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Advanced Turn Off Signal Alert System

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ABSTRACT

Road traffic accidents continue to pose a critical global challenge, with human error contributing significantly to incident rates, particularly among motorcyclists. One frequently overlooked issue is the failure to deactivate turn signals after maneuvering, which can mislead surrounding road users and increase accident risk. This study addresses the problem through the development of an Advanced Turn Off Signal Alert System (ATSAS) aimed at enhancing rider awareness and reducing signal-related errors. The objective of this research is to design and implement an intelligent, cost-effective alert mechanism capable of notifying riders when turn signals remain active beyond an appropriate duration. The system is developed using an Arduino-based platform integrated with a sensor, vibration motor, and buzzer. The methodology involves system design, circuit simulation, hardware integration, and functional testing. The ATSAS operates through a three-stage alert mechanism activated at 30, 45, and 60 seconds, incorporating progressive vibration intensity and an audible warning at the final stage to ensure effective rider notification. The results demonstrate a high level of effectiveness, with approximately 98% of respondents indicating improved awareness and reduced likelihood of signal misuse. The system successfully enhances rider responsiveness without introducing significant distraction, highlighting its practical applicability in real-world conditions. In conclusion, the ATSAS presents a robust and scalable solution to mitigate human error associated with turn signal usage. Its integration into motorcycle systems has strong potential to advance road safety standards and support the development of smarter, user-centric transportation technologies.

1. Introduction

Road accidents are a serious global issue, causing more than 1.35 million deaths and up to 50 million injuries every year [12]. These alarming statistics highlight the urgent need for effective safety measures, particularly among vulnerable road users such as motorcyclists. In many developing countries, motorcycles are widely used as a primary mode of transportation due to their affordability and convenience. However, this also contributes to higher accident rates involving motorcyclists compared to other types of vehicles.

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Studies have shown that road accidents occur due to multiple factors, including environmental conditions, vehicle performance, and human behaviour. Among these factors, human error remains the dominant contributor to road crashes, accounting for a significant proportion of incidents [7], [13]. Common human errors include lack of attention, poor decision-making, and failure to follow basic road safety practices. One frequently observed issue among motorcyclists is the improper use of turn signals, such as failing to activate or deactivate the signal after completing a turn [1,4].

The failure to turn off a signal can mislead surrounding road users, creating confusion and increasing the risk of accidents, particularly during lane changes and intersection manoeuvres [5]. This behaviour is often associated with rider negligence, distraction, or lack of awareness, and it remains a persistent issue despite ongoing road safety campaigns and enforcement measures.

To address this problem, various approaches have been introduced, including awareness programs and basic mechanical solutions such as automatic signal cancellation systems. However, these solutions are often limited in effectiveness, as they do not actively engage the rider or provide continuous feedback during riding. In addition, most existing systems do not consider user comfort and real-time interaction, which are important aspects in ensuring rider compliance and system usability.

In recent years, the development of intelligent alert systems has gained attention as a potential solution to reduce human error in transportation. These systems aim to improve user response by providing timely feedback through visual, auditory, or haptic signals. Studies in human-machine interaction (HMI) have shown that combining multiple types of feedback can significantly enhance user awareness and response time [8,10,11]. This concept is particularly relevant in motorcycle safety, where riders rely heavily on sensory input to make quick decisions.

Despite these advancements, there is still a lack of practical and cost-effective alert systems specifically designed for motorcyclists, especially in the context of turn signal misuse. Most existing technologies are either too complex, expensive, or not widely implemented in standard motorcycle designs. This indicates a clear research gap in developing a simple, user-friendly, and effective system that can assist riders in maintaining proper signal usage.

Therefore, this study proposes the development of an Advanced Turn Off Signal Alert System (ATSAS) to enhance rider awareness and reduce signal-related human error. The system is designed to provide a multi-level alert mechanism using vibration and sound, ensuring that the rider is notified when the turn signal remains active beyond a reasonable duration. By incorporating principles of usability, cost-effectiveness, and real-time feedback, the proposed system aims to offer a practical solution that can be implemented in real-world conditions.

The objective of this study is to design and implement an intelligent, cost-effective alert mechanism capable of notifying riders when turn signals remain active beyond an appropriate duration. The system focuses on improving rider awareness, enhancing safety, and contributing to the development of smarter motorcycle technologies.

2. Methodology

2.1 Flow Process of ATSAS Development

The development of the Advanced Turn Off Signal Alert System (ATSAS) follows a structured and systematic process, as illustrated in Figure 1.0. This process is designed to ensure that the system is developed efficiently while meeting the required functional and performance criteria. The development process begins with the design of the system circuit using Proteus software. This stage involves simulating the electrical connections and verifying the functionality of each component within a virtual environment. The simulation allows early identification of potential issues, thereby reducing errors during hardware implementation. Following the simulation phase, suitable components and tools are selected based on system requirements such as compatibility, cost-effectiveness, and reliability. The selected components include an Arduino Uno microcontroller, sensor, vibration motor, and buzzer [14]. These components are then integrated into a hardware design, ensuring proper connectivity and efficient system operation.

Next, the programming phase is carried out using Arduino IDE. The control algorithm is developed to manage the timing and activation of the alert system. The coding process includes defining input signals, setting time intervals, and controlling the output devices such as the vibration motor and buzzer. The program is repeatedly tested and refined to ensure accuracy and stability. Any errors detected during testing are corrected through iterative debugging until the system performs as expected. Once the software functionality is verified, the system components are assembled into a complete prototype. This stage involves physical integration of all hardware components, followed by functional testing to ensure that the system operates correctly under real conditions. If the system does not meet the required performance, necessary adjustments and improvements are made. After successful testing and validation, the system proceeds to the final stage, which includes finishing and data analysis. The performance of the system is evaluated based on its ability to detect active turn signals and provide timely alerts to the rider.

In terms of system operation, ATSAS utilizes a multi-level alert mechanism to enhance rider awareness. When the turn signal remains active, the system initiates a vibration alert in three stages based on time duration. The first stage is triggered at 30 seconds, producing a low-intensity vibration as an initial reminder. The second stage occurs at 45 seconds, with a medium-intensity vibration to increase the level of awareness. The final stage is activated at 60 seconds, where a high-intensity vibration is combined with an audible alert using a buzzer to ensure that the rider is fully notified. This gradual alert mechanism is designed to provide continuous feedback without causing sudden distraction to the rider. By increasing the intensity of the alert over time, the system effectively captures the rider’s attention and encourages corrective action. This approach improves usability and enhances safety, particularly in real-world riding conditions where distractions are common [8,10].

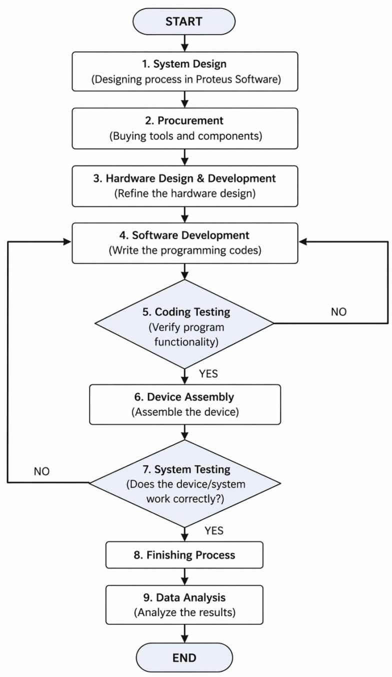


Fig. 1. The flow chart of the project

It is shown that the process to produce advanced turn off signal alert system.

2.2 Project Operation

The ATSAS operates using a programmed control system developed in Arduino IDE. When the turn signal is activated, the system starts with a timer. If the signal remains on, the system triggers alerts in three stages to notify the rider. The first stage is activated after 30 seconds, producing a low-level vibration. The second stage occurs at 45 seconds with a medium-level vibration. The final stage is triggered at 60 seconds, where a high-level vibration is combined with a sound alert to ensure the rider is fully aware of the active signal.

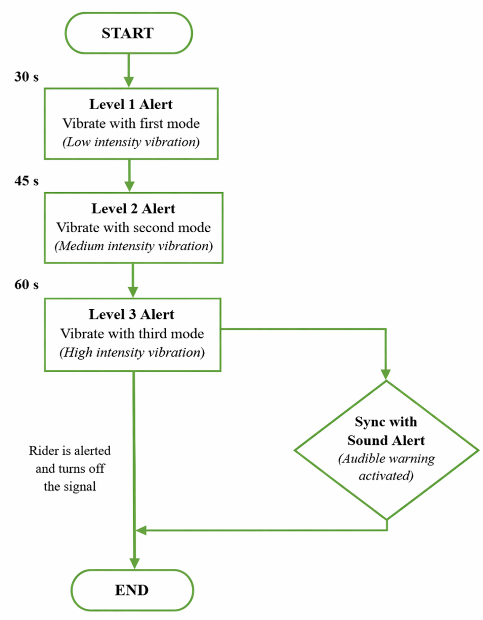


Fig. 3. Illustrates the operation flowchart of the system, showing the sequence of alert activation based on time intervals

The system consists of several main components. A sensor is used to detect the status of the turn signal. The Arduino Uno acts as the main controller, processing input data and determining the activation of alerts based on the preset timing. The vibration motor provides physical feedback to the rider, while the buzzer generates an audible alert. The development of ATSAS involves several key stages:

1. Sensor design – The sensor is designed to be small, low-power, and capable of accurately detecting the signal status.
2. Alert mechanism development – The Arduino system processes data and controls the timing of alerts efficiently.
3. Buzzer selection – The buzzer is selected to ensure it is loud enough to be heard in real riding conditions.
4. System integration – All components are integrated into a single unit suitable for motorcycle installation.
5. System testing – The system is tested to ensure reliability, accuracy, and proper functionality.

Overall, ATSAS is a simple, reliable, and practical system that can be implemented in motorcycles to improve rider awareness and reduce accidents caused by signal-related human error.

2.3 Project Description and Mechanism

The ATSAS is developed based on project objectives to enhance rider awareness and improve road safety. This behavior is closely related to unsafe riding practices and lane-change risks, which have been identified as major contributors to traffic accidents [5]. The system is integrated into the motorcycle signal system and functions as an alert mechanism to notify riders when the turn signal remains active after use.

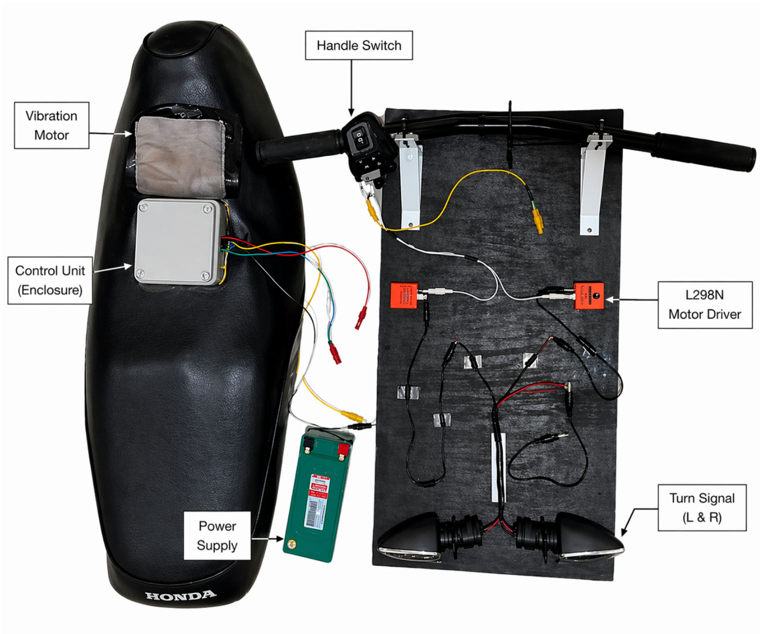


Fig. 3. The overall structure of the ATSAS, including the arrangement of its main components

The system operates based on the programmed logic in Arduino IDE. When the turn signal is activated, the system begins monitoring the duration. If the signal is not turned off, the vibration alert is triggered in stages according to the preset timing. The system design also considers human-machine interaction principles to ensure effective communication between the rider and the alert system [8,9].The final stage includes both vibration and sound alerts to ensure maximum rider awareness.

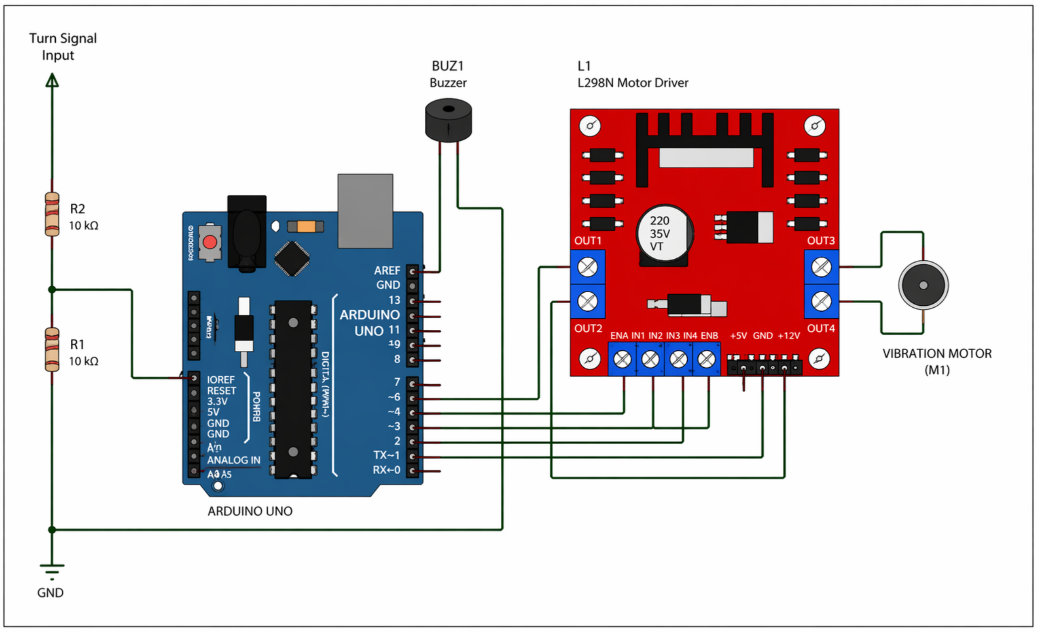


Fig. 4. Presents the circuit diagram, illustrating the connection between the Arduino Uno, sensor, vibration motor, and buzzer

The vibration and sound functions are controlled based on the programmed time settings, as summarized in table 1. The alert times of 30, 45, and 60 seconds are selected based on normal riding conditions, where most turns are completed within a short time. If the signal remains active after 30 seconds, it is likely that the rider has forgotten to turn it off. At 30 seconds, a light vibration is given as a reminder, followed by a stronger vibration at 45 seconds to increase awareness. At 60 seconds, a strong vibration combined with a sound alert is activated to ensure the rider notices it. This gradual alert approach helps avoid sudden disturbance while improving rider awareness, which is commonly applied in safety system design [8,10,11].

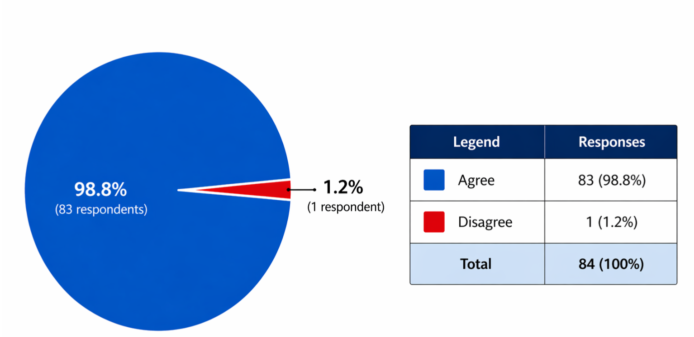
Table 1
ATSAS alert mechanism based on time duration

Time After Signal Activation	Alert Level	Vibration Intensity	Sound Alert
30 seconds	Level 1	Low (Slow)	No
45 seconds	Level 2	Medium	No
60 seconds	Level 3	High	Yes

3. Result

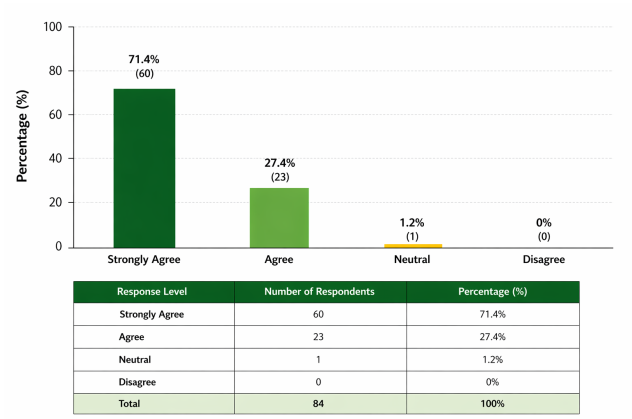
The Advanced Turn Off Signal Alert System (ATSAS) was successfully developed and tested. The system operates as intended by providing a multi-level alert mechanism to notify riders when the turn signal remains active. The combination of vibration and sound alerts helps improve rider awareness in a gradual and controlled manner. Previous studies on driver behaviour also support that improved alert mechanisms can significantly enhance user response and decision-making [9,11].

Based on a survey conducted among 84 respondents, 98.8% agreed that the ATSAS is effective in increasing awareness and has the potential to reduce accidents caused by unattended turn signals. This indicates a high level of user acceptance towards the system. Figure 4 presents the overall respondents' feedback on the effectiveness of ATSAS. The results show that most of the respondents agree with the usefulness of the system, confirming that the alert mechanism is relevant and practical for real-world application. Figure 5 illustrates the level of agreement among respondents regarding awareness improvement. Majority of respondents strongly agree, followed by those who agree, while only a very small number remain neutral. This distribution shows that ATSAS is not only accepted but also perceived as highly effective in improving rider awareness.



Legend	Responses
Agree	83 (98.8%)
Disagree	1 (1.2%)
Total	84 (100%)

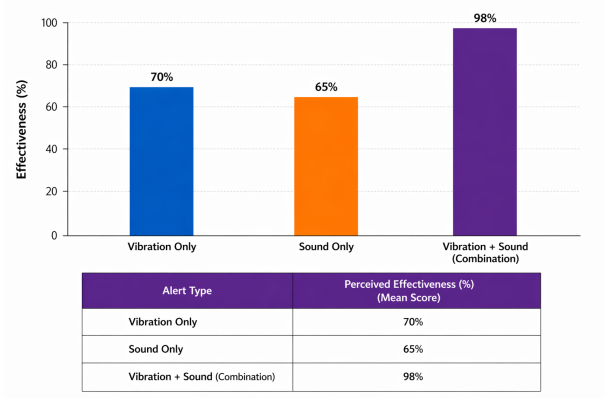
Fig. 5. Diagram shows respondents feedback on the ATSAS survey on effectiveness of this system



Response Level	Number of Respondents	Percentage (%)
Strongly Agree	60	71.4%
Agree	23	27.4%
Neutral	1	1.2%
Disagree	0	0%
Total	84	100%

Fig. 6. Diagram shows respondents feedback on the ATSAS survey on effectiveness of this system

In addition, figure 6 presents the effectiveness of different alert features used in the system. The results indicate that the combination of vibration and sound alerts provides the highest effectiveness compared to vibration-only or sound-only alerts. This supports the design approach of using a multi-level alert mechanism to ensure that the rider receives clear and noticeable feedback.



Alert Type	Perceived Effectiveness (%) (Mean Score)
Vibration Only	70%
Sound Only	65%
Vibration + Sound (Combination)	98%

Fig. 7. Effectiveness of ATSAS alert features

These findings are consistent with previous studies on alert systems, which suggest that combining multiple types of feedback can improve user response and reduce human error. However, it should be noted that the results of this study are based on user perception and a relatively small sample size. During the development process, several technical challenges were encountered, including issues related to missing resistors and unstable DC voltage supply. These issues were addressed by selecting alternative components and applying basic voltage regulation techniques, which improved the stability and performance of the system. These findings are consistent with previous studies, which suggest that combining multiple types of feedback improves user response and reduces human error [8,10]. Similar findings in rider assistance systems also indicate that user perception plays an important role in safety adoption [6].

Overall, the ATSAS demonstrates strong potential as a practical safety solution for motorcyclists. Nevertheless, further improvements are recommended, such as enhancing system durability (e.g., waterproofing), optimizing component placement, and conducting real-world testing with a larger sample size to validate the effectiveness of the system.

4. Conclusions

In conclusion, this study successfully achieved its objective to design and implement an intelligent, cost-effective alert mechanism capable of notifying riders when turn signals remain active beyond an appropriate duration. The developed Advanced Turn Off Signal Alert System (ATSAS) integrates a multi-level alert mechanism at 30, 45, and 60 seconds, using vibration and sound to effectively inform riders. The system demonstrates practicality and usability, particularly with the placement of vibration at the seat area, which provides a more comfortable and less distracting alert compared to conventional approaches. This supports the development of an intelligent alert system that enhances rider awareness without causing sudden disturbance.

Based on the findings, the system is effective in notifying riders and improving awareness of active turn signals. However, it does not completely eliminate accident risks but increases the likelihood of appropriate rider response. Therefore, ATSAS should be considered as a supportive safety feature rather than a complete solution. Overall, the system fulfils its intended function as a simple, cost-effective, and practical alert mechanism suitable for real-world application. With further improvement and large-scale testing, ATSAS has strong potential to contribute to safer motorcycle technology in the future.

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