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The Impact of Glare During Daylight on Driving Performance: An Experimental Setup

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Abstract – *An Advanced Rear Visualization (ARV) based on camera technology is becoming more widely available in the automobile market as it increases the ability to see beyond the area of a mirror's image as well as helping to eliminate the driver's blind spot. Besides, it assists the driver in parking, reversing, and maneuvering safely. Therefore, it is necessary to understand how people use them to do so effectively and efficiently. This paper describes an experimental setup to observe the driver's behavior while reverse parking the car with and without the use of a camera as well as to observe the impact of glare during daylight on the driving performance. An area of 14 meters x 12 meters is designed as the Test Environment (TE) to fit in two parking spaces. Three cameras are used to monitor the participant's head movements and eye movements. This research is designed to study and collect driver behavior data including the reaction time taken during parking concerning the driver with different age groups, camera usage during a sunny day, and also two different parking conditions which are parallel parking and perpendicular parking. This setup is expected to be implemented to forecast the camera usage among the drivers to help the driver park their car in the reverse direction to solve the limited blind spot issue. Collected data from this study will be used as the preliminary data for road test evaluation. It is to further study the impact of glare during daylight on driving performance.*

Keywords: Advanced Rear Visualization (ARV), camera technology, reverse parking

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1.0 INTRODUCTION

With the development of the automotive industry, the usage of smart camera technology that is closely related to the development of intelligent vehicles is becoming significant (Zhao et al., 2020). Recently, embedded camera modules using embedded assembly technology to meet the industry's growing needs for rearview cameras, front-view cameras, surround-view cameras, multi-lens array cameras, stereoscopic and most other automotive camera assembly and test requirements had been improved (Kim et al., 2016).

Automotive manual assembly cannot avoid operations with limited sight for the associate. To complete the process, the association often must rely on tactile feel or assume ergonomically challenging positions. A wearable camera system that can record a field of view near an associate's hand and display it remotely to the associate and determine user preference and acceptance. Baburaj et al. (2019) developed three types of camera systems: (1) wearable camera with arm wearable display, (2) wearable camera with external stationary display, and (3) wearable camera with smart glasses screen to determine driver's behavior while using different types of camera-based technology while driving

High-quality cameras are fundamental sensors in assisted and autonomous driving. In particular, long-range forward-facing cameras can provide vital information about the road ahead, including detection and recognition of objects and early hazard warnings. These automotive cameras should provide high-resolution images consistently (Sahin, 2019).

This shows the necessity for ASEAN region vehicle manufacturers to include this technology in their products. This research aims to provide a study on the usability of the Advanced Rear Visualization (ARV) camera among drivers. The study must assist the driver's awareness of the behavior while using ARV during parking. The three main objectives of this research are first to study driver behavior while using and not using ARV during parking. Secondly, to collect driver behavior data through experiments including the reaction time taken during parking concerning the driver with different age groups, camera usage during a sunny day and rainy day, and also two different parking conditions which are parallel parking and perpendicular parking. Lastly, is to validate the data collection.

2.0 EXPERIMENTAL SETUP

2.1 Controlled Environment

An area of 14 meters x 12 meters is designed as the Test Environment (TE) to accommodate two types of parking spaces. Two types of parking are chosen for this experiment. There are parallel parking and perpendicular parking. Based on Parking Planning Guidelines by the Department of Town and Country Planning, the minimum size of parking space is 2.5 meters (width) x 6 meters (length) (Jabatan Perancangan Bandar dan Desa, 2017). Therefore, both parking spaces are aligned as shown in Figure 1. A participant will start the experiment from the starting point located at the center of the TE. At first, the participant will drive the car to the parallel parking lot numbered as ①. After it is done, they will park the car in a perpendicular parking lot numbered as ②. A camera will be located in the area of TE to monitor the external view during the parking process.

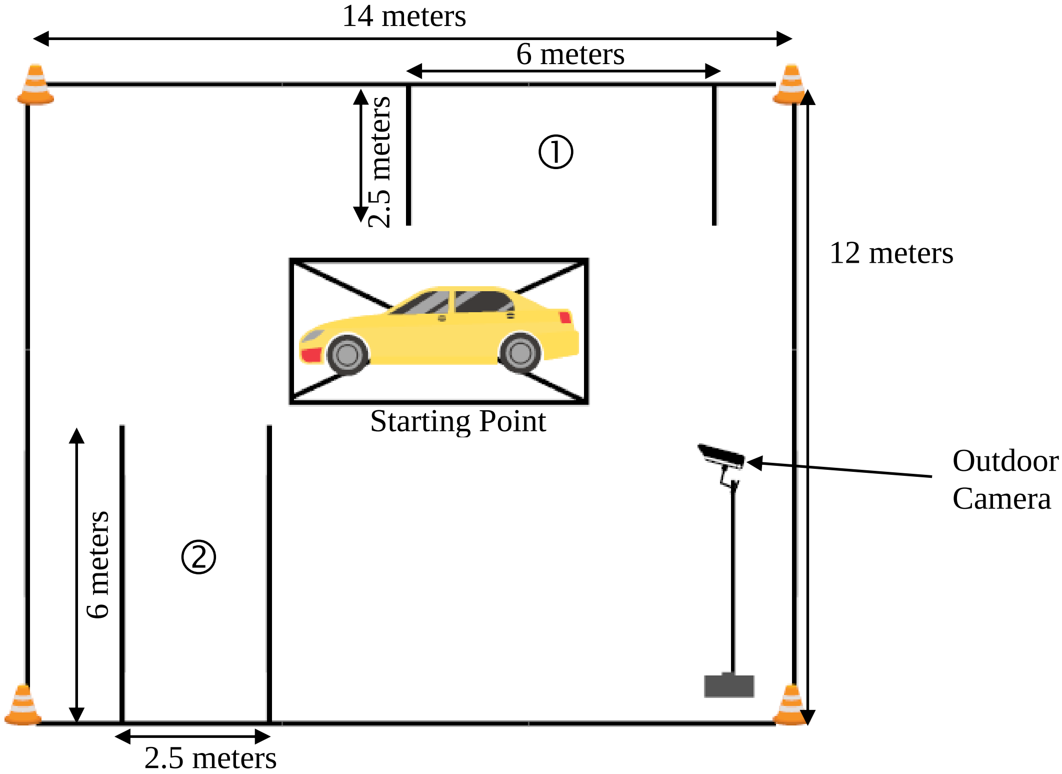


Figure 1: Test environment

2.2 Setup Condition

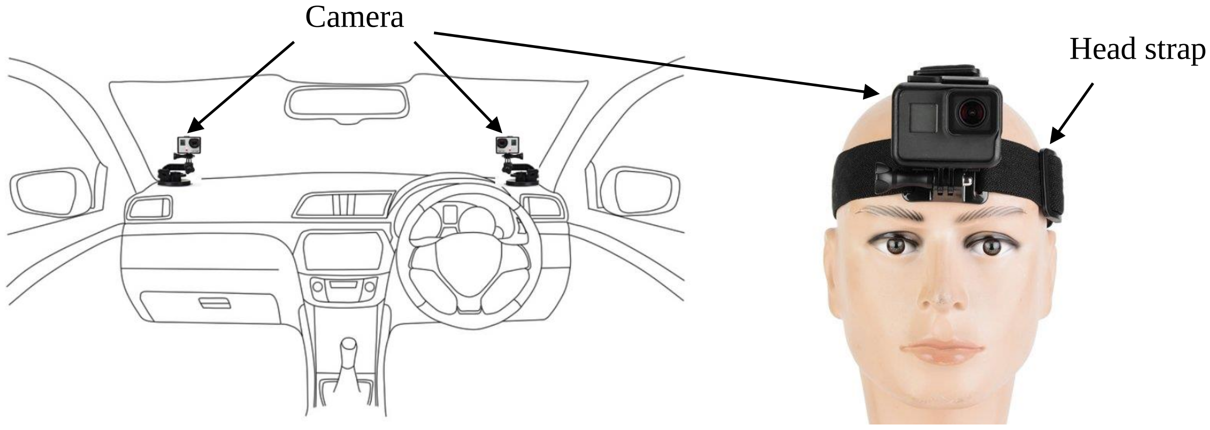
Four items need to be considered in designing the experiment. There are camera positions to record the behavior of the driver while parking the car and parking conditions that consider parallel parking and perpendicular parking. Besides, camera usage while parking the car during different weather and basic elements related to the selection of participants is also taken into account.

2.2.1 Camera position

Three cameras will be used to monitor the participant's head movements and eye movements. Figure 2(a) illustrates two cameras retained in the holder mounted on the left side and the right side of the dashboard while a single camera is attached to the participant's forehead as shown in Figure 2(b). An ARV camera will be attached to the rear of the vehicle as well as a rear-view monitor will be installed inside the car to display recorded views by the ARV camera.

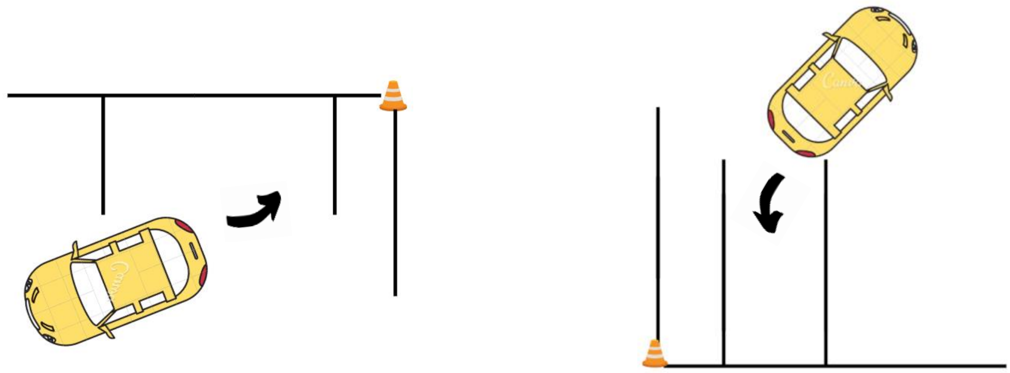
2.2.2 Parking condition

There are different types of parking and the most common are angle parking, perpendicular parking, and parallel parking. Two parking spaces are chosen for this research study. There are parallel parking and perpendicular parking as illustrated in Figure 3(a) and Figure 3(b), respectively. The size for each parking space is designed based on the minimum measurement stated in Parking Planning Guidelines by the Department of Town and Country Planning which is 2.5 meters (width) x 6 meters (length) (Jabatan Perancangan Bandar dan Desa, 2017). In this experiment, reverse parking will be a choice of parking direction to park the car. Although reverse parking is safer compared to forward parking (Xie & Hlynka, 2019), it requires greater care in steering turning as it provides limited views due to the driver's blind spot area. This is where the ARV camera usage is greatly helping the driver park the car in the reverse direction.



(a) (b)

Figure 2: Camera positions: (a) Two cameras mounted on the left side and the right side of the dashboard, and (b) Camera mounted to the forehead



(a) (b)

Figure 3: Parking space: (a) Parallel parking, and (b) Perpendicular parking

2.2.3 Camera usage

Figure 4 shows the eight conditions that need to be considered to identify parking time take based on camera usage. Each participant will undergo an experiment for all conditions and parking time for each condition will be captured. The conditions are:

a) Reverse parking using the ARV camera on a sunny day for parallel parking.
b) Reverse parking using the ARV camera on a sunny day for perpendicular parking.
c) Reverse parking using the ARV camera on a rainy day for parallel parking.
d) Reverse parking using the ARV camera on a rainy day for perpendicular parking.
e) Reverse parking without using the ARV camera on a sunny day for parallel parking.
f) Reverse parking without using the ARV camera on a sunny day for perpendicular parking.

g) Reverse parking without using the ARV camera on a rainy day for parallel parking.
h) Reverse parking without using the ARV camera on a rainy day for perpendicular parking

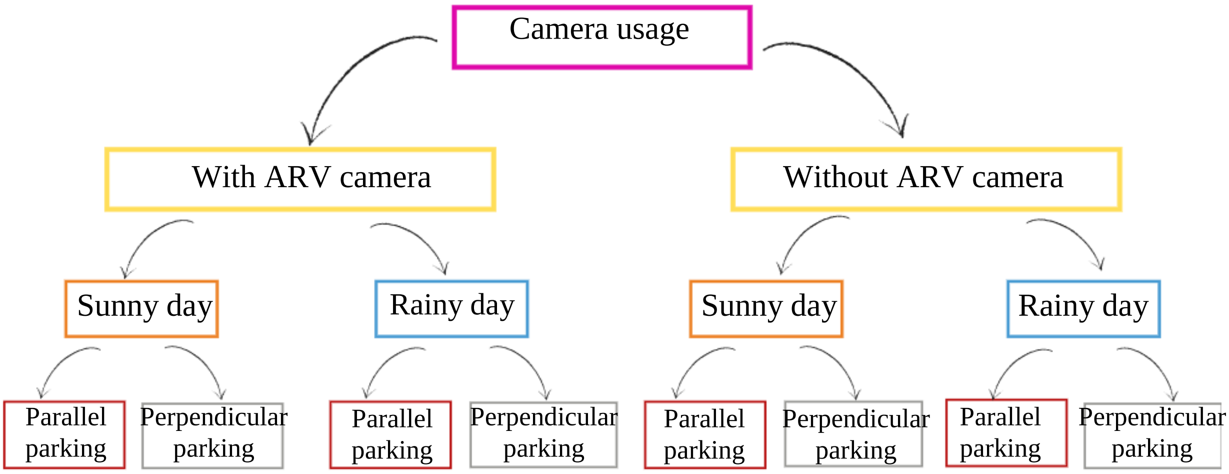


Figure 4: Parking space for (a) Parallel parking

2.2.4 Participants

Qualified drivers from Universiti Teknikal Malaysia Melaka (UTeM) will be selected randomly as a participant. 18 participants will be grouped into six participants per group based on age and gender. Three groups of age will be formed; 20-30 years old, 30-40 years old, and 40-50 years old. Each group will have an equal number of males and females as shown in Table 1.

Table 1: Participant selection

Age	Quantity	Sex
20-30 years old	3	Male
	3	Female
30-40 years old	3	Male
	3	Female
40-50 years old	3	Male
	3	Female

2.3 Data Analysis

The study will look into the driver's reaction in terms of head movements and eye movement while reverse parking the car in two different parking conditions which are parallel parking and perpendicular parking. Hence, the analysis of the parking time taken by the participant with different camera usage will be done. The result will show whether or not there is a correlation that exists between age and gender with ARV camera usability.

3.0 CONCLUSION

This paper is a preliminary component to forecast the usability of the ARV camera among the drivers to figure out the significance of the ARV camera to help the driver park their car in the reverse direction to solve the limited blind spot issue. At the end of the research, the effect of glare during daylight using camera technology for Advance Rear Visualization can be identified.

4.0 FUTURE WORK

The second phase of this study will be continued by analyzing the factors which give a significant impact to the driving performance which using camera-based technology for Advanced Rear Visualization (ARV). All the factors which influence the driver's view while using the camera will be considered for road test assessment. Route selection for this assessment will be from Ayer Keroh Toll to Cameron Highland Toll.

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