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Enhancing protection of vehicle drivers and road safety by deploying ADAS and Facial Features Pattern Analysis (FFPA) technologies

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Enhancing protection of vehicle drivers and road safety by deploying ADAS and Facial Features Pattern Analysis (FFPA) technologies

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Abstract*—The latest technology associated with Intelligent Transportation Systems (ITS) have been designed with the aim to minimize the numbers of person injury in road accidents and improve the overall road safety. The driver behavior is one major concern in many accidents in HK urban road links. In particular, the driver's attitudes, such as fatigue, drowsiness and concentration are the major causes to road accidents. It will affect the driver's ability and decisions in properly controlling their vehicles. Very often, this kind of driver distraction is particularly obvious when driving after 2 to 3 hours from most research sources. In the traffic data sourced from Transport Department of HKSAR, around 82% of the personal injury in road accidents belongs to the drivers' fault. This paper used the latest technology and applied it to a group of transport vehicles, i.e. taxi. The objective is set up to monitor, record and analyze the fatigue and drowsiness situation of drivers by means of advanced AI system, facial recognition detection system (the sensors) and early warning devices (LDWS) via ADAS technology. The result will be used to give real time early warning and subsequent analysis for the transport operators or researchers for better and safer management of their transport fleets. The system aimed to have a good precaution and protection on all road users, including drivers, passengers and pedestrians. In turn, it largely saves our community resources, such as the medical and social services consumed on treating the injured persons.

***Keywords*—ADAS, LDWS, DDDS, sensors, data analytics, vehicular fleet management**

I. Introduction

Among all the transport issues, the road safety is the one mostly affect and direct impact on our daily lives. The occurrence of accident rates is a tragically loss to the community and the indicator to reflect our socio-economic conditions. There are numbers of studies around the globe thinking of the numerous methods to prevent the road traffic accidents happen. In Hong Kong, it costs the loss of Gross Domestic Product (GDP) for around 2%, which is equivalent to 5.7 billion in HK dollars. In average, each personal injury accidents causes the loss of 290,000 HK dollars.

In addition, according to the figures listed in HK Traffic Police Report 2018 and Annual Traffic Census 2019 (Figure. A and B), the personal injured accidents most likely occurred in various types of road junctions and pedestrian crossings, while human fault accounted for 82% of all traffic accidents. Thus, the human behaviours will be the most key factors in the cause of road transport accidents.

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In particularly, when compared with previous year, the total number of traffic casualties decreased by 251 persons (-1%) from 19,888 (2017) to 19,637 persons (2018). In respect to the category of traffic casualties for 2018, there were distributed as 51% for drivers, 33% for passengers and 16% for pedestrians. Some studies (Klauer)*[*] have stated that drowsiness can largely increase the collision risk around 5 times. In conclusion, the use of an effective real time monitoring systems and it can give early warning before fall asleep is in urgent need.

In this report, it is mainly to investigate and evaluate the effectiveness of the DDD with the support of ADAS and AI system on different types of vehicles, like taxi and buses. The result were listed in fig 8 , 9 and 10 for reference.

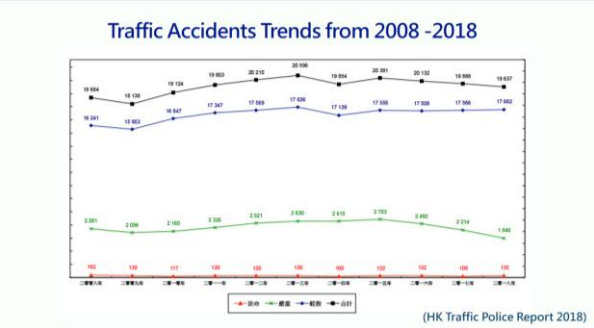

Figure A. Traffic accidents trends from 2008-2018

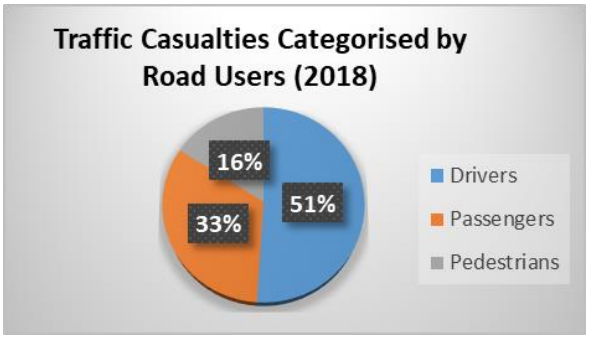

Figure B. Traffic causalties categorised by road users (2018)

II. The Methodology

Since there is evidence to show that the car drivers (51%) is the most important cause to the overall road traffic accidents. In particular, the sense of Drowsiness is not just a symptoms of fatigue, but also the good indicator for driving performance. For the better protection of all road users, driver must use and to develop a kind of tactics with the help of latest technologies to give an early warning, real time monitoring of driving behaviours' database for the review

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by drivers and / or transport operator in oversee the transport fleet management.

Although there are minor categories of drivers' misbehavior attitudes, for instance, distraction and tiredness. In fact, the system concentrate only on the driver's tiredness. The approach in this system development project will be analysed and to measure its performance to avoid traffic accidents by this technology, i.e. the driver drowsinesss detection system (DDDS). The set-up system comprised of 3 parts: An Advance Driving Assistance System (ADAS) sensors (Figure 3 to 9), the in-car real time response warning system and the AI database system for management reporting.

In this project, a driving safety monitoring device was installed to alert the driver in various ways so that it enables to measure the relative distance headway warning; lane changing warning (LDWS); speeding warning; moving objects warning; the driver drowsiness detection system by facial recognition imaging to alert any driving misbehaviors. The overall design is based on an Internet on Vehicles (IoV) (Figure 7)

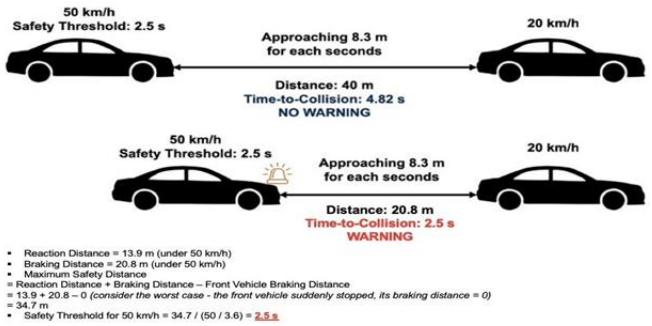

Figure 1. Relative Distance Headway Collision Warning (RDHC) system

Besides that, the system collect the driver driving attitudes and other raw data for subsequent analysis while using it as test drive on taxi and bus services. The system will clearly video the real driving situation, the locations of drivers' misbehavior driving practices occurred whilst running on the road. It matches clearly with each driving misbehaviour attitudes under this system with the help of Global Positioning System (GPS) into our HK road map. (refer to fig. 8, 9, 10 and 11)

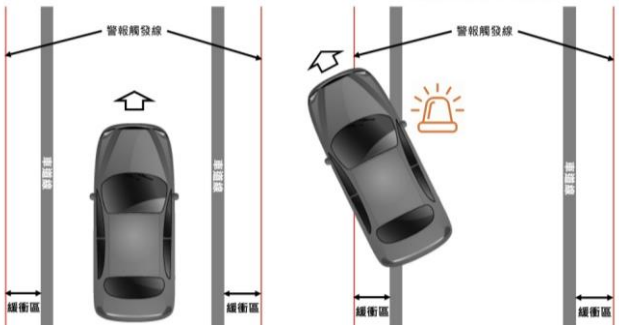

Figure 2. Lane Displacement Warning System (LDWS)

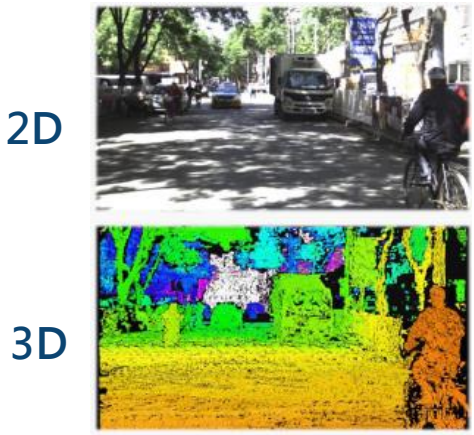

Figure 3. The ADAS with 2-cameras to detect moving objects

Figure 4. ADAS with 2 camera can detect any moving objects in 3D

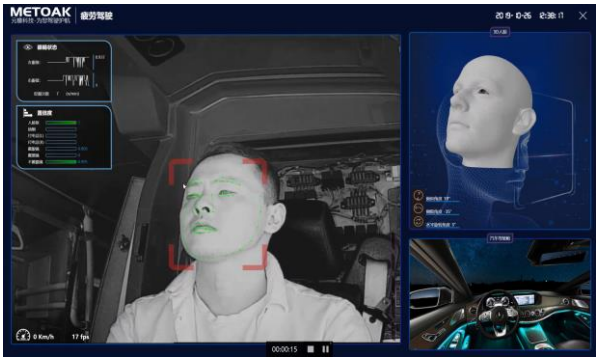

Figure 5. The Driving Drowsiness Detection System (DDDS)

Figure 6a. The installation of DDDS and ADAS on board (Outside view)

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Figure 6b. The installation of DDDS and ADAS on board (Inside view)

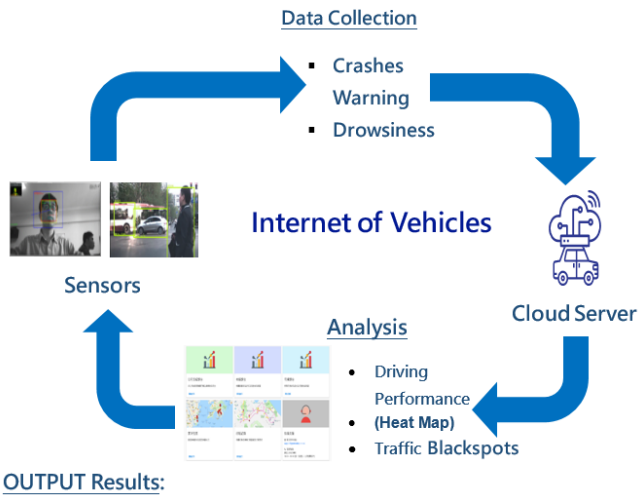

Figure 7. The Overview of the Internet of Vehicles (IoV)

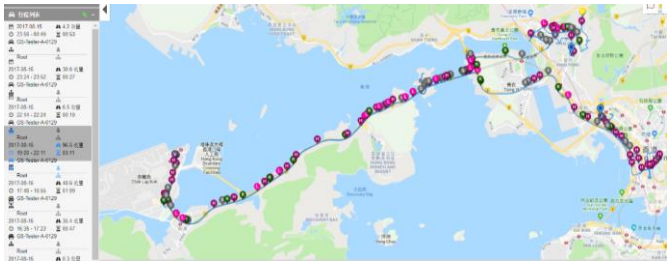

Figure 8a. The locations of driving behaviours on map (bad situation)

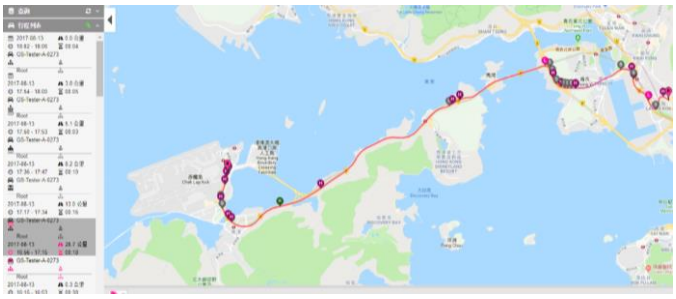

Figure 8b. The locations of driving behaviours on map (good situation)

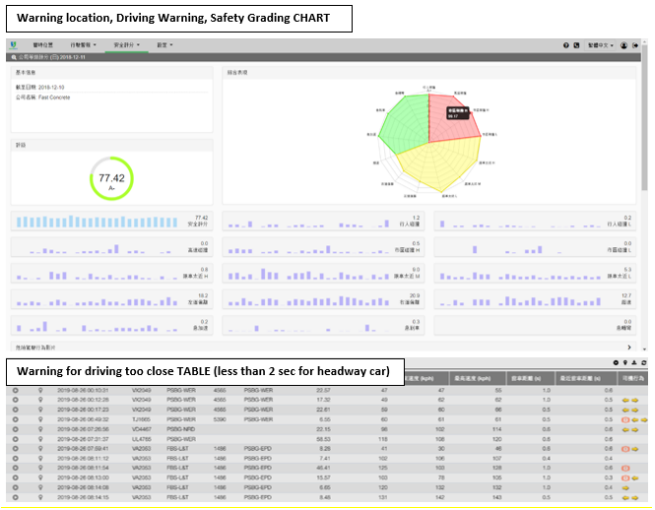

Figure 9. All Outputs (for the performance of drivers on board)

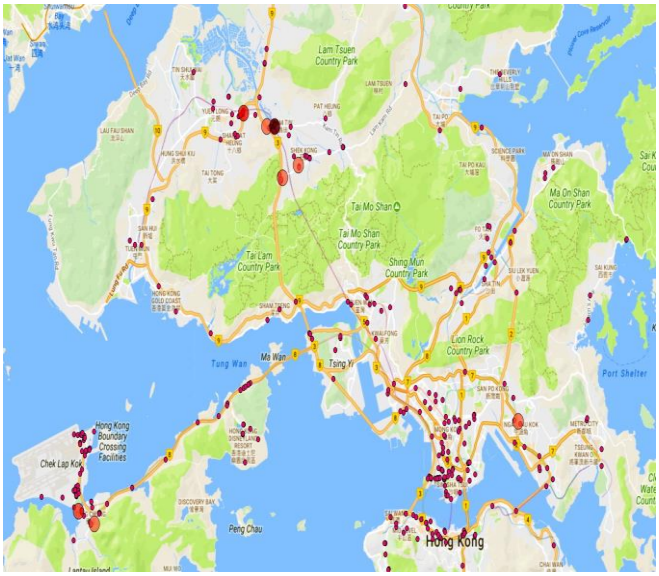

Figure 10. Real-time review for the potential traffic black-spots on local maps.

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Figure 11. Smart Transportation in future (Vehicle connect to Anything, V2X)

The system has been successfully installed into numbers of taxi and buses in the period of 2018-2019. Please refer to the above (fig. 5 and 6). The frequency of early warnings on any drivers' misbehaviours (fig. 1 and 2) were recorded in memory card and uploaded up to server. All warning devices and user interfaces will send out warning in real time via suitable audio and visual display panels. This newly integrated detection system was able to keep track of those abnormal driving conditions for subsequent improvements or analysis by transport fleet management.

For transport operator, user can experience the driving scores and performance reports for the entire fleet, vehicle groups, driver groups by age or number of years in driving experience; The unique driving behavior for triggered the alarm system as a reference to the driver's reaction and a 10-second video is auto-captured for the reference in road conditions before and after the alarm.

After the test run, the systems feedback from drivers and the management team of Transport Operators are very positive and it receive great applause in terms of the system did alert drivers for any driving malpractices, fatigues situation. Such early warning system also produced a good training practices for all drivers who are working in these public vehicle sectors. Some major transport operators adopt this system and it did give out a good sample reference on road safety and the protection of vehicle drivers.

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IV. Other keywords

ADAS, LDWS, DDDS, FCWS, HMWS, SWS, sensors, data analytics, vehicular fleet management

The following are the warning detection system embedded inside the early warning system in this studies:

When warning for bad driving behaviours happened:

Moving Object Collision Warning; Headway Warning; Lane Displacement Warning; Impact Collision Warning

For the real time response systems, the alerted warning including:

Speeding; Frequency and intensity of acceleration and braking (such as hard braking and sudden accelerate) on the road

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