ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug059

Solar-Assisted Smart Driving System for Sustainable Transportation

Namburi Nireekshana[1]; K Pulla Reddy[2]; A Archana[3]; P Rajini Kanth[4]

[1,2,3,4]Assistant Professor, Department of Electrical and Electronics Engineering,
Methodist College of Engineering and Technology, Hyderabad, India

Publication Date: 2025/08/12

Abstract:

- ***Objective:***

The is an innovative solution constructed to upgrade technology and provide a safety procedure in the world of transportation. The operation addresses the common fault of driver fatigue and incapability in certain unfortunate situations, providing a safe aid to the man behind the wheel. The system enables the usage of multi-powered source to reduce environmental harm combined with its Intelligent Machine learning algorithms which are utilising high advanced sensors to provide safe directional driving and assistance to our fellow people.

- ***Novelty:***

This incentivizing solution to the current predicament in our country aims to reduce accident by huge percent. The goal isn't merely to present an answer to our helpless drivers but to produce a better alternative to "conventional vehicles". By leveraging state-of-the-art technology and intelligent algorithms imbued inside an advanced version of EV, this system aims to redefine futuristic transportation and contribute to a more secure and efficient public transportation environmentally. In short, This Project represents a potential advancement in transportation, security of lives, technology, and offering proactive measures to prevent catastrophes.

- ***Methodology:***

In this project, a Control kit is employed which is responsible for monitoring the driver's behaviour in real-time. Our Driver Alert System (Control kit) uses Arduino Mega, a 16 Channel Relay, a 12V Batteries, 22V Solar Panel, sensors like Ultrasonic along with Laptop and its camera. All together combined and assembled using several jumper wires and program code run in software to perform intended operation. The Project involves combining the python and C++ run code in master-slave fashion for smooth and lag free operation. The application in the real world would be replacing laptop with Raspberry Pi and suitable code and assembling it all with PCB Board. When potential risks are identified by camera which are constantly monitoring the user behind the wheel, the system promptly alerts the driver through feedback by engaging modes. In case of absence of response from driver, Auto-Pilot mode enters action and takes control of steering, driving the vehicle safely. While this operation is active the user cannot tap out system out of the mode unless special command keys that are designed to operate our Solar Bus. The vehicles use powerful Motor systems for robust pickup and performance. Also, it uses renewable energy technology for environ concerns and prepares drive efficient V2G system which allows for charging for vehicle batteries and also for power supply. The Vehicle-to-Grid aids other EV's in reducing time consumption of charging.

- ***Findings:***

Solar Based EV, Auto Pilot Assist, Driver Monitoring, Efficient Energy Usage, Vehicle-Grid application.

Keywords: *Control Kit, Command Modes, Master-Slave, Ultrasonic Sensor.*

How to Cite: Namburi Nireekshana; K Pulla Reddy; A Archana; P Rajini Kanth (2025) Solar-Assisted Smart Driving System for Sustainable Transportation. *International Journal of Innovative Science and Research Technology*, 10(8), 168-173. https://doi.org/10.38124/ijisrt/25aug059

I. INTRODUCTION

The operation of heavy vehicles is a cornerstone of modern logistics and transportation, facilitating the movement of goods across vast distances. However, this critical industry is persistently challenged by the significant safety risks associated with driver incapability. Driver impairment, stemming from a multitude of factors, poses a grave threat to

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug059

the well-being of the drivers themselves, other road users, and the integrity of transported goods. Among the primary contributors to this issue is fatigue, a state of mental and/or physical exhaustion that significantly degrades a driver's cognitive and psychomotor abilities. The demanding schedules, long hours, and often irregular sleep patterns inherent in heavy vehicle operation make drivers particularly susceptible to fatigue. This state of reduced alertness can manifest in various detrimental ways, including decreased reaction time, impaired judgment, diminished vigilance, and even microsleeps – brief, involuntary lapses in consciousness. The consequences of such impairments while operating a multi-ton vehicle can be catastrophic, transforming routine journeys into potential hazards[1]-[2].

While fatigue stands as a prominent cause of driver incapability, it is crucial to recognize that other factors also contribute significantly to this pervasive problem. Medical conditions, both chronic and acute, can lead to sudden incapacitation or gradual impairment of driving abilities. Conditions affecting sensory functions (such as vision), motor skills, and cognitive processes (including attention, memory, and decision-making) can severely compromise a driver's capacity to operate a heavy vehicle safely. The risk of sudden medical events, such as cardiac arrhythmias, seizures, or strokes, presents an immediate and critical danger. Furthermore, the influence of medications and other treatments, as well as temporary conditions like post-surgical recovery or severe illness, can transiently impair a driver's fitness to drive. Even seemingly normal conditions like pregnancy can, in certain circumstances, be associated with symptoms that affect driving safety. Addressing the broad spectrum of potential incapacitating factors, beyond just fatigue, is essential for a holistic approach to enhancing heavy vehicle safety[3]-[4].

The consequences of driver incapability are starkly reflected in the statistics surrounding heavy vehicle accidents. Globally, a significant proportion of road traffic accidents, including those involving severe injuries and fatalities, are attributed to human factors, with driver fatigue and impairment playing a substantial role. Studies have indicated that fatigue alone can be a contributing factor in a considerable percentage of heavy truck crashes, with some estimates suggesting involvement in as many as 10-20% of all such incidents. In fatal collisions involving large trucks, driver fatigue has been identified as a factor in a notable percentage of cases. The sheer size and mass of heavy vehicles amplify the severity of accidents when they occur, leading to a higher likelihood of devastating outcomes for all involved. These accidents not only result in tragic loss of life and serious injuries but also incur significant economic costs through property damage, cargo loss, and disruptions to supply chains. Understanding the statistical prevalence of these accidents and the consistent link to driver incapability underscores the urgent need for effective countermeasures[5].

Delving deeper into the statistics reveals the alarming extent of the problem. In various regions, analyses of crash data consistently highlight driver fatigue as a critical concern. For instance, reports indicate that a notable percentage of fatal crashes involve driver fatigue as a contributing factor. Moreover, the time of day plays a significant role, with fatigue-related crashes being more frequent during the early morning hours and the mid-afternoon, aligning with the body's natural circadian rhythms that promote sleepiness. While efforts to improve road safety and regulate driving hours have shown some progress in reducing fatigue-related accidents over the long term in certain areas, it remains a persistent issue. The data also suggests that other factors, such as the combination of fatigue with alcohol or speeding, exacerbate the risks, leading to more severe crash outcomes. The reality is that despite increased awareness and regulations, driver incapability continues to be a major contributor to heavy vehicle accidents worldwide, demanding innovative solutions to mitigate these risks effectively[6]-[7].

Addressing the critical challenges posed by driver incapability in heavy vehicle operations, this project offers significant safety enhancements through its proactive Driver Alert System. The real-time monitoring of driver behavior, enabled by the integrated "Control kit," allows for the early detection of potential risks associated with impairment. This early detection facilitates timely alerts, providing drivers with crucial feedback to regain focus and prevent accidents. Furthermore, the innovative Auto-Pilot mode offers a vital safety net in situations where a driver fails to respond, autonomously taking control of the vehicle to ensure safe operation[8]-[9]. This autonomous intervention capability has the potential to drastically reduce the incidence of accidents caused by driver incapacitation. The unique override mechanism for the Auto-Pilot mode ensures system integrity while still allowing for driver control under specific, safe conditions. Beyond safety, the system's integration with Solar Bus vehicles and their V2G technology offers the additional benefits of sustainable energy utilization and efficient power management, potentially contributing to a greener transportation infrastructure and reduced charging times for other electric vehicles. By combining proactive driver monitoring with autonomous safety features and sustainable technology, this proposed solution offers a comprehensive approach to improving safety and efficiency in heavy vehicle operations[10].

II. PROPOSED METHOD

Addressing the critical challenges posed by driver incapability in heavy vehicle operations, this project offers significant safety enhancements through its proactive Driver Alert System. The inherent risks associated with the operation of large commercial vehicles, exacerbated by factors such as fatigue and potential medical episodes, necessitate innovative solutions that move beyond traditional safety measures. This project introduces a system focused on the real-time monitoring of driver behavior, enabled by the integrated "Control kit." This continuous assessment of key indicators allows for the early detection of potential risks associated with impairment, providing a crucial window for intervention before a critical situation arises. This early detection facilitates the issuance of timely alerts, providing drivers with crucial feedback that can enable them to regain focus, correct potentially unsafe driving patterns, and

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug059

ultimately prevent accidents. Furthermore, recognizing that not all instances of driver incapability allow for conscious correction, the innovative Auto-Pilot mode offers a vital safety net. In situations where a driver fails to respond to alerts or experiences a sudden incapacitating event, the system is designed to autonomously take control of the vehicle to ensure safe operation and mitigate the potential for a collision. This autonomous intervention capability holds the potential to drastically reduce the incidence of accidents directly caused by driver incapacitation, providing a crucial layer of safety for both the driver and other road users. To ensure system reliability and driver trust, the unique override mechanism for the Auto-Pilot mode ensures system integrity while still allowing for experienced and alert driver control under specific, safe operating conditions. Beyond the immediate safety benefits, the project explores synergies with sustainable transportation initiatives through its integration with Solar Bus vehicles and their V2G technology, offering the additional benefits of sustainable energy utilization and efficient power management, potentially contributing to a greener transportation infrastructure and reduced charging times for other electric vehicles. By combining proactive driver monitoring with autonomous safety features and sustainable technology considerations, this proposed solution offers a comprehensive and forward-thinking approach to significantly improving both the safety and efficiency of heavy vehicle operations, marking a crucial step towards a more secure and sustainable future for the transportation industry.

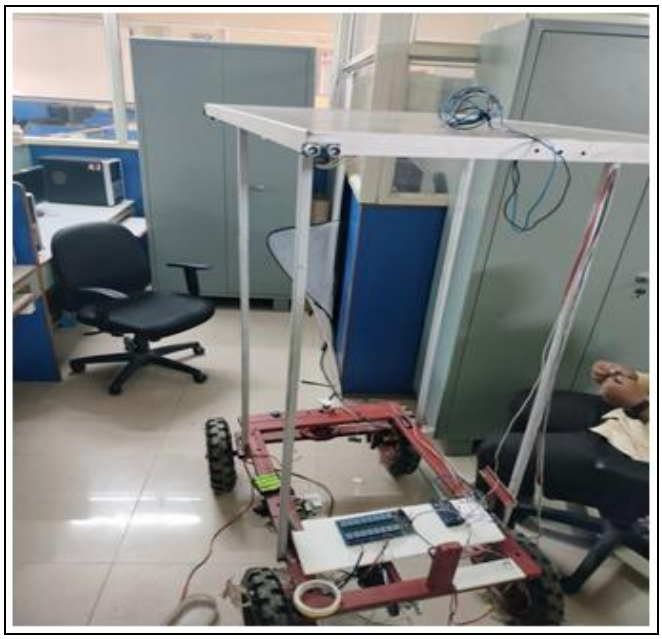

Fig 1 Smart Driving System Configuration

➢ *Components*

- *Arduino Mega*:

The Arduino Mega is a microcontroller board based on the ATmega2560, featuring a large number of digital and analog input/output pins, making it suitable for complex projects requiring extensive connectivity. It provides a platform for prototyping and controlling electronic circuits through programmable code.

Fig 2 Ardiuno

- *16 Channel Relays*:

A 16-channel relay module is an electronically controlled switch that allows a low-power signal to control multiple high-power circuits simultaneously. It provides electrical isolation between the control circuit and the load being switched.

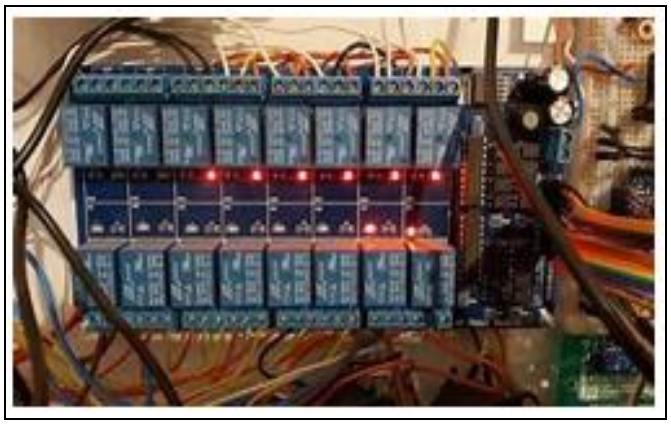

Fig 3 Relays

- *Ultrasonic Sensor*:

An ultrasonic sensor measures distance by emitting ultrasonic sound waves and detecting the time it takes for the echoes to return. It is commonly used for obstacle detection and distance measurement in robotics and automation.

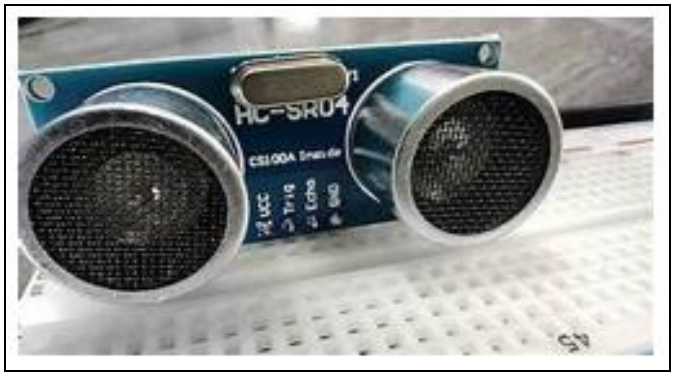

Fig 4 Sensors

- *Breadboard:*

A breadboard is a solderless prototyping tool with interconnected holes that allows for temporary electronic circuit construction and testing. Components can be easily inserted and rearranged without the need for soldering.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug059

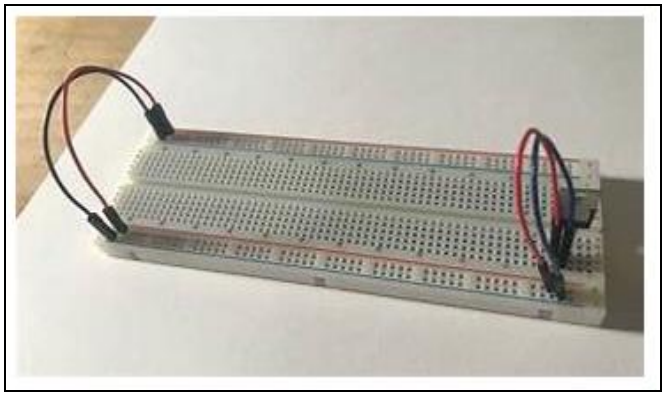

Fig 5 Breadboard

- *Jumper Wires*:

Jumper wires are short electrical wires with connectors at both ends, used to establish temporary connections between components on a breadboard or between different electronic modules. They facilitate easy and flexible circuit wiring during prototyping.

Fig 6 Jumper Wires

- *LED Bulb*:

An LED (Light Emitting Diode) bulb is a semiconductor light source that emits light when current flows through it. It is an energy-efficient and long-lasting alternative to traditional incandescent bulbs.

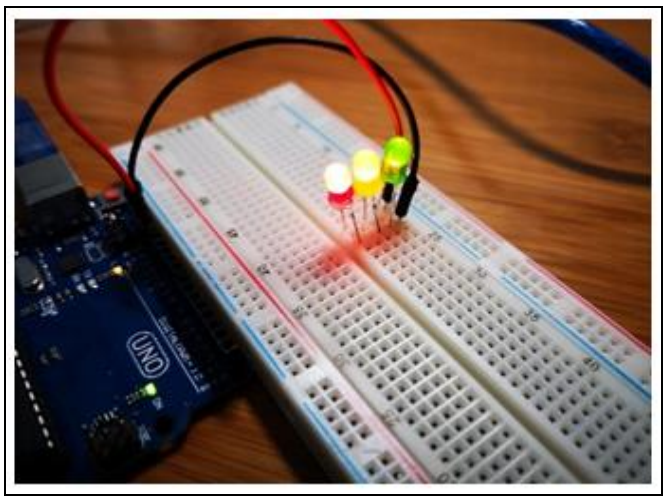

Fig 7 LED Bulb

- *Solar Panel*:

A solar panel converts sunlight into direct current (DC) electricity using photovoltaic cells. It provides a renewable energy source for powering various electronic devices and systems.

Fig 8 Solar Panel

- *Vehicle Framework*:

A vehicle framework is the structural base or chassis of a vehicle, providing support and mounting points for all other components like motors, wheels, and electronics. It determines the vehicle's overall shape and stability.

Fig 9 Vehicle Framework

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug059

- *Batteries 12V*:

A 12V battery is a chemical energy storage device that provides a direct current (DC) electrical output at a nominal voltage of 12 volts. It is commonly used to power various electronic devices and as a power source in vehicles and portable systems.

Fig 10 Batteries 12V

- *12V DC Motors*:

12V DC motors are electric motors that operate on a 12-volt direct current power supply and convert electrical energy into rotational mechanical motion. They are widely used in robotics and automation for tasks requiring controlled movement.

Fig 11 12V DC Motor

➢ *Operation*

The Driver Alert System operates through continuous, multi-faceted monitoring of driver behavior and vehicle dynamics via an integrated "Control kit." Real-time data encompassing steering patterns, lane deviations, braking and acceleration profiles, and potentially physiological indicators are analyzed by sophisticated algorithms. These algorithms establish a baseline of the driver's typical operation and actively detect deviations indicative of impairment such as fatigue or distraction. Upon identifying such deviations exceeding predefined safety thresholds, the system initiates a tiered alert mechanism. Initially, the driver receives subtle warnings, such as auditory or haptic feedback, prompting self-correction. If the unsafe driving patterns persist or escalate, the alerts become more prominent, employing visual and more insistent auditory cues to ensure driver attention. A critical safety component is the Auto-Pilot mode, designed to autonomously intervene if the driver fails to respond appropriately to the escalating alerts, suggesting an inability to maintain safe vehicle control. Triggered by prolonged unsafe behavior or a lack of response, the Auto-Pilot assumes control of essential functions like steering, braking, and acceleration. Its primary function is to safely guide the heavy vehicle to a controlled stop in a secure location, effectively mitigating the risk of potential accidents. To ensure operational flexibility and maintain driver authority under normal circumstances, the system incorporates a unique and carefully calibrated override mechanism for the Auto-Pilot. This allows a fully alert and capable driver to disengage the autonomous control and resume manual operation. Successful override typically requires the driver to demonstrate a return to safe and consistent driving behavior for a predetermined duration, assuring the system of their regained capacity to operate the vehicle safely. This balanced design integrates the critical safety benefits of autonomous intervention with the practical necessity of driver control during routine operations. Furthermore, the system's comprehensive data logging capabilities provide invaluable insights for post-incident analysis, contributing to potential improvements in driver training protocols and the refinement of the alert system's effectiveness over time. This data-driven approach ensures continuous enhancement of safety within heavy vehicle operations.

III. SYSTEM DESCRIPTION

Table 1 Requirement of Parameters for Proposed Project

Parameter	Value	Quantity
Solar Panel	22V	1
Ultra sonic sensors	HCSR04	4
DC motor	12V motor	2
Batteries	12V	2
Jumping wires	quantity as per requirement	--
Arduino	Mega 2560	1
Relays	16 channel	1

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25aug059

IV. CONCLUSION

Addressing driver incapability in heavy vehicle operations requires a proactive and multi-faceted approach. The implementation of a Driver Alert System, incorporating real-time monitoring and autonomous intervention capabilities, offers a significant step towards enhancing safety and mitigating the risks associated with driver impairment. This technology, coupled with sustainable energy considerations, presents a comprehensive solution for a safer and more efficient future for the transportation industry. Continued development and integration of such systems hold the potential to drastically reduce accidents and improve overall road safety for all.

REFERENCES

[1]. N. Nireekshana, R. Ramachandran, and G. V. Narayana, “A New Soft Computing Fuzzy Logic Frequency Regulation Scheme for Two Area Hybrid Power Systems,” Int. J. Electr. Electron. Res., vol. 11, no. 3, pp. 705–710, 2023.

[2]. N. Nireekshana, N. Ravi, and K. R. Kumar, “A Modern Distribution Power Flow Controller With A PID-Fuzzy Approach: Improves The Power Quality,” Int. J. Electr. Electron. Res., vol. 12, no. 1, pp. 167–171, 2024.

[3]. N. Nireekshana, R. Ramachandran, and G. Narayana, “A Novel Swarm Approach for Regulating Load Frequency in Two-Area Energy Systems,” Int J Electr Electron Res, vol. 11, pp. 371–377, 2023.

[4]. N. Nireekshana, R. Ramachandran, and G. V. Narayana, “A Peer Survey on Load Frequency Contol in Isolated Power System with Novel Topologies,” Int J Eng Adv Technol IJEAT, vol. 11, no. 1, pp. 82–88, 2021.

[5]. N. Nireekshana, “A POD Modulation Technique Based Transformer less HERIC Topology for PV Grid Tied-Inverter,” in E3S Web of Conferences, EDP Sciences, 2025, p. 01001. Accessed: Apr. 11, 2025. [Online]. Available: https://www.e3s-conferences.org/articles/e3sconf/abs/2025/16/e3sconf_icregcsd2025_01001/e3sconf_icregcsd2025_01001.html

[6]. N. Nireekshana, R. Ramachandran, and G. V. Narayana, “An innovative fuzzy logic frequency regulation strategy for two-area power systems,” Int. J. Power Electron. Drive Syst. IJPEDS, vol. 15, no. 1, pp. 603–610, 2024.

[7]. N. Nireekshana, T. H. Nerlekar, N. Kumar, and M. Mohsin, “An Innovative Solar Based Robotic Floor Cleaner,” Int. J. Innov. Sci. Res. Technol. IJISRT, vol. 8, no. 4, pp. 1880–1885, 2023.

[8]. Y. Mastanamma, B. Laxman, J. R. Babu, N. Nireekshan, and E. Saidulu, “Electric Cargo Tricycle-A New Mobility,” in E3S Web of Conferences, EDP Sciences, 2025, p. 03015. Accessed: Apr. 11, 2025. [Online]. Available: https://www.e3s-conferences.org/articles/e3sconf/abs/2025/16/e3sconf_icregcsd2025_03015/e3sconf_icregcsd2025_03015.html

[9]. N. Nireekshana, M. A. Goud, R. B. Shankar, and G. N. S. Chandra, “Solar Powered Multipurpose Agriculture Robot.” May, 2023. Accessed: Apr. 11, 2025. [Online]. Available: https://scholar.google.com/scholar?cluster=14706811096260049536&hl=en&oi=scholarr

[10]. N. Nireekshana, R. Ramachandran, and G. V. Narayana, “Novel Intelligence ANFIS Technique for Two-Area Hybrid Power System’s Load Frequency Regulation,” in E3S Web of Conferences, EDP Sciences, 2024, p. 02005. Accessed: Apr. 11, 2025. [Online]. Available: https://www.e3s-conferences.org/articles/e3sconf/abs/2024/02/e3sconf_icregcsd2023_02005/e3sconf_icregcsd2023_02005.html