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Does a Circular Convex Blind Spot Mirror Increase the Driver's Field of View?

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Abstract – *Many road traffic accidents occur in Malaysia every year. Road fatalities has been one of the main causes of death in Malaysia. More than half of these fatalities were among motorcyclists. An accident between a passenger car and a motorcycle might be caused by the blind spot of the car driver, in which the driver was unable to notice an incoming motorcycle from behind or the side. Blind spot monitoring system has been developed using recent technology. However, this active blind spot monitoring system is expensive and only available in luxury cars. Another type of blind spot monitoring is known as passive blind spot monitoring by means of a convex mirror. Many convex blind mirrors are being sold nationwide that come in various shapes. Nonetheless, the effectiveness of this convex mirror has never been quantified. This study aims to experimentally quantify the effectiveness of this mirror by using a spotlight, projecting a direct light to the side mirror. A circular convex mirror was placed at four different locations, one at a time. It is hypothesised that the reflection of the light on a flat, white wall indicates the driver's field of view. The area of the reflection was calculated using image processing, and the values of all five cases were compared. It was found that the circular convex mirror increases the field of view by up to 211 %. The position of the convex mirror plays an important role to ensure a maximum field of view is achieved. This paper has demonstrated that the usage of a circular convex mirror does increase the driver's field of view.*

Keywords: Blind spot, field of view, convex mirror

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1.0 INTRODUCTION

Road traffic accidents have been the fourth cause of death in Malaysia in 2018, at 3.7 % (DOSM, 2019). Although the rate has slightly reduced by about 0.9 % from 2017, it is still a problem that warrants attention from the government and policymakers. Malaysia has recorded a yearly average of 6,350 fatalities due to road traffic accidents each year (Radzuan et al., 2019). The average value has not been changed much for the past 20 years, with a yearly difference of less than 10 %. This is an alarming situation and needs to be given a lot of attention.

Motorcycle is one of the popular vehicles on Malaysian roads. In 2017, the number of registered motorcycles in Malaysia accounts for 45.84 % (more than 13 million) of the total number of registered vehicles (JKJR, 2019). In most of the states in Malaysia, the number of registered motorcycles is larger than that of passenger cars. A large number of motorcycles on the road have resulted in the high number of accidents involving motorcyclists. It has been reported that 60 % of the road fatalities recorded in Malaysia were among motorcyclists (Hamzah et al., 2018).

Blind spot is one of the contributing factors to the accidents between a passenger car and a motorcycle. The inability of the driver to notice an incoming motorcycle from behind, or from the side has posed a great threat to the motorcyclists (Abu Kassim et al., 2019). Many efforts were made to tackle the blind spot issues. Active blind spot detection using high-end technology has started to be implemented in recent passenger cars (Md Isa et al., 2015). This is achieved utilizing electromagnetic waves or a camera mounted on the side of the car. Nonetheless, this technology could be expensive and is only made available on luxury cars.

In addition to the active blind spot detection, an alternative way is known as passive blind spot detection. This method is not using high-end technology, but instead, using a convex mirror installed on the side mirror. These small blind spot mirrors are currently being sold in many stores nationwide, with an extremely cheap price in comparison to the active blind spot monitoring system. Nonetheless, there has been no study conducted to scientifically measure the effectiveness of this mirror.

This study proposes a novel method to measure the effectiveness of this small blind spot mirror. Our aim is to quantify by how much this convex mirror could increase the driver's field of view, if it really is. Does this cheap mirror really effective and could increase the field of view of the driver? This paper seeks to answer this question through an experimental work and a little bit of image processing. The following section details the experimental procedure as well as the post-processing of the images captured in the experiment. Ultimately, the analysis will show how many percent the use of the convex mirror installed on the side mirror on the driver's side would increase the field of view.

2.0 METHODOLOGY

This section shall discuss the experimental procedure and image processing done in this study.

2.1 Experimental Procedure

This study aims to measure the driver's field of view through the side mirror with and without using the circular convex blind spot mirror. We proposed a new method of measuring the field of view using a spotlight. A spotlight (model Aputure Light Storm LS - mini20c) was used to project direct light to the side mirror (the driver's side mirror of the first generation Perodua Myvi). Both the spotlight and the side mirror were mounted on an individual pole as shown in Figure 1.

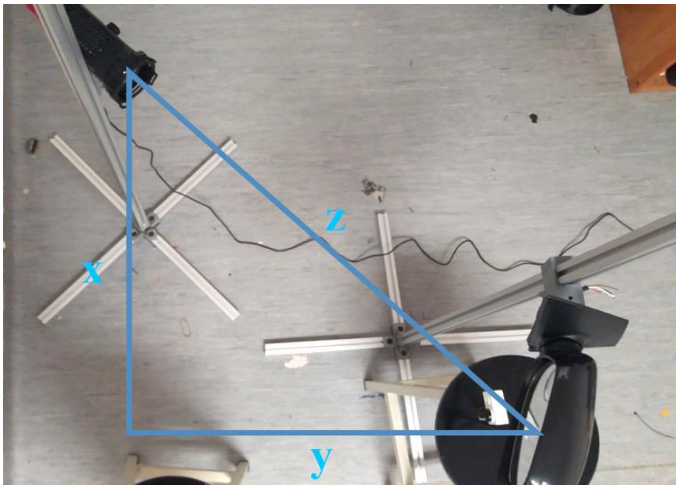

Figure 1: Experimental setup

The side mirror was fixed on the pole such that its height from the ground is identical to the height of an actual side mirror of the first generation Perodua Myvi as measured from the ground. The distance of the spot light from the side mirror, which is indicated by the letter 'Z' in Figure 1, is the distance from the driver's eye to the side mirror, which was measured using an actual first-generation Perodua Myvi. The projection of the light on the side mirror will result in a reflection on a flat, white wall as shown in Figure 2.

(a) (b)

Figure 2: (a) Reflection of the side mirror on the wall; (b) An example of the reflection

A digital camera was used to capture the reflection. Five images of five different cases were captured: (1) without a circular convex mirror; (2) circular convex mirror placed on the bottom right corner; (3) circular convex mirror placed on the top right corner; (4) circular convex mirror placed on bottom left corner; and (5) circular convex mirror placed on the top

left corner of the side mirror, as shown in Figure 3. The recorded images were traced in Adobe Photoshop before they were imported into MATLAB to calculate the area of the reflection. The subsequent subsection explains the image processing technique used to obtain the area.

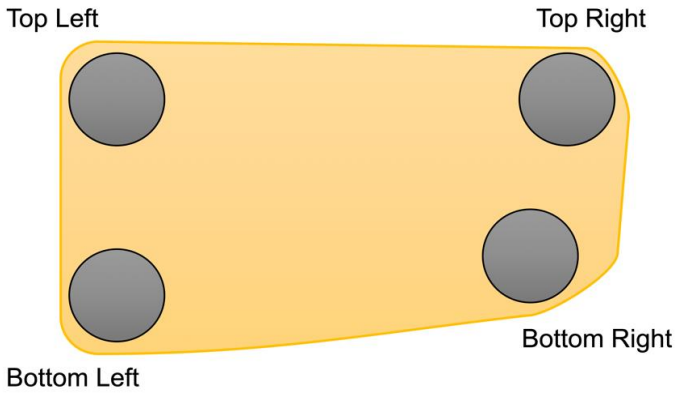

Figure 3: Position of the circular convex mirror on the side mirror

2.2 Image Processing

Once the images were traced in Adobe Photoshop, they were loaded in MATLAB. The global threshold was calculated from the imported grayscale using Otsu's method. Then, the greyscale image was converted to a binary image based on the previously calculated threshold.

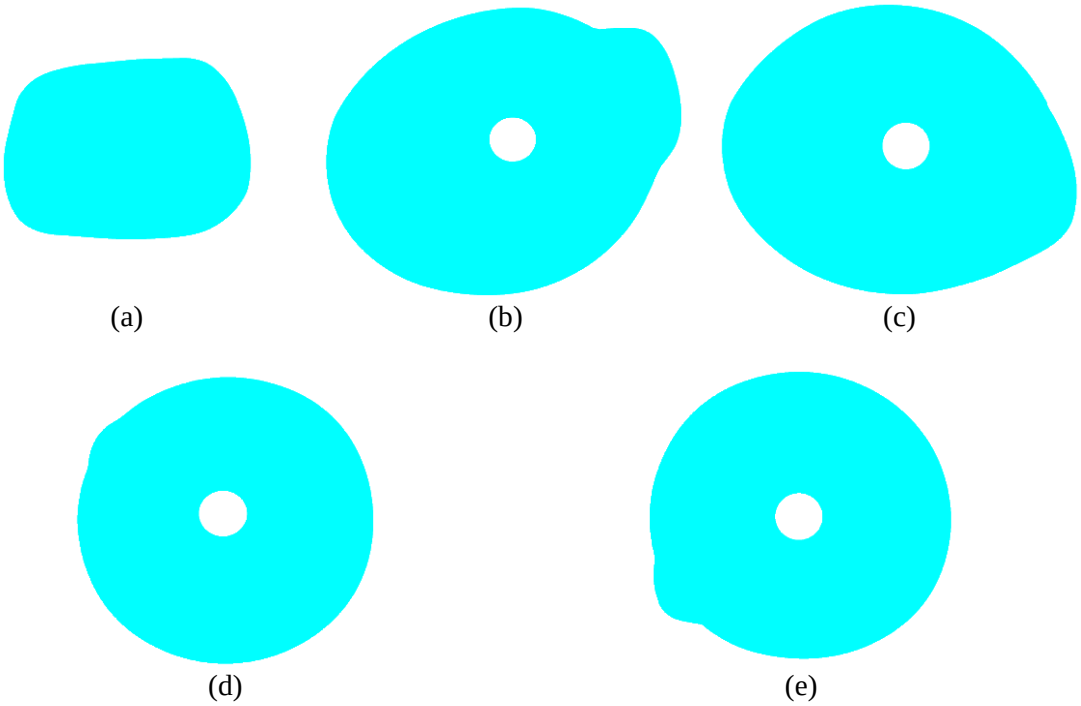

Figure 4: Processed images of five positions of the circular convex mirror: (a) without; (b) bottom left; (c) top left; (d) bottom right; and (e) top right

This was achieved by replacing all pixels in the input image with luminance greater than the calculated threshold with white colour, and replacing all other pixels with black colour. Figure 4 shows the processed images of the five cases as mentioned in the previous subsection. Once the image was converted to the binary that consists of only two colours, the area of the image was measured by requesting the properties of the region. This returns the area of the reflection region in terms of pixels.

3.0 RESULTS AND DISCUSSION

Figure 5 depicts the comparison between the area of the reflection of the aforementioned five cases. It is hypothesised that the reflection corresponds to the driver's field of view. It is apparent that the installation of the circular convex mirror on the side mirror increases the area of the reflection from 162 to 211 %.

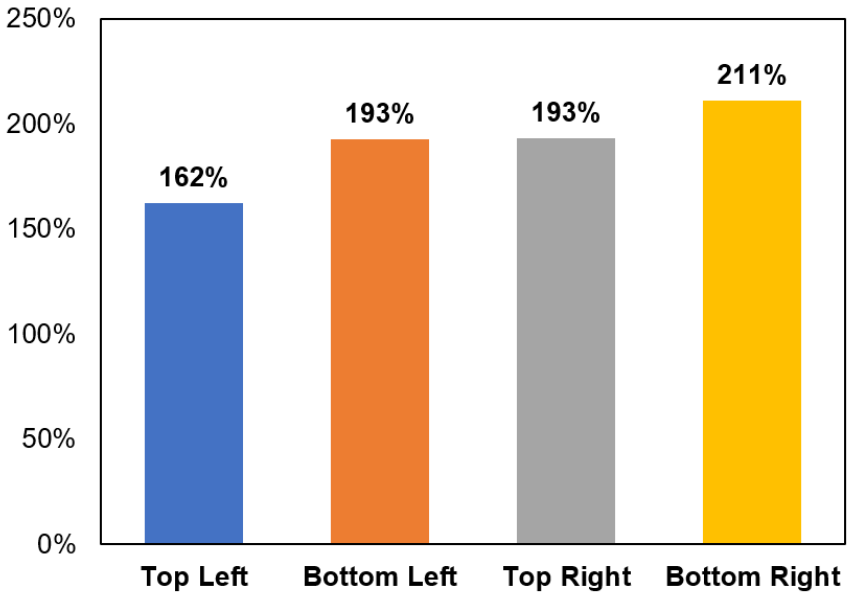

Figure 5: The increase of the reflection area based on the position of the circular convex mirror, compared to that of without using the mirror

In general, the use of a circular convex mirror does increase the field of view of the driver by more than double. The position of the mirror is crucial to obtain the maximum field of view possible. From the experiment, a circular convex mirror placed on the bottom right of the side mirror was found to increase the driver's field of view up to 211 %. This is an increment of almost three times.

As mentioned earlier, the aim of this study is to quantify whether the use of a circular convex mirror increases the driver's field of view. From the results obtained, we have answered this question. The installation of the circular convex mirror does indeed increase the driver's field of view significantly. Nonetheless, this study has a limitation. That is, the method uses to quantify the driver's field of view is novel, hence it has never been validated. However, we believe that according to the law of reflection, the reflected image indicates the incident ray, hence suggests that it is the image that the driver sees in the side mirror.

4.0 CONCLUSION

An experiment was conducted to measure the effectiveness of using a small circular convex mirror installed on the side mirror in terms of the field of view of a driver. A novel method utilising a spotlight projecting direct light on the mirror was used. The reflection of the projected light on a white flat wall was captured using a digital camera. Image processing was done to the captured image to obtain the area of the reflection. Five cases were studied, that is without using the convex mirror in addition to the mirror being placed at four corners of the side mirror. The analysis shows that the use of a convex mirror could increase the driver's field of view by up to 211%. The position of the convex mirror is also important to obtain the optimal field of view. Our future work is to validate this measurement method against published work. In general, it is advised to install a circular convex mirror on the side mirror to increase the driver's field of view to improve visibility, thus reduce potential accidents with motorcyclists.

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