NAVHELM: Reducing Distractions, Increase Focus and Responsiveness

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NAVHELM: Reducing Distractions, Increase Focus and Responsiveness

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Abstract

Increased number of motorcycles on the road cause a high number of accidents which are primarily due to the usage of mobile phone while riding. Motorcyclists use mobile phones mostly to see navigation instructions, which involve their head movement that leads to distraction and as a result, it may cause accidents. The objective of this paper is to present the development of a helmet with integrated navigation (i.e., NAVHELM) and present evidence that demonstrates how it reduces riders' distraction and increases focus and responsiveness. NAVHELM utilizes Node MCU ESP8266, an Internet of Things (IoT) platform as the microcontroller that receive navigational data from navigator mobile application and data are displayed on the helmet head-up display. Two food delivery riders have tested NAVHELM. The outcome shows that the use of NAVHELM lessens the rider interruption and increased focus on the street while getting response data through display and audio navigation. The rating given by the riders indicated that having NAVHELM is an added advantage. The use of NAVHELM kept their attention on the road, increase focus and allowing navigation through the head-up display. One of the most significant advantages of this innovation is the possibility of reducing the number of accidents among food delivery riders.

Keywords: *mobile application, voice recognition, Internet of Things (IoT), navigation system*

1. Introduction

In developing nations, motorcycles have become popular and as the most common mode of transport in many countries including Vietnam, Malaysia, Indonesia, and Thailand. One of the reasons motorcycles are categorized as "common" in these nations is because they are comparatively cheap and use less fuel, which makes it affordable to everyone. Another factor of the choosing motorcycle as a medium to commute is due to traffic condition especially in city whereby the road is always congested and having motorcycle can make the journey to one destination shorter [1] . As the number of the motorcycle rider is expanding, the number of motorcycle accidents and related fatal injuries are also increasing [2]. Accidents happen as a result of many reasons and not just caused by a single solitary reason. Fatalities and road injuries are a growing concern in

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Malaysia, with more than 6000 killed and over 25,000 recorded injuries in the past five years [3]. In 2013, Malaysia was ranked second-highest number of motorcycles per 1000 populations with the number of 332 motorcycles behind Vietnam in which the highest with 358 motorcycles per 1000 population [3]. When there is a high number of motorcycles on the road the number of accidents involving motorcycles are affected [2]. According to [4], the top cause of motorcycle collision fatalities in Malaysia is head damage resulting from not wearing a helmet. [2] also stated that bike helmets were able to decrease the risk of head injury by up to 72 percent. In Malaysia, head injuries were engaged in 62.9 percent of all reported injuries resulting in death among motorcyclists. Therefore, Malaysia has put obligation that every motorcycle rider needs to wear a helmet which can protect the head by 70% [5].

One of the factors of motorcycle collision fatalities in Malaysia is due to distractions that occur while riding [3]. Distraction happens when rider's attention is voluntarily or involuntarily diverted from the road by a case or object to the extent that the riding is no longer appropriately or securely performed [6]. [7] stated that road distraction can be categorized into four categories mainly the usage of cellphones, involvement other passengers, in-vehicle activities and cognitive. Previous research that investigates motorcyclists distractions caused by using cellphone with navigation systems has found that it takes up to 9 minutes to enter information on the phone involving about 10-12 views manually and therefore, often leads to inattentiveness [8].

Recently, several navigation systems have been introduced for many types of vehicles. On the opposite hand, the navigation system for motorcycle riders has not been widely introduced [9]. This shows that current navigation systems for motorcycles are presently inadequate. Navigation systems have become a popular and widespread user interface in vehicles over the past decade. Over the past few years, their volatility and sophistication have increased in number. Its benefits address possible disruptive consequences that decrease the likelihood of an accident. Up to 10% of all accidents are known to cause by distractions [8]. Previous research is rather heterogeneous about distractions caused by navigation systems. The mode of use seems to play an important role: manual driving data entry takes up to 9 minutes and leads to more distraction than mobile phone talk or radio turning [10]. Just selecting a predefined destination requires 10-12 views and often leads to inattentiveness. [10] have identified three distraction-reducing aspects: spoken rather than manual data entry, auditory rather than visual direction, and step-by-step rather than general instructions.

Recent research has suggested the idea of providing data near to where the motorcyclist is looking so that the rider can get information faster than looking at the motorcycle mounted smartphone navigation. By using head-up display (HUD) technology [11] or head-mounted display [12], the principle of showing navigation data for motorcycle riders is considered to be competent. In any case, the display of navigation data when driving is generally known to distract the driver, where distraction is also widely known as one of the leading causes of accidents for any type of vehicle [8]. Hence, displaying navigation information shall be properly configured to decrease the risk. A data from previous studies of [9] have shown that the perspective of the motorcycle rider moved vertically from −20 to 5. Estimating the eye height of the rider (1.55 m) and determining the closest distance from the road (4.26 m), the focal distance of the navigation information was configured to be the distance marginally closer to the road surface (4 m) considering aspects of display at an ideal distance.

Furthermore, significant automotive navigation was reviewed; vehicle navigation systems are becoming omnipresent. By adding new features to their systems, vendors continuously aim to improve route navigations [13]. The driving function is defined as an information-decision-action operation, where information obtained in-transit is used in a continuous feedback system with information and knowledge in-storage to make decisions and carry out actions. Drivers gather data from sources inside and outside the car and process it to formulate choices. In some situations, mission expectations can be so simple for riders to get bored and tired and show less vigilance. There are situations, on the other hand, where the task is complex and requires more focus. Too many information sources will compete for the driver's attention and the need to perform more subtasks at the same time. Situations where riders need a custom data store, including a tour schedule, and where they need it and in a way that best suits their conditions, the necessary data must be provided [13]. Drivers need navigation information due to the nature of the driving role and its navigation aspect, the inability of traditional navigation aids to satisfy both pre- and in-transit information needs, the likelihood of failure inherent in the current situation, and the need for a navigator to assist the driver [14]. Eventually, drivers need navigation information to create an acceptable tour schedule.

For driver's travel purposes and desires, navigation needs data on the best path. Numerically, the navigation system is based on the shortest path problem in graph theory, which looks at how to differentiate between two points in a large network the route that best fits certain requirements (shortest, least expensive, quickest) [15]. A navigation system is part of automotive controls or an add-on used by a third party to find direction in an automobile. It uses a satellite navigation system regularly to obtain its position data, which is then matched to a location position. Routing can be determined using the registered route at the point where directions are needed. On the fly, traffic information can be used whenever applicable to change the route.

Nowadays, most people own a smartphone and people are getting navigation using it, including motorcycle riders. However, a navigation application that is not designed for motorcyclists on the road could be harmful. This issue relates to the motorcycle rider's head and viewpoint movements. While most car drivers enjoy driving cars while navigating through their smartphone, motorcycle riders are having trouble as it is inconvenient to look at the smartphone or put it anywhere on the motorcycle. This shows the lack of choices of visual navigation for motorcycle riders. Conventional ways of these motorcycle rider getting navigation are by mounting their phone to the handle of the motorcycle. Hence, it increases the risk of accidents as the phone is located too far from the biker, which distracts their attention on the road while focusing on maps.

In brief, there is a need for efficient navigation systems that should deliver two important features: (1) gives the best ideal route, and (2) should be safe and not distracting users. The first feature should be efficiently giving the best possible path. When some unwanted condition causes drivers to abandon their ideal route, the navigation systems should be able to recover and suggest alternative plans. While delivering the ideal routing is important, this study aims to present the details of building a safe navigation system for motorcyclists (particularly food delivery riders) that could retain their attentiveness, distraction and increases focus as well as responsiveness on the road. NAVHELM is a helmet with an integrated navigation system using head-up display technology and it is designed based on requirements and concerns gathered from food delivery riders. Two food delivery riders tested the complete prototype on the road. This paper presents the test findings which were conducted to ensure that NAVHELM could alleviate road accidents that happened due to lack of attention.

2. Methodology

The methodology is divided into several stages. Stages include requirement planning, design and development, and testing which follow the software development life cycle (SDLC). Before the development phase started, requirement gathering was conducted to ensure the feasibility of the research is met and it was crucial in understanding the problems and challenges. The summary of these requirement gatherings are presented below:

2.1. Requirement Gathering

Interview sessions were conducted with two riders to understand the real problems that food delivery riders are facing when using the traditional way of navigating. The two interviewees are riders from Mat Runner Service Delivery. The delivery service company is located in a town known as Seri Iskandar, Perak in Malaysia. Both riders are male and aged 22 years old. The interviews were conducted with every interviewee at a place that is convenient for them. They brought their motorcycle to demonstrate how navigation was performed on the phone while riding on the road.

Next, a survey was distributed to motorcyclists that use any kind of navigation system on the road. A total of 53 respondents have replied to the survey and gave opinions concerning the current traditional navigation approach and its effect. These surveys are important to include more crucial features to NAVHELM. Similar research and products were also explored to expand the requirement and functionalities of NAVHELM. A comparative study was made and important functionalities required for NAVHELM were taken into account.

2.2. System Design and Prototype Development

The system architecture design is then developed, as shown in figure 1. It has the details for displaying navigation information with the implementation of a head-up display (HUD) concept. Node MCU ESP8266 of Internet of Things (IoT) platform is used as the microcontroller and OLED display is used for displaying navigation route, path and instructions. Referring to figure 1, a mobile app was developed as part of the navigation system. The mobile navigation app has voice recognition functions and is connected to a microcontroller that acts as a platform for information transfer to display suggested ideal route in the OLED display of NAVHELM. The information gained from the requirement gathering was then analyzed and been converted to prototype design, as shown in figure 2 and 3. This is to ensure that NAVHELM has all the features that can allow riders to view the navigation route with less distraction and able to retain focus on the road.

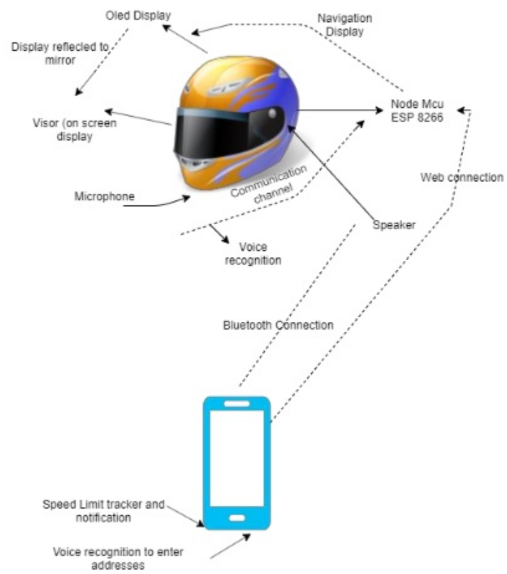

Figure 1. System architecture

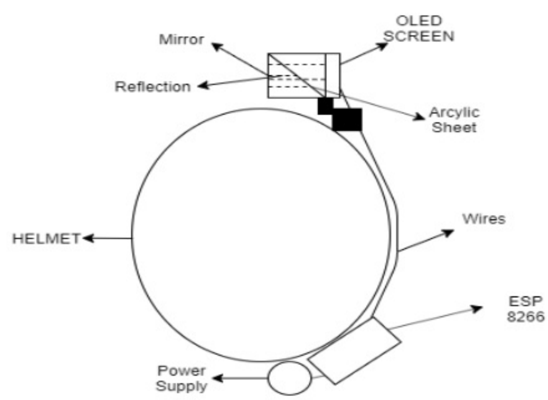

Figure 2. NAVHELM prototype design (top view)

Figure 3. NAVHELM prototype (side view)

2.4. Testing

Finally, testing stages are crucial to check and test the developed prototype (i.e., the navigation helmet and mobile application) functionalities. Following the functionality test, usability testing with users was conducted. The functionality tests were carried out to ensure the navigation helmet and mobile application functions are performing as intended. This is followed by a usability test that focuses on the rider's ability to navigate with less distraction and maintain focus on the road. Observations were conducted and have been conducted in an unimpeded way. Responses from the two food delivery riders who tested the prototype on roads were captured for improvements. The results from both tests were taken into account and led to a few modifications and rectification of errors.

3. Results and Discussion

In this section, results and findings collected are presented. First, the result of the survey questionnaire that has been distributed during the requirement gathering phase and testing are presented followed by the insights collected from the observations.

A survey was distributed to gain insights on the conventional navigation approach among riders. Figure 4 shows the result of the most used approach for motorcycle navigation. The highest used was a mounting phone on the motorcycle handlebar with a result of 50.9% equivalent to 27 people. From this result, we can observe that there were various approaches that motorcyclists have used in getting navigation, such as by using only audio navigation, integrated motorcycle GPS (external GPS unit) and stopping for some period to check on the phone and then continue the journey. The survey also seeks opinions about distractions due to the chosen navigation approach. As shown in figure 5, 66% of the respondents agreed that they are distracted when riding and navigating. This shows that the majority of motorcycle riders are distracted from the road when navigating routes.

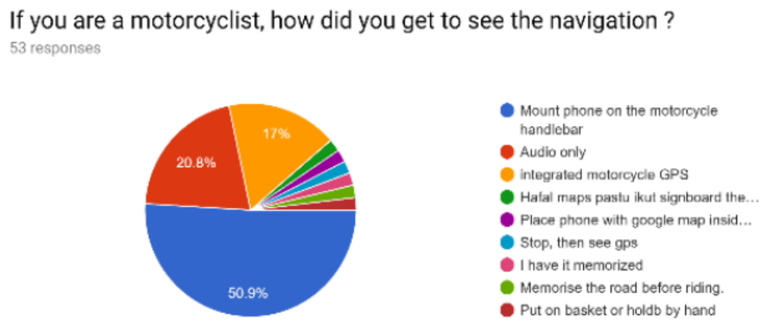

Figure 4. survey results on conventional approach on motorcycle navigation

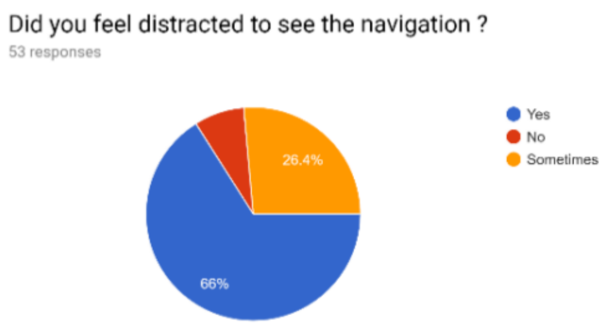

Figure 5. survey results on distraction factors

Two food delivery riders had voluntarily tested NAVHELM. Rating evaluation based on table 1 was made by both riders after completing the testing session to rate their experiences using NAVHELM for navigating. The survey is designed to evaluate the level of experience and have a scale range from 1 to 4. As shown in figure 6, the ratings are given by rider 1 are positively showing NAVHELM assists in reducing distraction and increasing focus and responsiveness. Figure 8 shows the comparative rating between NAVHELM presence and the conventional approach. Rider 1 rated value of 3.8 out of 4 for responsiveness while using the NAVHELM compared to 1.5 with the conventional approach. This means the rider was able to respond better when NAVHELM provided the navigation instructions. He also rated 3.5 compared to 2.4 on the level of focus. This implies that rider 1 could focus better when using NAVHELM. The rider rated 2 compared to 3.7 on level of distraction which means lesser distractions when using NAVHELM. Rider 2 has gone through the same process as rider 1 and figure 7 shows the result of ratings given. The results for responsiveness and focus for rider 2 are in the same pattern, where responsiveness and focus are higher with NAVHELM as compared to the conventional approach. This presents the ability of the rider to respond faster and focuses better on the road with NAVHELM. However, rider 2 rated distraction with value 3 while using NAVHELM which shows a high value. The reason behind this result was that rider 2 felt a little distracted on having the display being shown in front of the visor as he is not used to it. He prefers to depend on audio navigation in getting information.

Table 1. Indicator description for responsiveness, focus and distraction rider's rating value

Rate	1	2	3	4
Responsiveness	Unresponsive	No immediate response	Responsive enough	Very Responsive
Focus	Unable to focus	Partly focus	Focus with road environment	Very focus
Distraction	Undistracted	Not distracted after awhile	Distracted but able to see	Distracted and unable to see

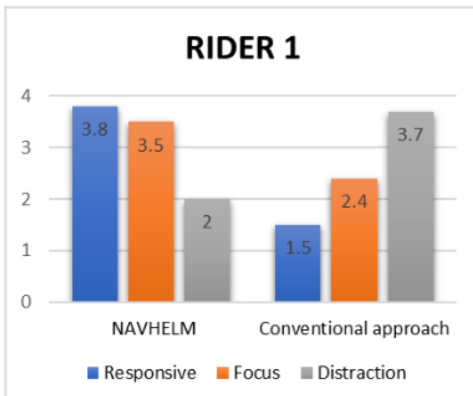

Figure 6. Rider 1 rating value

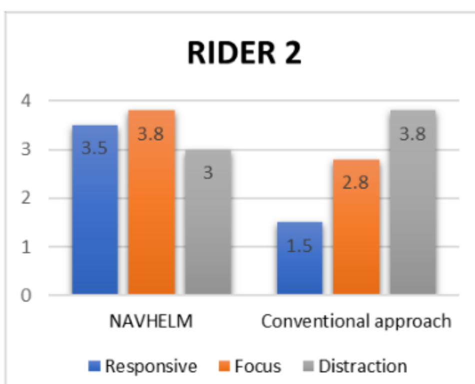

Figure 7. Rider 2 rating value

Observations were conducted during the testing session and have shown that an integrated helmet navigation display brings a positive effect on increasing both riders' focus and responsiveness towards navigation instructions. At the same time, it reduces distractions that motorcyclist has been experiencing during navigation using conventional approaches. During the observation, it appeared that the ability of the riders to focus on the road were significantly higher. It was noted that both riders had less head movement (i.e., moving the head downwards and tilting towards phone navigations) throughout the riding session. When compared to using the conventional method (i.e., phone navigation), riders tend to look at the phone when stopping at every junction to get the navigation instructions. Contrarily, NAVHELM (as shown in figure 8), eliminates the need for riders to check their phone to retrieve navigation instructions. Riders could refer to the navigation route from the HUD display that is placed right in front of them.

Figure 8. The rider with NAVHELM is able to get navigation information without looking down

Figure 9. NAVHELM implement speaker inside the helmet to provide audio navigation

Figure 10. The rider is able to adjust the display placement in front of the visor

It was also observed that both riders have a better response to navigation information as NAVHELM provides audio navigation that is built in the helmet (as shown in figure 9). The probability of the rider missing a turn is significantly reduced as the audio navigation periodically reminded them of how many meters left for a turn to be made. On the other hand, the level of distractions between the two riders was significantly different. Rider 1 was satisfied with the HUD display that is shown in front of the visor and he was able to read the navigation instructions without feeling distracted. Contrarily, during the observation, rider 2 appeared to be distracted by the HUD display. He felt uneasy about having a display in front of the visor. Due to this, customizable placement of display was constructed to solve the issue. The customizable display allows riders to adjust the position of the HUD display to get the best suit for the rider's preferences, as shown in figure 10.

Based on the evidence presented in this section, table 2 summarizes NAVHELM's value propositions which are: reducing riders' distractions and increases focus and responsiveness on the road.

Table 2. Conventional method vs NAVHELM

Conventional Method	NAVHELM
Rider need to look down at the phone to get navigation information	Navigation information is displayed in front of the helmet visor, eliminating the need to move the head
Manual data entry for addresses is needed	Voice recognition feature in the mobile application process speech to translate into addresses and provide voice navigations
Manual data entry for addresses is needed	Voice recognition feature in the mobile application process speech to translate into addresses and provide voice navigations

3. Conclusion

This study has highlighted several associations between crash involvement and risky riding behaviors among motorcyclists, in particular the use of mobile phones for navigation. This study has introduced a new solution for food delivery riders and motorcyclists in getting navigation while riding. This study has also collected evidence that shows integrated navigation display and audio instructions built in a helmet helped in reducing distractions and increases focus and response while on the road. At the same time, NAVHELM facilitates food delivery riders and motorcyclists to get accurate and relevant navigation information through a HUD display and audio navigation. Future directions of this study is to conduct more testing to food delivery riders in a large scale and commercialize NAVHELM than just functioning as prototype. In conclusion, having such technology like NAVHELM provides a convenient solution for navigation, ensuring road safety and abiding road laws. It is hoped that such a solution would increase the possibility of reducing the number of road accidents, particularly among food delivery riders and motorcyclists.

Acknowledgments

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References

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