Safety 2018*. Geneva, Switzerland.

Wu, R.C., Lin, C.T., Liang, S.F., Huang, T.Y., Chen, Y.C. & Jung, T.P. (2004). Estimating driving performance based on EEG spectrum and fuzzy neural network. *IEEE International Joint Conference on Neural Networks (IEEE Cat. No. 04CH37541)* (1):585-590). IEEE.

Xie, Y., Lord, D. & Zhang, Y. (2007). Predicting motor vehicle collisions using Bayesian neural network models: An empirical analysis. Accident Analysis & Prevention, 39(5):922-933.

Xu, T., Jiang, R., Wen, C., Liu, M. & Zhou, J. (2019). A hybrid model for lane change prediction with V2X-based driver assistance. Physica A: Statistical Mechanics and its Applications, 534:122033.

Yuksel, A.S. & Atmaca, S. (2021). Driver's black box: A system for driver risk assessment using machine learning and fuzzy logic. *Journal of Intelligent Transportation Systems, 25(5)*:482-500.

Zhao, L., Chai, H., Han, Y., Yu, K. & Mumtaz, S. (2022). A collaborative V2X data correction method for road safety. IEEE Transactions on Reliability.

Bibliography

Hossain, M.A., Noor, R.M., Yau, K.L.A., Azzuhri, S.R., Z'aba, M.R. & Ahmedy, I. (2020). Comprehensive survey of machine learning approaches in cognitive radio-based vehicular ad hoc networks. *IEEE Access*, *8*:78054-78108.

Note to self:

Here's another article that has the same authors (Xie et al., 2007) except that Li, Y. is a new contributing author.

- Li, X., Lord, D., Zhang, Y. and Xie, Y., 2008. Predicting motor vehicle crashes using support vector machine models. *Accident Analysis & Prevention*, *40*(4), pp.1611-1618.