NATURALISTIC STUDY ON COMMUNICATION IN MIXED TRAFFIC SCENARIOS: AUTONOMOUS VEHICLE VS MOTORCYCLIST

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DECLARATION

I declare that this project report entitled "Naturalistic Study on Communication in Mixed traffic Scenarios: Autonomous vehicle vs. Motorcyclist" is the result of my own work except as cited in the references.

Signature : ……………………………

Name : ……………………………

Date : ……………………………

APPROVAL

I hereby declare that I have read this project report and in my opinion this project report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering

Signature : ....

Supervisor's Name : ....

Date : ....

DEDICATION

To my beloved father and mother

ABSTRACT

This paper discusses whether the knowledge of the automation of an oncoming vehicle (Av vs. Non-Av) affects Motorcyclist's decision to cross the junction. In addition, this paper investigates how different appearances interact with the driving style in affecting motorcyclists' willingness to cross the junction. In a video-based experiment with 54 participants, two vehicles (Perodua Myvi) with different colors (grey vs. white) are presented as automated vehicles and manually-driven vehicles. A LiDAR was designed and set up on the top of the automated vehicle. Both vehicles go through 4 scenarios (right turn, right straight, left turn, and left straight) with different driving styles (assertive vs. defensive) at the junction. The participants were asked to indicate whether they would cross into the junction in front of the approaching vehicle at a distance ranging from 100 m to 25 m. The data was collected through Google form and analyzed using SPSS statistics. The results showed no significant influence of the knowledge of the automation on the Motorcyclist's willingness to cross into the junction. Although there was no significance in three-way interaction and two-way interaction in the analysis, we found that the motorcyclists have more trust in automated vehcile than manually-driven vehicles at distances 50 m and 25 m. We conclude by discussing the limitation and the future of the study.

ABSTRAK

Makalah ini membincangkan sama ada pengetahuan mengenai automasi kenderaan yang akan datang (Av vs. Non-Av) mempengaruhi keputusan Penunggang Motosikal untuk melintasi persimpangan. Di samping itu, makalah ini menyiasat bagaimana penampilan yang berbeza berinteraksi dengan gaya pemanduan dalam mempengaruhi kesediaan penunggang motosikal untuk melintasi persimpangan. Dalam eksperimen berasaskan video dengan 54 peserta, dua kenderaan (Perodua Myvi) dengan warna yang berbeza (kelabu berbanding putih) disajikan sebagai kenderaan automatik dan kenderaan yang digerakkan secara manual. LiDAR telah dirancang dan dipasang di bahagian atas kenderaan automatik. Kedua-dua kenderaan menjalani 4 senario (belok kanan, kanan lurus, belok kiri, dan kiri lurus) dengan gaya pemanduan yang berbeza (tegas berbanding bertahan) di persimpangan. Para peserta diminta untuk menunjukkan sama ada mereka akan melintasi persimpangan di hadapan kenderaan yang menghampiri pada jarak antara 100 m hingga 25 m. Data dikumpulkan melalui borang Google dan dianalisis menggunakan statistik SPSS. Hasilnya tidak menunjukkan pengaruh yang signifikan dari pengetahuan automasi terhadap kesediaan Penunggang Motosikal untuk memasuki persimpangan. Walaupun tidak ada makna dalam interaksi tiga arah dan interaksi dua arah dalam analisis, kami mendapati bahawa penunggang motosikal lebih mempercayai kenderaan automatik daripada kenderaan yang dipandu secara manual pada jarak 50 m dan 25 m. Kami membuat kesimpulan dengan membincangkan batasan dan masa depan kajian.

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INTRODUCTION

1.1 Background

An autonomous vehicle is a vehicle that can self-driving and operating without a driver by sensing its environment. The passenger needs to sit in the car without controlling anything. An autonomous vehicle can travel anywhere and do everything as an experienced human driver does.

Autonomous vehicles entirely rely on processors, radar sensors, complex algorithms, and machine learning systems instead of controlled by a driver. The sensors have a vital role in an autonomous car to create and maintain a map of its surroundings. For instance, radar sensors, light detection and ranging (LIDAR) sensors, and ultrasonic sensors are situated on different parts of the autonomous car. Radar sensors function as detecting the position of nearby vehicles, and LIDAR sensors may monitor road edges and identify lane markings by bouncing pulses of the light off the car's surroundings to measures distances.

Furthermore, autonomous vehicles will contribute many benefits to society. For example, when the kids were at summer camp and forgot their bags or daily necessaries, the car could bring them the things without disturbing our planned schedule on that specific day. Besides, autonomous vehicles could save transportation costs and free up parking lots, especially at schools, parks, and community centers. Traffic congestion and accidents could be reduced by autonomous cars

(Pettigrew et al., 2018). Autonomous vehicles also get considerable support from all vehicle users in Malaysia (Kassim et al., 2019).

1.2 Problem Statement

In this era of technological advancement, several manufacturers like Ford, Audi, and BMW are in the journey of developing such an advanced technology called autonomous vehicles that to be mass-produced (Christiaan Hetzner, 2019; Connie Loizos, 2019). Many efforts have been seen in developing autonomous vehicles in Malaysia (Kassim et al., 2019). The autonomous vehicles' research could take some time to be studied to solve several factors, including policy and legislation (Fagnant and Kockelman 2015). However, we cannot deny that autonomous vehicles are new technologies that evoke excitement and apprehension among the public.

Before launching autonomous vehicles in the Malaysian market, road users like motorcyclists, pedestrians, and vehicles could not necessarily adopt autonomous vehicles technology. Previous research in Europe and the USA has studied the interaction and communication between pedestrian and autonomous vehicles (Dey & Terken, 2017; Rothenbucher et al., 2016). However, Malaysia has the most road fatality risk among the ASEAN countries, and more than 50% of the accidents involve motorcyclists (Abdul Manan & Várhelyi, 2012).

Road injuries and fatalities are a growing concern in Malaysia. In 2009 alone, motorcyclists recorded the highest fatalities (4070) from 2002 to 2012 (Abdul Manan & Várhelyi, 2012). Malaysia recorded more than 50% of the road accident fatalities involving motorcyclists and is the highest road fatality risk among the ASEAN countries. There are three (3) main types of accidents in Malaysia which are collisions with passenger cars (28%), collisions with other motorcycles (25%), and single-motorcycle crashes (25%). Accidents are mainly due to mixed traffic conditions where Motorcyclist are the most vulnerable road users while sharing the roads with the cars (Abdul Manan & Várhelyi, 2012). Based on the study, the accidents caused by the collision between the motorcyclist and passenger cars is the highest in Asian countries. If the mixed-traffic conditions involve an autonomous vehicle, the safety of the Motorcyclist will be threatened. Thus, communication between the Motorcyclist and autonomous vehicles was studied in this project.

1.3 Objective

Below are the objectives for this study:

a) To develop a mock autonomous vehicle will be developed using the ghost driver method to simulate autonomous vehicle driving on an actual road setup and automatic data collection in terms of produced acceleration.

b) To study the interaction between an autonomous vehicle and motorcyclists in terms of the types of autonomous driving styles.

c) To measure the willingness of the Motorcyclist to cross the marked junction when encountering scenarios involving a manually-driven vehicle and autonomous vehicle.

1.4 Scopes

In this study, a Perodua Myvi car will be used as an instrumented vehicle that will behave like an autonomous vehicle. The instrumented vehicle will simulate the autonomous vehicle and be done on real roads with the motorcyclists to investigate their interaction. Hence, these are the scopes that will be covered in this project:

a) The study only covers motorcyclists as vulnerable road user instead of pedestrians or cyclists.

b) The "Ghost driver" method was implemented using the instrumented Perodua Myvi as the test vehicle. In contrast, another Perodua Myvi (same model but different colour) was used as a baseline for this study.

c) The road studies were only done at unsignalized three-legged junctions on a Malaysian road to which its traffic laws apply.

d) Two specific and different autonomous driving styles were used in this study.

1.5 Chapter Summary

The introduction has discussed the general information and the advantages of autonomous vehicles. The problem statement has been stated to be the focus of this study. Then, objectives were set to ensure achieving the aim of this project. Lastly, the project scope is explained to have a clear vision of this project's coverage area. Next, the literature review will be discussed in the next chapter.

CHAPTER 2

Literature Review

2.1 Vehicle

Many types of vehicles exist in this world, for instance, motorcycle, car, bus, and others. The number of vehicles increases rapidly from time to time. There are 31.2 million vehicles registered in Malaysia in 2019 alone (Anthony Lim, 2020). The traffic congestion has even become more severe in Malaysia. However, the vehicles will be upgraded to be automated in order to reduce traffic accidents caused by human errors and improve traffic congestion in the future (Adnan et al., 2018; Jing et al., 2020).

2.1.1 Automation

The definition of automation means that the vehicles can be self-driving but still in the driver's presence. Automation is concerned with performing a process utilizing programmed commands combined with automatic feedback control to ensure proper instructions (Groover, 1999). Automation is the ability of a system to complete tasks and produce deterministic results. Automation's primary function is usually not to replace human resources but reduces the difficulty of completing a job. It changes human work's nature from self-handling to a more supervisory role (W. Xu, 2020). For instance, the pilots always have auto-flight mode while controlling the airplane.

The automation process requires the driver's vision to ensure it performs well-defined tasks, but sometimes some incidents happened to like the driver falls asleep and failed to monitor it.

2.1.2 Autonomous vehicles

Autonomous vehicles could bring many benefits and allow some powerful and convenient functionality. Autonomous vehicles can be described as self-driving cars with an internal computing platform to drive themselves by interpreting the whole scenario on the road and having wise driving skills without any driver control (Geng et al., 2017). Since the drivers are no longer driving, they are most likely to perform activities such as watching a video and entertaining their family and others (Wienrich & Kirstina, 2019).

Based on Figure 1, autonomous vehicles' appearance is different from regular vehicles, especially the vehicles' exterior part. Autonomous vehicles need to sense their environment by themselves. Hence autonomous vehicles entirely rely on sensors, actuators, complex algorithms, machine learning systems, and processors (Hancock et al., 2019). The sensors help autonomous vehicles make and maintain a map of their surroundings. The radar sensor will be set up at the top of the autonomous car to monitor nearby vehicles' positions. Video cameras track the road signs, traffic lights, and others. Lidar sensors will bounce light pulses to their surroundings to measure the distance (Osman, 2020).

Figure 1: Autonomous Vehicle (Lambert, 2020)

The technology of autonomous vehicles improves the quality of life and brings the most significant convenience to the world (Jing et al., 2020). Autonomous vehicles could reduce CO_2 emission, reduce traffic congestion, and improve mobility (Alexander-Kearns et al., 2016; Pettigrew et al., 2018). In the future, autonomous vehicles were coming to our roadways. Some problems and issues pop up to the researcher that has not yet been encountered. The present work addressed how the machine's automation can be understood by the public (Hancock, Nourbakhsh, and Stewart 2019). Autonomous vehicles' safety is still a worry and full of uncertainty. Before further studying autonomous vehicles' development, autonomous vehicles' acceptance is essential and may affect development growth.

2.2 Acceptance of Autonomous Vehicles

Malaysia is a rapidly growing country in the field of technologies in the future. In today's age of artificial intelligence, autonomous vehicles are coming for sure. So, the acceptance of autonomous vehicles is of concern to the researcher. The pillars of adopting autonomous vehicles are technology and innovation, infrastructure, consumer acceptance, and policy and legislation (Kassim, Mohd Jawi, and Nasruddin 2019).

From the technological point of view, autonomous vehicles require major investment to be safely deployed for public usage. Not only that, specific road infrastructures cater to autonomous vehicles are needed to adopt this technology. This scenario showed that the lack of infrastructure becomes one obstacle for a country to create an autonomous world.

On the other hand, public acceptance is also vital in adopting the autonomous vehicle technology. Most Malaysians are still reluctant to trust autonomous vehicles as their vehicle for daily transportation due to their uncommonness to society (Kassim et al., 2019). According to a study in France, participation from the public while testing autonomous vehicles will help build trust (Piao et al., 2016). Trust appears to a significant role that can affect human-computer interaction (Jing et al. 2020). The Government of Malaysia has not yet clearly addressed the arrival of autonomous vehicles on public roads (Kassim et al., 2019). Policymakers need to make the correct decision to benefit both the technology developers and the general public while ensuring safe deployment simultaneously.

Furthermore, safety is the main reason for the general public to trust and accept the autonomous car (Jing et al., 2020; Lee et al., 2020; Stanciu et al., 2017). The autonomous vehicle will be improved by minimizing perception errors, decision errors, and action errors to achieve safety (Wang et al., 2020). The number of deaths of autonomous vehicle accidents makes the public more focused and concerned about safety issues (Nazari, Noruzoliaee, and Mohammadian 2018). Besides, autonomous vehicles are more environmentally friendly than regular vehicles due to reducing greenhouse gas emissions and fuel usage. Some studies found that respondents who have purchased electric vehicles will agree with autonomous vehicles (Jing et al., 2020).

According to a study on the general attitudes regarding autonomous vehicles (Jamil et al. 2019), the data recorded for the question of "What is your general opinion regarding autonomous and self-driving vehicles?" stated that most of the respondents choose to be neutral of the autonomous technology with 40.72% among the options. The data showed that most of the public does not exclude autonomous technology.

The level of the autonomation is according to the Society of Automotive Engineers (SAE), which has established its international’s standard (J3016) (Jamil et al., 2019). The level of autonomous vehicles owned will be affected by factors like salary, age, and gender. Level 0 of the autonomous vehicle refers to a vehicle with no driving automation. Then, at level 1 automation, the driver is responsible for the most driving vehicle with just one driving assistance. Level 2 autonomous vehicle provides multiple advanced driver assistance systems (ADAS) that can control steering, acceleration, and braking events in set scenarios. Level 3 automation is defined as conditional self-driving with drivers who can decide on their own. Based on Figure 2, the data showed that 'male' consider vehicles with a higher level of autonomous vehicles than 'female.' The respondents who are more than 46 years old have a higher percentage (51.9%) willing to own level 1 autonomous vehicles. Based on Figure 2, the respondents' salary has influenced the respondents' decisions. The respondents with a salary of more than RM 5000 per month have 68.2% owning autonomous vehicles level 1 and above.

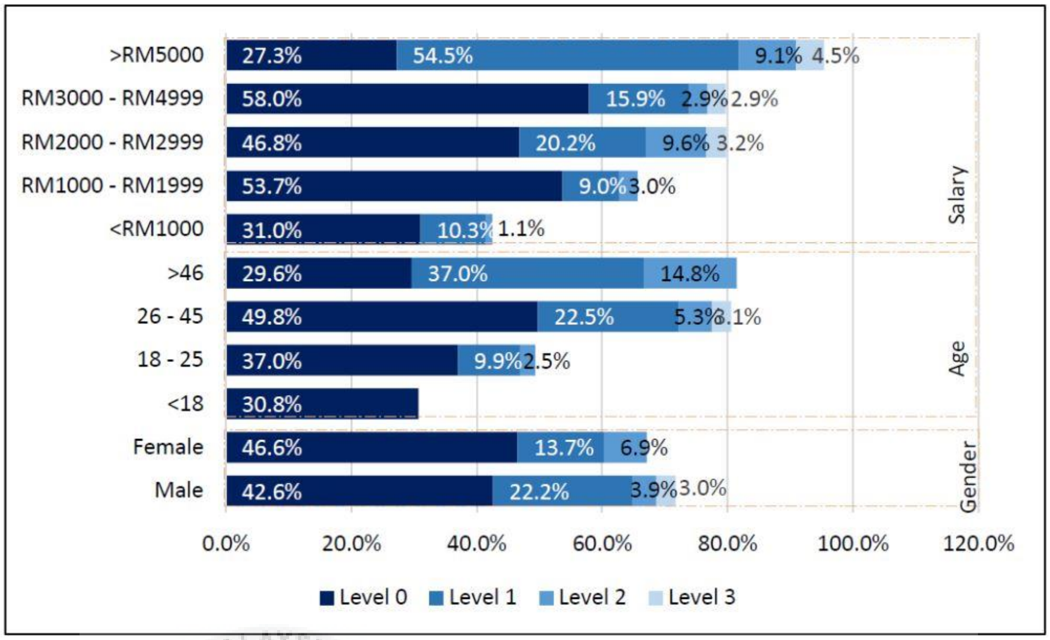

Figure 2: Level of autonomous vehicles (Jamil et al., 2019)

The respondents are concerned the most about is "safety consequences of equipment failure" by referring to the summary below (Figure 3). The safety issue is always the main point to build up respondents' trust and confidence regardless of the benefits that autonomous vehicles bring to them. Secondly, once the vehicle turned into autonomous, the issues of vehicle security and system security from hackers are concerned by respondents—these statistical data collected as a powerful suggestion for improving autonomous vehicles in the future.