

# Integrated Steering System Design for Bus Driver Drowsy Behavior Change

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**Abstract.** The paper presents an integrated steering system design for bus drivers' drowsy driving behaviour change. Busses involved in accidents due to drowsy driving is increasing nowadays and those accidents involved a lot of people due to the number of passengers it carries. In order to decrease the rate of accidents for bus driver due to drowsy driving, an integrated steering system that can change their driving behaviour is developed. The developed integrated steering system is then being validated through surveys conducted on drivers with valid driving licence. The survey results have shown that the integrated steering system is a feasible system to the drivers.

## Introduction

The active steering in the current market is an advanced technology that can adjust the angle of the steering wheel electronically. The features of Active Steering include variable steering ratio as well as providing an interface to support vehicle dynamic control system [1]. Besides, this steering aid system is also used to reduce the wind gust effect, wind force disturbances and improve stability while driving on slippery roads [2].

According to director of Road Safety Department (JKJR) Kuala Lumpur, Muhammad Heeza Hassa [3], 70% of the road accidents are caused by driver behaviours, 20% are caused by road conditions and another 10% are caused by vehicle problems. Therefore, changing driver behaviours is the most effective way to decrease the accident rates. The examples of driver behaviours that caused accidents are over speeding, drunk while driving, using mobile phone while driving, drowsy or tired while driving.

## Literature Review

Sleepiness is the condition where the nervous system is inactive, the eye is closing, the postural muscles are relaxed and consciousness practically suspended [4]. When the driver feels drowsy, their sense of alert will decrease and may cause the driver to fall asleep during driving [5]. We can conclude that [5]:-

1. Most of the accidents happened in the afternoon or at night.
2. The accidents involved vehicle running off the roadway, or rear-end and head-on collisions.
3. The accidents happened on higher speed roadway.
4. The accidents involved only the driver as occupant, who is young and male.
5. Accident caused serious injuries

Usually those sleep-related accidents happened during driving because there is no reaction from the driver. So the vehicle will be diverting off the road and hit obstacles [6]. National Sleep Foundation, US carried out a survey for 1361 people from different age groups. From the statistics, it is shown that 52% of the people felt drowsy while driving at least once a month. This showed that drowsy driving problem is very serious.

From the study recently, 80% of the sample recorded drowsy driving on the road. In Norway, 73% of driver will continue to drive although they felt drowsy [7]. From the “Sleep in America” at year 2002 survey, it was found that 51% of the respondents state that they will drive although they felt tired and sleepy. The public believed that drowsy driving is normal because they assumed that they can overcome drowsiness during driving [5].

One of the examples of an active steering is from BMW where it is focused on the steering that can bring precision, agility and comfort to the driver in every driving situation. A planetary gear is being used as the core of the new steering system and a steering column is integrated. It uses an electric motor to change the wheels’ steering angle following the vehicle’s speed [8].

When driving in low speed such as during traffic jam and parking a car, the active steering enables the drivers to handle their vehicle easier as a small turn movement on the steering will trigger the front wheels respond immediately. When driving in high speed (around 120km/h to 140km/h) such as on highway, the active steering enables the drivers to drive in better stability by altering the front wheels to only respond to a bigger turning movement on the steering. This creates more precise turning compared with the current steering systems [9].

### Prototype Design

Fig. 1 shows the conceptual design that will be selected to build the prototype. The system is initiated by detecting irregular steering behavior which is rapid turning movements to the left and right in this case. A light sensor is used to sense the light emission diode signal. When the steering is moving left and right, the signal from the light emission diode to the light sensor appears to be detectable and undetectable within a time frame. The steering turning left and right rapidly resembles a drowsy driver who cannot hold the steering correctly. When this situation occurs, the system will generate outputs such as vibration and sound alert to aware the driver.

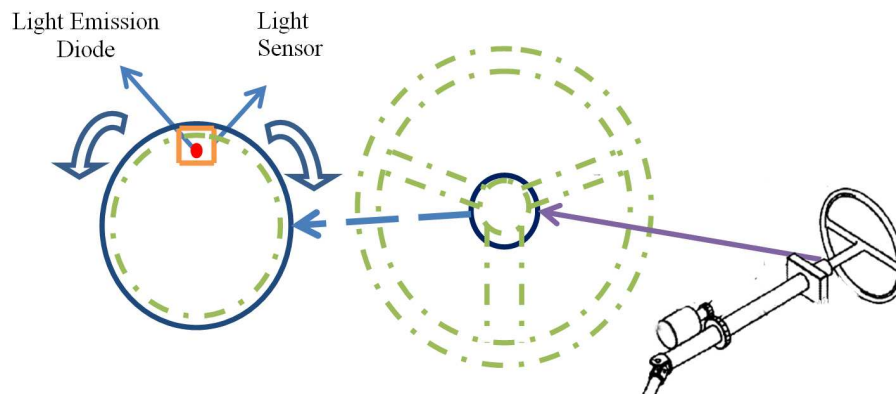


Figure 1. Integrated steering system conceptual design

Fig. 2 shows the prototype which will be used for pre-test survey before building the actual prototype. The purpose of having a pre-test prototype is to validate the feasibility of the conceptual design before proceeding to the next step. The pre-test prototype will be focused on the feasibility of buzzer and vibrator alert. Subsequently, an actual prototype as shown in Fig. 3 will be built to validate the entire idea of integrated steering system. The prototype shown in Fig. 3 is a gaming racing wheel being integrated with light source, light sensors and a microcontroller to enable the racing wheel function as what is described in Fig. 1. The actual prototype will once again be validated through a survey and the results will be presented in the following section.

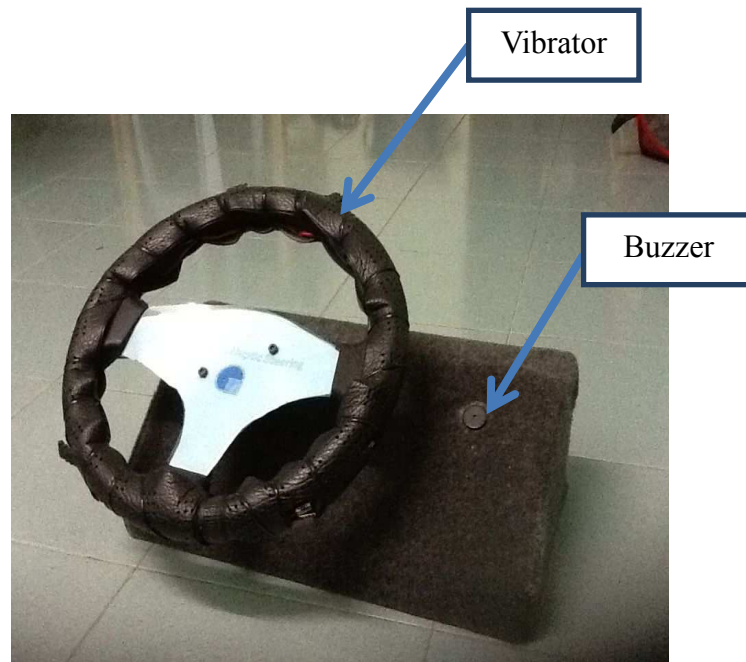


Figure 2. Pre-test prototype



Figure 3. Actual prototype

## Results and Discussions

**Pre-Test Prototype.** The feasibility of this design is being evaluated by conducting a survey among a group of drivers with valid driving licence. There were 25 drivers consist of 64% males and 36% females who took part in the survey. 80% of the participants are inside the age group of 21 to 30 years old and the remaining 20% of the participants are inside the age group of 41 to 50 years old. Most of the participants which is 40% of them fall in the category of having their driving licence more than 6 years but not more than 8 years. As shown in Table 1, 56% of the participants ‘agreed’ that the buzzer can alert whereas 20% of the participants ‘strongly agreed’ that the buzzer can alert. However, it can seen in Table 1 that a comparably big amount of participants felt that the buzzer is annoying. This could be interpreted as one of the indicators that the buzzer managed to alert the drivers as well. On the other hand, 36% of the participants ‘disagreed’ that the vibrator can alert them followed by 56% of the participants ‘disagreed’ that the vibrator is annoying. This could once be interpreted as the vibrator did not alert the participants significantly as compared to the buzzer.

Table 1. Feasibility of buzzer and vibrator alert

Scale Parameters	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
Buzzer can alert	0	0	24	56	20
Buzzer is annoying	4	12	24	24	36
Vibrator can alert	8	36	24	16	16
Vibrator is annoying	24	56	12	8	0

**Actual Prototype.** As shown in Table 2, survey revealed that 50% of the participants felt ‘rather yes’ and 20 % of the participants felt ‘absolutely yes’ for the active steering to be able to alert drivers. None of the participants gave negative feedback regarding the active steering in alerting drivers. 50% of the participants felt ‘neutral’ that the active steering can change driver behavior but at the same time, there is no negative feedback for this criterion as well. Furthermore, there are 40% of the participants who felt ‘rather yes’ that the active steering can change driver behaviour. Lastly, there are a small amount of participants who felt that the active steering needs improvement.

Table 2. Actual prototype evaluation

Scale Parameters	Absolutely No (%)	Rather No (%)	Neutral (%)	Rather Yes (%)	Absolutely Yes (%)
Alert Driver	0	0	30	50	20
Driver Behaviour Change	0	0	50	40	10
Needs Improvement	10	20	30	30	10

## Conclusion

An integrated steering system has been built and validated through surveys. From the survey results shown, it can be concluded that the active steering system idea is feasible and able to fulfill the objective of designing the system to reduce bus accidents.

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