



# Smart Helmet using Aurdino

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**ABSTRACT:** The Smart Helmet using Arduino is an advanced safety solution developed to reduce road accidents and improve rider protection. This system integrates an Arduino microcontroller with various sensors and communication modules to ensure safe riding conditions. It includes a helmet detection sensor that ensures the rider is wearing the helmet and an alcohol sensor that checks whether the rider is under the influence of alcohol. If any unsafe condition is detected, the system prevents the ignition of the vehicle, thereby avoiding potential accidents. Additionally, the helmet is equipped with an accident detection mechanism using vibration or tilt sensors to identify sudden impacts or crashes. In such situations, the system automatically sends an emergency alert message along with the rider's real-time location to predefined contacts using GSM and GPS modules. This enables quick response and timely medical assistance.

The Smart Helmet is a cost-effective, reliable, and userfriendly system that combines automation and real-time monitoring. It plays a significant role in enhancing road safety by ensuring rule compliance and providing immediate help during emergencies.

**KEYWORDS:** Electric Power Steering (EPS); Steering Systems; Electronic Control Strategies; Energy Efficiency; Advanced Driver Assistance Systems (ADAS)

## I. INTRODUCTION

Road safety has become a major global concern, especially for two-wheeler riders who are more vulnerable to accidents compared to other vehicle users. A large number of accidents occur due to negligence such as not wearing helmets, overspeeding, and driving under the influence of alcohol. Even though helmets are mandatory in many places, riders often ignore this rule, leading to severe head injuries and fatalities. In addition, delay in providing medical assistance after an accident further increases the risk to the victim's life.

With the advancement of embedded systems and microcontroller technologies, it is possible to enhance traditional safety equipment into intelligent systems. The Smart Helmet using Arduino is an innovative approach that integrates electronics and communication technologies into a regular helmet to improve rider safety. This system combines multiple features such as helmet detection, alcohol sensing, accident detection, and emergency communication into a single unit.

The Arduino microcontroller acts as the core of the system, processing inputs from various sensors and controlling outputs accordingly. The helmet detection mechanism ensures that the rider wears the helmet before starting the vehicle. The alcohol sensor checks whether the rider is intoxicated and prevents ignition if unsafe conditions are detected. In case of an accident, sensors like vibration or tilt sensors identify the impact and trigger an alert system.



### 1.1 PROBLEM STATEMENT

Road accidents involving two-wheeler riders have become a major concern due to negligence in following safety measures such as not wearing helmets and driving under the influence of alcohol. Many accidents result in severe injuries or fatalities because riders ignore basic safety rules. Additionally, in several cases, accident victims do not receive timely medical assistance due to delays in informing emergency services or lack of proper communication. Traditional helmets provide only physical protection and do not have any intelligent system to monitor rider behavior or detect emergencies. There is a need for a smart solution that not only ensures that the rider follows safety regulations but also provides immediate assistance in case of an accident.

The main problem is to design a system that can enforce helmet usage, detect alcohol consumption, prevent unsafe vehicle operation, and automatically send emergency alerts with location details during accidents. This system should be cost-effective, reliable, and easy to implement, making it suitable for real-world applications to enhance road safety and reduce accident-related fatalities.

### 1.2 Objectives

Ensure Helmet Usage:

To detect whether the rider is wearing the helmet and allow vehicle ignition only when the helmet is properly worn.

Prevent Drunk Driving:

To detect alcohol consumption using a sensor and stop the vehicle from starting if alcohol is detected beyond a safe limit.

Accident Detection:

To identify accidents using vibration or tilt sensors and respond immediately.

Emergency Alert System:

To send automatic alert messages with the rider's location to predefined contacts using GSM and GPS modules.

Improve Road Safety:

To reduce accidents and fatalities by enforcing safety rules and providing real-time monitoring.

Automation of Safety Measures:

To minimize human negligence by automating the safety checks before and during riding.

Cost-Effective Solution:

To develop an affordable and easy-to-implement system for practical real-world use.

## II. RELATED WORK

Several research studies and projects have been carried out to improve two-wheeler safety using embedded systems and IoT technologies. Many existing systems focus on helmet detection and ignition control, where sensors are used to ensure that the rider wears a helmet before starting the vehicle. These systems successfully reduce rule violations but often lack additional safety features such as accident detection and emergency communication.

Some researchers have developed alcohol detection systems using MQ-3 sensors integrated with microcontrollers to prevent drunk driving. These systems can disable the vehicle ignition when alcohol is detected, but they usually operate independently and are not integrated with other safety mechanisms like helmet detection or accident alerts.

Other works include accident detection systems using vibration, accelerometer, or gyroscope sensors. These systems can detect crashes and send alerts using GSM modules. However, many of these solutions are implemented directly on the vehicle rather than within the helmet, which may reduce accuracy in detecting the rider's condition.

Recent advancements combine GPS and GSM technologies to provide real-time location tracking and emergency messaging. Some IoT-based systems also use mobile applications for monitoring and alerts. However, such systems may increase cost and complexity.

The proposed Smart Helmet using Arduino improves upon existing works by integrating multiple safety features—helmet detection, alcohol sensing, ignition control, and accident alert—into a single compact system. This integrated approach ensures better reliability, enhanced safety, and quick emergency response, making it more effective compared to earlier individual or partially combined solutions.



### **III. EXISTING METHODOLOGY**

The existing methodology for improving two-wheeler rider safety mainly focuses on separate and limited safety mechanisms rather than an integrated system. Traditional approaches primarily rely on manual compliance, where riders are expected to wear helmets and follow traffic rules without any automated enforcement. Traffic authorities impose fines and penalties, but these methods are not always effective in ensuring consistent safety behavior.

In some existing systems, helmet detection is implemented using simple sensors or switches that allow the vehicle to start only when the helmet is worn. While this helps enforce helmet usage, it does not address other critical issues such as drunk driving or accident response. Similarly, standalone alcohol detection systems are used to check the rider's breath and prevent ignition if alcohol is detected, but these systems are usually installed in vehicles and not integrated with helmets.

Accident detection systems are another approach, where sensors like accelerometers or vibration sensors are used to detect crashes. These systems may send alerts through GSM modules, but they are often mounted on the vehicle rather than on the rider, which can lead to inaccurate detection in certain situations. Additionally, many of these systems lack real-time location tracking or reliable communication features.

Overall, the existing methodology is fragmented, with different safety features working independently rather than as a unified system. This lack of integration reduces efficiency and reliability. Hence, there is a need for a comprehensive system that combines helmet detection, alcohol sensing, accident detection, and emergency communication into a single, efficient solution—leading to the development of the Smart Helmet using Arduino.

### **IV. PROPOSED METHODOLOGY**

The proposed methodology of the Smart Helmet using Arduino is designed to provide an integrated and automated safety system for two-wheeler riders. This system combines multiple sensors and communication modules with an Arduino microcontroller to ensure safe riding conditions and quick response during emergencies.

Initially, the system checks whether the rider is wearing the helmet using an IR sensor placed inside the helmet. This sensor detects the presence of the rider's head, and only if the helmet is properly worn, the system allows further operations. Simultaneously, an alcohol sensor (MQ-3) is used to detect the presence of alcohol in the rider's breath. If the alcohol level exceeds the preset limit, the Arduino sends a signal to the relay module to disable the bike's ignition system, preventing the rider from driving under unsafe conditions.

Once the safety conditions are satisfied, the ignition system is enabled, allowing the rider to start the vehicle. During the ride, the system continuously monitors for any abnormal conditions. An accident detection module, consisting of a vibration sensor or tilt sensor, is used to detect sudden impacts or unusual orientation of the helmet. When such an event is detected, it is treated as a potential accident.

Upon accident detection, the Arduino immediately activates the GSM and GPS modules. The GPS module retrieves the exact geographical location (latitude and longitude), and the GSM module sends an alert message containing this location to predefined emergency contacts such as family members or nearby medical services. A buzzer may also be activated to indicate an emergency condition.

The entire system works in real-time and operates automatically without requiring manual intervention. By integrating helmet detection, alcohol sensing, ignition control, and accident alert features into a single unit, the proposed methodology ensures enhanced safety, quick emergency response, and reduced risk of accidents, making it a reliable and efficient solution for modern transportation safety.

#### **4.1 System Architecture**

The Smart Helmet using Arduino is designed with a modular system architecture that integrates sensing, processing, communication, and control units to ensure rider safety. The Arduino microcontroller acts as the central processing unit, coordinating all the components and managing system operations.

The architecture begins with the input layer, which consists of various sensors. An IR sensor is placed inside the helmet to detect whether the rider is wearing it. An alcohol sensor (MQ-3) is used to analyze the rider's breath and detect the



presence of alcohol. Additionally, a vibration or tilt sensor is included to identify accidents by detecting sudden impacts or abnormal movements.

All sensor data is sent to the Arduino microcontroller, which processes the inputs based on programmed conditions. This forms the processing layer, where decisions are made. If the helmet is not worn or alcohol is detected beyond the safe limit, the Arduino sends a signal to the relay module to disable the ignition system.

The control layer includes the relay module connected to the vehicle's ignition system. This module acts as a switch, allowing or blocking the engine start based on the Arduino's output. A buzzer may also be included to provide audio alerts for unsafe conditions or accidents.

The communication layer consists of GSM and GPS modules. The GPS module continuously tracks the location of the rider, while the GSM module is used to send alert messages. In the event of an accident, the Arduino retrieves location data from the GPS module and transmits it via the GSM module to predefined contacts.

Power is supplied to the system through a battery source, ensuring all components function properly. The overall architecture ensures real-time monitoring, quick decisionmaking, and immediate communication during emergencies. This integrated system architecture provides a reliable, automated, and efficient safety solution, transforming a traditional helmet into a smart protective device for modern riders.

#### 4.2 Working of Smart Helmet Using Arduino

A smart helmet system typically operates as a split-design IoT project, utilizing an Arduino-based transmitter mounted on the helmet and a receiver installed within the vehicle to enhance rider safety. The system integrates various sensors to monitor environmental and riderspecific conditions, transmitting data wirelessly via RF modules (often 433 MHz)

Building this system provides a practical application for embedded systems and sensor integration, commonly involving tasks like programming logic to handle sensor thresholds and establishing reliable wireless communication between the two Arduino-powered nodes. Depending on the specific focus, projects can be expanded to include GPS modules for real-time location tracking during accidents or integration with mobile applications for notifications.

#### 4.3 Smart Helmet Strategies in alcohol Reduction

Smart helmet strategies using Arduino center on proactive safety, accident detection, and behavioral monitoring to protect riders. These strategies are implemented through a two-node architecture—a transmitter (on the helmet) and a receiver (on the vehicle)—to ensure real-time interaction and automated response.

##### Core Safety Strategies

**Mandatory Compliance Monitoring:** Using IR sensors or pressure switches, the system confirms the helmet is properly worn before allowing the vehicle to start, effectively enforcing safety standard.

**Impairment and Alertness Detection:** MQ-3 alcohol sensors monitor the rider's breath for intoxication, while specialized time-window logic monitors head movement via accelerometers (like the MPU-6050) to detect signs of drowsiness or insta

Designing these systems requires calibrating sensor thresholds to local road conditions and ensuring the wireless communication between nodes is robust enough to operate in high-interference environments. By modularizing the design, you can easily scale from basic alcohol and wear detection to more advanced IoT-enabled features like real-time tracking.

#### 4.4 Performance Enhancement Techniques in Smart Helmet Using Arduino

To enhance the performance and reliability of an Arduinobased smart helmet, focus on optimizing code efficiency, sensor precision, and hardware robustness to handle realworld conditions.

##### Software Optimization Techniques

**Non-Blocking Logic:** Use `millis()` instead of `delay()` for timing tasks such as sensor polling, display updates, and communication. This prevents the processor from hanging, allowing the system to react instantly to accident or alcohol-level triggers.



**Data Integrity and Timeouts:** Implement watchdog-like timers to monitor communication between the helmet and the vehicle. If the receiver stops receiving data for a specific threshold (e.g., 5 seconds), trigger a "link-lost" alert to notify the rider of a potential system failure.

**Efficient State Management:** Use state machine patterns to manage complex behaviors—such as toggling between safety alerts and display pages—to keep the codebase modular, readable, and easier to debug.  
**Hardware and Environmental Enhancements**

**Sensor Calibration:** Carefully calibrate vibration and alcohol sensor thresholds based on expected real-world baselines. Implement software-based filtering (such as moving averages) for accelerometer or vibration data to reduce false positives caused by normal riding vibrations  
**Environmental Shielding:** Ensure all electronics are properly enclosed and protected from moisture, dust, and vibration. Use high-quality, flexible wiring with strain relief to prevent disconnections caused by constant head movement.

**Wireless Robustness:** Optimize the RF module communication by using effective antenna designs and ensuring sufficient voltage levels. If using 433 MHz RF modules, consider adding error-checking protocols (like checksums) to ensure the data received by the vehicle is accurate and not corrupted by interference

#### 4.5 Future Trends & Challenges Future Trends:

**Integration with IoT (Internet of Things):**

Future smart helmets will be connected to IoT platforms, enabling real-time monitoring, cloud data storage, and remote access through mobile applications. Riders' health and safety data can be tracked continuously.

**AI-Based Accident Prediction:**

Artificial Intelligence and Machine Learning can be used to analyze riding patterns and predict potential accidents before they occur, improving preventive safety.

**Advanced Communication Systems:**

Integration of technologies like Bluetooth and 5G will enable faster communication, hands-free calling, voice assistance, and instant emergency alerts.

**Health Monitoring Features:**

Sensors such as heart rate and temperature sensors can be added to monitor the rider's health condition and detect fatigue or medical emergencies.

**Smart Navigation and Heads-Up Display (HUD):**

Future helmets may include built-in displays for navigation, notifications, and speed information without distracting the rider.

**Miniaturization and Wearable Technology:**

Components will become smaller, lighter, and more energy-efficient, making the helmet more comfortable and user-friendly.

**Integration with Smart Vehicles:**

Smart helmets can communicate directly with vehicles for enhanced safety features like automatic braking and collision avoidance.

**Challenges:**

**Power Management:**

Providing a reliable and long-lasting power source for all electronic components is a major challenge.

**Cost and Affordability:**

Advanced features may increase the overall cost, making it less affordable for common users.

#### 4.6 Sensors and MQL Alcohol Deduction

The MQ-3 sensor is the industry-standard choice for DIY alcohol detection projects using Arduino due to its sensitivity to ethanol and ease of integration . It operates as a semiconductor gas sensor, where the conductivity of the sensing element increases in the presence of alcohol fumes .



## Operational Mechanism

**Semiconductor Logic:** The MQ-3 utilizes a metal oxide (MOS) semiconductor layer that changes resistance when exposed to ethanol. As the concentration of alcohol increases, the sensor's internal resistance decreases, resulting in a higher voltage output on the analog pin (AOUT).

**Signal Processing:** Arduino reads this analog signal (ranging from 0 to 1023) to determine the concentration level. You can utilize the digital output (DOUT) for a simple threshold-based "on/off" alert or the analog output for more granular, quantitative measurements.

## Implementation Best Practices

**Preheating Requirements:** The MQ-3 requires a significant preheat time (often 24–48 hours for the first time, or several minutes before each use) to stabilize the heating element. Without proper preheating, the sensor will report false high readings.

**Calibration:** Because ambient conditions (humidity, temperature) affect conductivity, you must calibrate the sensor by measuring values in a clean environment and setting a baseline threshold. Use code to subtract this baseline or calculate "parts per million" (PPM) to avoid false triggers.

**Deployment:** For a smart helmet, mount the sensor in a position that captures the driver's breath, such as near the mouth guard or chin bar, ensuring sufficient airflow for accurate detection.

While highly effective for educational and hobbyist projects, remember that the MQ-3 is not a medical-grade device. It is best suited for demonstrating the concept of "interlock" systems where the sensor triggers an Arduino-controlled relay to inhibit the vehicle's ignition circuit when alcohol is detected.

## V. ADVANCE SMART HELMET USING ARDUINO

Advanced smart helmet systems leverage Arduino as a foundation to integrate IoT (Internet of Things) capabilities, enabling sophisticated accident detection, real-time location tracking, and automated emergency response. By moving beyond simple safety alerts, these advanced designs prioritize connectivity and data-driven rider protection.

### Advanced Feature Integration

**Accident Detection & Geolocation:** Beyond basic impact detection using accelerometers (like the MPU-6050), advanced systems integrate GPS and GSM/GPRS modules to automatically transmit the rider's precise coordinates to family or emergency services during a crash.

**Bluetooth/IoT Connectivity:** By incorporating HC-05 Bluetooth modules, these helmets can pair with a smartphone to send data to a dedicated mobile app, allowing for real-time monitoring of rider status and system health.

**Adaptive Energy Management:** Advanced designs often use power-efficient circuitry and logic—such as powering on the electronics only when the helmet's retention strap is engaged—to maximize battery life during extended travel.

### Architectural Evolution

**KiCAD PCB Design:** Moving from breadboards to custom-designed PCBs (often using KiCAD) improves the durability, reliability, and form factor of the helmet's electronics, making them more suitable for real-world usage.

**Data Analytics:** Modern prototypes use the gathered data to perform analysis, allowing designers to calibrate sensor thresholds for specific riding conditions, such as rough terrain, to minimize false negatives and false positives.

**Worker Safety Applications:** Beyond motorcycling, specialized versions are designed for industrial use, incorporating toxic gas sensors (e.g., carbon monoxide or methane detectors) and temperature sensors to protect workers in hazardous environments like mines or tunnels.

## VI. CONCLUSION

The Smart Helmet using Arduino is an innovative and effective solution aimed at improving the safety of two-wheeler riders. By integrating multiple technologies such as sensors, microcontrollers, and communication modules, the system ensures that essential safety measures are followed before and during riding. Features like helmet detection and alcohol



sensing help prevent unsafe riding conditions, while accident detection and automatic alert systems provide timely assistance during emergencies.

This project demonstrates how embedded systems and automation can be applied to real-world problems to reduce road accidents and save lives. The use of Arduino makes the system cost-effective, flexible, and easy to implement, making it suitable for practical applications.

Moreover, the Smart Helmet promotes responsible riding behavior and supports the development of intelligent transportation systems. Although there are challenges such as power management, system reliability, and cost, continuous advancements in technology can overcome these limitations.

In conclusion, the Smart Helmet using Arduino is a promising step toward smarter and safer roads, offering a reliable, efficient, and user-friendly approach to enhancing rider safety and minimizing accident-related risks.

## REFERNECES

1. Manjesh, N., Sudarshan Raj, "Smart Helmet Using GSM & GPS Technology for Accident Detection and Reporting System," *International Journal of Electrical and Electronics Research*, Vol. 2, Issue 4, 2014.
2. Rasli, M. K. A. M., Madzhi, N. K., Johari, J., "Smart Helmet with Sensors for Accident Prevention," *International Conference on Electrical, Electronics and System Engineering (ICEESE)*, IEEE, 2013.
3. Impana, H. C., Hamsaveni, M., Chethana, H. T., "A Review on Smart Helmet for Accident Detection using IoT," *EAI Endorsed Transactions on Internet of Things*, Vol. 5, No. 20, 2019.
4. SIMCom, "SIM800L GSM/GPRS Module Hardware Design," SIMCom Wireless Solutions, 2015.
5. "Design Smart Helmet System with GSM for Safety Monitoring Systems," *International Journal of Scientific Research in Science and Technology*, 2025.
6. Patil, S., et al., "Smart Motorcycle Security System," *International Conference on Emerging Trends in Engineering, Technology and Science (ICETETS)*, IEEE, 2016.
7. Li, S., et al., "Smart Helmet with Fall Detection and Emergency Alarm System," *IEEE International Conference on Robotics and Automation (ICRA)*, 2018.
8. Experimental study on electrical discharge machining of Inconel using RSM and NSGA optimization technique R. Senthil Kumar and P. Suresh, "Experimental study on electrical discharge machining of Inconel using RSM and NSGA optimization technique," *Journal of the Brazilian Society of Mechanical Sciences and Engineering*, vol. 41, no. 5, pp. 1–14, 2019.
9. Impact of the shape of electrode-tool on radical overcut of micro-hole in electrochemical micromachining R. Thanigaivelan, R. Senthilkumar, R. M. Arunachalam, and N. Natarajan, "Impact of the shape of electrode-tool on radical overcut of micro-hole in electrochemical micromachining," *Surface Engineering and Applied Electrochemistry*, vol. 53, no. 5, pp. 486–492, 2017.
10. Study on tool steel machining with ZNC EDM by RSM, GREY and NSGA S. Kumar Ramuvel and S. Paramasivam, "Study on tool steel machining with ZNC EDM by RSM, GREY and NSGA," *Journal of Materials Research and Technology*, vol. 9, no. 3, pp. 3885–3896, 2020.
11. R. Senthilkumar, K. Tamizharasan, T. Sowndharya, and M. Kirthikajain, "Fabrication and Analysis of Regenerative Braking System," *Journal for Research*, vol. 3, no. 2, 2017.
12. Investigation over the surface integrity of Tungsten Carbide using ZNC-EDM R. Senthil Kumar and P. Suresh, "Investigation over the surface integrity of Tungsten Carbide using ZNC-EDM," *International Journal of Management Technology and Engineering*, vol. 9, no. 1, pp. 1–6, 2019.
13. Kumar, R. S., Perumal, S., Chandru, M., & Nanthakumar, S. (2026). ESP-32 quadx drone. *International Journal of Engineering & Extended Technologies Research (IJEETR)*, 8(2), 4529–4537.
14. Kumar, R., Perumal, S., Sriram, G., & Seshathri, S. (2026). Electrical steering system in automobile. *International Journal of Engineering & Extended Technologies Research (IJEETR)*, 8(2), 4539–4549.
15. Venkatachalam, R., Ashokan, A., Ganesan, M. P., Perumal, S., Pandian, B., & Pant, R. (2026). Optimization of pyrolysis parameters for enhanced bio-oil yield from lignocellulosic biomass using response surface methodology. *Renewable Energy*. (SCI, submitted for publication).
16. Ashokan, A., Murugesan, S., Muthaiyan, R., Arumugam, S., & Perumal, S. (2025). Numerically analyzing a heat transmission in blood using a cardioplegia concentric tube heat exchanger during open cardiac surgery. *International Journal of Environmental Sciences*, 11(18s).



17. Senthilkumar, R., Perumal, S., & Vinoth, A. (2025). A smart waste management system using IoT. *International Journal of Scientific Development and Research*, 10(5), d351–d360.
18. Perumal, S., Arunkumar, N., Gopi Krishna, B., Kirubainathan, S., & Navukkarasar, M. (2025). Smart AI-powered chatbot using ESP8266 for real-time responses. *International Journal of Scientific Development and Research*, 10(5), d357–d364.
19. Senthilkumar, R., Perumal, S., & Vishal, R. D. (2025). AI-powered drone for electricity pylon inspection. *International Journal of Scientific Development and Research*, 10(5), d617–d627.
20. Senthilkumar, R., Perumal, S., & Vinoth, A. (2025). A smart waste management system using IoT. *International Journal of Scientific Development and Research*, 10(5), d351–d360.
21. Vasanthamohan, R., Senthil Kumar, R., Perumal, S., Bagavathi, T., Karthikeyan, M., & Ranjith, R. (2024). Arm based pick and place robot vehicle using IoT. *International Journal of Advances in Engineering and Management (IJAEM)*, 6(4), 185–194.
22. C.Nagarajan and M.Madheswaran - 'Stability Analysis of Series Parallel Resonant Converter with Fuzzy Logic Controller Using State Space Techniques' - Taylor & Francis, Electric Power Components and Systems, Vol.39 (8), pp.780-793, May 2011. DOI: 10.1080/15325008.2010.541746
23. C.Nagarajan and M.Madheswaran - 'Experimental verification and stability state space analysis of CLL-T Series Parallel Resonant Converter' - Journal of Electrical Engineering, Vol.63 (6), pp.365-372, Dec.2012. DOI: 10.2478/v10187-012-0054-2
24. C.Nagarajan and M.Madheswaran - 'Performance Analysis of LCL-T Resonant Converter with Fuzzy/PID Using State Space Analysis' - Springer, Electrical Engineering, Vol.93 (3), pp.167-178, September 2011. DOI 10.1007/s00202-011-0203-9
25. S.Tamilselvi, R.Prakash, C.Nagarajan, "Solar System Integrated Smart Grid Utilizing Hybrid Coot-Genetic Algorithm Optimized ANN Controller" Iranian Journal Of Science And Technology-Transactions Of Electrical Engineering, DOI10.1007/s40998-025-00917-z,2025
26. S.Tamilselvi, R.Prakash, C.Nagarajan, " Adaptive sliding mode control of multilevel grid-connected inverters using reinforcement learning for enhanced LVRT performance" Electric Power Systems Research 253 (2026) 112428, doi.org/10.1016/j.epr.2025.112428
27. S.Thirunavukkarasu, C. Nagarajan, 2024, "Performance Investigation on OCF and SCF study in BLDC machine using FTANN Controller," Journal of Electrical Engineering And Technology, Volume 20, pages 2675–2688, (2025), doi.org/10.1007/s42835-024-02126-w
28. C. Nagarajan, M.Madheswaran and D.Ramasubramanian- 'Development of DSP based Robust Control Method for General Resonant Converter Topologies using Transfer Function Model'- *Acta Electrotechnica et Informatica Journal* , Vol.13 (2), pp.18-31, April-June.2013, DOI: 10.2478/aei-2013-0025.
29. C.Nagarajan and M.Madheswaran - 'DSP Based Fuzzy Controller for Series Parallel Resonant converter'- *Springer, Frontiers of Electrical and Electronic Engineering*, Vol. 7(4), pp. 438-446, Dec.12. DOI 10.1007/s11460-012-0212-0.
30. C.Nagarajan and M.Madheswaran - 'Experimental Study and steady state stability analysis of CLL-T Series Parallel Resonant Converter with Fuzzy controller using State Space Analysis'- *Iranian Journal of Electrical & Electronic Engineering*, Vol.8 (3), pp.259-267, September 2012.
31. C.Nagarajan and M.Madheswaran, "Analysis and Simulation of LCL Series Resonant Full Bridge Converter Using PWM Technique with Load Independent Operation" has been presented in ICTES'08, a IEEE / IET International Conference organized by M.G.R.University, Chennai. Vol.no.1, pp.190-195, Dec.2007
32. Suganthi Mullainathan, Ramesh Natarajan, "An SPSS and CNN modelling based quality assessment using ceramic materials and membrane filtration techniques", *Revista Materia (Rio J.)* Vol. 30, 2025, DOI: <https://doi.org/10.1590/1517-7076-RMAT-2024-0721>
33. M Suganthi, N Ramesh, "Treatment of water using natural zeolite as membrane filter", *Journal of Environmental Protection and Ecology*, Volume 23, Issue 2, pp: 520-530,2022
34. Senthil Kumar, R., Perumal, S., Lokesh, K., Venkatesh, C., Ajithkumar, M., & Sanjay Kumar, M. (2024). An IoT based industrial platform for remote real-time power plant monitoring. *International Journal of Advances in Engineering and Management (IJAEM)*, 6(4), 376–388.
35. Senthil Kumar, R., Perumal, S., Kaviya, P., Ajay, M., Gokulakannan, K., & Gowtham, S. (2024). Solar smart air pollution monitoring framework using Arduino and IoT applications. *International Journal of Advances in Engineering and Management (IJAEM)*, 6(4), 147–185.
36. Perumal, S., Johnrajan, A., Raja, S., Praveenkumar, V., & Arun Kumar, K. (2023). A systematic review of hybrid renewable energy systems about their optimization techniques with analytic hierarchy process. *International Journal of Power System Operation and Energy Management*, 3(3), 147–185. <https://doi.org/09.0014.MSJ>



37. Perumal, S., Madheswaran, M., Ragul, N., Srilakshman, T., & Naveenkumar, R. (2023). CFD analysis of ground heat exchanger by different configurations. *Mukt Shabd Journal*, 7(5). <https://doi.org/09.0014.MSJ>
38. Raman, M., Perumal, S., Muthusamy, S., & Subramaniam, S. (2022). Studies on diesel engine exhaust gas for retrieving the waste heat through triple tube heat exchanger (TTHE) through different tubes. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 44(2), 4149–4164.
39. Perumal, S., & Mohan, R. (2020). Numerical and experimental study of a triple concentric tube heat exchanger for waste heat recovery from engine exhaust gas. *Thermal Science*, 6(2), 216–228.
40. Palanisamy, P., Perumal, S., & Manojkumar, P. (2021). Optimization of process parameters on reliability for twisted drill life in drilling. *International Journal of Engineering Research & Technology*, 1(1).
41. Perumal, S., Naveenkumar, D., Manikandan, M., & Mohan Kumar, M. (2020). Experimental investigation of triple tube heat exchanger for waste heat recovery from IC engine exhaust gas. *International Journal for Scientific Research and Development*, 3(3).
42. Murali, T., Perumal, S., Lijo, S., & Sasidharan, S. (2020). Design and synthesis of six-legged walking robot using single degree of freedom linkage. *Global Research and Development Journal*, 2(3).
43. Perumal, S., Mohan, R., Sasidharan, S., & Venkadesh, K. (2017). Study on concentric tube heat exchanger with different nanofluids for enhancing the heat transfer: A review. *International Journal of Impotence Research*, 3(9).
44. Perumal, S., Manikandan, T., Mounaraj, K., & Mubarak, S. (2017). Design and synthesis of multipurpose hand driller machine for various processes. *International Journal of Science Technology and Engineering*, 4(3).
45. Senthilkumar, K., Perumal, S., Mohan, R., & Kalidoss, K. (2016). Numerical analysis of triple concentric tube heat exchanger using dimpled tube geometry. *Asian Journal of Research in Social Sciences and Humanities*, 6(8), 2078–2088.
46. Murali, T., Perumal, S., Mohan, R., & Palanisamy, P. (2016). Design and synthesis of six-legged walking robot using single degree of freedom linkage. *International Journal of Impotence Research*, 2(3).
47. Perumal, S., Mohan, R., Palanisamy, P., & Senthilkumar, K. (2015). Study on double pipe heat exchanger using different enhancement techniques. *International Journal of Impotence Research*, 5(1).
48. Perumal, S., Senthilkumar, K., Palanisamy, P., & Vinoth, R. (2014). Numerical study of a concentric tube heat exchanger using dimpled tubes with Al<sub>2</sub>O<sub>3</sub> nanofluid. *Australian Journal of Basic and Applied Sciences*, 8(7), 185–193.