Determination of blind spot zone for motorcycles

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Abstract. The problem of the blind spot zone (BSZ) for motorcycles is common, as it causes many accidents that occur between motorcycles and cars, or motorcycles with other vehicles. The problem of BSZ is occurring for many reasons, such as if the motorcyclist wants to change the lane or manoeuvre or turn without realizing the presence of other vehicle which may cause a terrible collision and leads to casualties, either because of darkness, the full dependence on side mirrors that give a limited scope of vision, or due to a malfunction in the front lights of the car that prevented the motorcyclists from recognizing it. However there were limited research on identification of BSZ for motorcycle, even though most vehicle accidents in Malaysia involved motorcycles. This paper discusses the initial works on the identification of BSZ for motorcycles. Three types of motorcycles were used to determine the BSZ using grid-based technique. From the data collected, the BSZ was identified for the motorcycles.

1. Introduction

In the late 1800s, the first motorcycle has been taken to the street by inventor Sylvester Roper in America [1], and it was only a few years before it became famous all around the world. The motorcycles were competing with cars in terms of popularity because of its fuel economy and relatively cheap price compared to the car, and ease of driving in narrow and rugged roads. However, motorcycle accidents are much more risk than car accidents as the motorcyclist is not surrounded by any structure. Unlike the car driver, the motorcyclist is expose to physical injuries at a very high rate as the motorcyclist only depends on the balance during riding. Globally, 23 % of accidents deaths are motorcycle riders [2], and more than 24 % of motorcycle accidents were caused by maneuvers or lane changes [3]. This percentage shows the motorcyclist was unable to spot any car around him. Thus, there is a need for identifying the blind spot zone for motorcycles to study the risk and further to develop the crash prevention system for the motorcycles.

Most researchers had used ultrasonic sensor [4-6] and camera [7] for detecting other vehicles around the motorcycles. Nazrul Islam et al. [4] had invented a blind spot detection system for cars based on ultrasonic sensors and microcontroller to calculate the distance between the motorcycle and a vehicle in a blind spot. The sensor data is then sent to the application by Bluetooth technology. After receiving and analyzing the data, the driver is alerted by the application if necessary. Later, Yaashwanth et al. [5] had developed a detection system uses Arduino and ultrasonic to prevent blind
spot accidents for motorcycles. When a sensor detects a vehicle in blind zone, it will send signals to the microcontroller, and then the microcontroller will receive and analyze the signals, and display it on the LCD to alert the driver if necessary. They called the system as GUARD and successfully tested the system at the stationary bike. Then Pineda [8] had focused on solving the problem of detecting the blind spot independently of the lean angle of the motorcycle. This system includes several parts that have contributed to solving this problem such as an accelerometer, a gyroscope, and a detection device for detecting the presence of a vehicle. For this system, the accelerometer detects a gravity force vector, then the gyroscope detects the position of the motorcycle relative to the gravity force vector to calculate the lean angle of the motorcycle. After that the detection device is configured to keep the position of the motorcycle relative to the gravity force vector exactly same. Thus, the system can detect the vehicles in blind spot zone accurately regardless the lean of the motorcycle.

In 2012, a group of researchers were developed a system to detect the vehicles in blind spot zone for motorcycles by using a single camera in the visible spectrum that has been designed to detect a vehicles in both daytime and nighttime conditions, during daytime vehicle detection is carried out using optical flow features and Support Vector Machine-based (SVM) classification, and during night time vehicle detection is based on head lights detection. This system alerts the driver if the there is any vehicle in his blind spot area, this system also provides information about position and type of vehicle to the driver [7].

Therefore, the blind spot problem is a main reason of accidents between motorcycles and other vehicles. However, sometimes the accident happens because of the car driver does not see the motorcyclist around him, or realises the motorcyclist only at the last moment [8]. Thus, the important point is to identify the blind spot zone for the motorcycles and then this information can be used to develop the system for detecting and preventing other vehicles in blind spot zone. This paper proposes a method for identifying the blind spot zone for motorcycles.

2. Experiment Setup

2.1. Grid-based technique

Blind spot zone for motorcycles was determined by using grid-based technique [9,10] as shown in Figure 1. The shaded area indicates the area of blind spot and $\theta$ is angle of blind spot. Each grid was set to 500 mm $\times$ 500 mm. The area covered is 2000 mm $\times$ 4500 mm for each side of the motorcycle. The motorcycle was placed in the middle of the grid and data collection by manually observation from the motorcyclist.

![Figure 1: Grid-based technique for BSZ](image_url)

Each data was recorded for each grid based on area and angle for left and right side of the motorcycle. Various heights of the motorcyclist and types of motorcycles were used for data collection.
2.2. Experimental works

The experimental works were conducted on three motorcycles as shown in Figure 2. The motorcycle were selected based on engine capacity and types of motorcycle; which are underbone (110cc and 115cc) and roadster (200cc). There were eight motorcyclists volunteered for data collection and the height of the motorcyclists were ranging from 172 cm to 189 cm.

![Data collection for BSZ](image1)

**Figure 2:** Data collection for BSZ

The experiment began by adjusting the motorcycle to the middle of the grid and adjusting the side mirror. Then the data was collected by observing the present of a person on grid-by-grid using the side mirror. Each grid was marked if motorcyclist can see the person or not.

3. Result and Discussion

The data collected were the plotted as in Figure 3. From the results, it was observed that the angle of BSZ is linearly decrease with the increment of motorcyclist height. In contrast to angle, the area of BSZ is linearly increase with the increment of motorcyclist height. Furthermore, it was observed that the left and right side had the identical results for angle and area. This is because of the location of the motorcyclist, which is in the middle of the motorcycle. The results for BSZ of motorcycles are slightly different from the BSZ for the passenger car, which the car had different results for left and right side [9].

![Graphs for angle and area](image2)

**Figure 3:** Results for various height of motorcyclists for (a) angle of the BSZ and (b) area of BSZ.
The average blind spot angle for the left and right side of the motorcycle were 45.3° and the average blind spot area for the left and right side of the motorcycle were 2.4 m². The identified BSZ for motorcycle is depicted in Figure 4.

Figure 4: Blind spot zones for motorcycle

4. Conclusion

The problem of the blind spot was one of the reasons for many accidents involving motorcycles that resulted a large number of deaths. Many researchers tried to solve this problem by developing systems that can prevent the impact of the blind spot area or reduce the probability of collision and accidents that happen because of it. In this paper, the blind spot zone for motorcycles was established as an initial work before developing the detection and prevention system for blind spot. From the results, the blind spot area for motorcycle was identified for further reference. It shows that the blind spot zone for both sides are equal for angle and area, respectively. Furthermore, the relationship between the blind spot angle and area with the height of motorcyclists can be shown in linear relationship.

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