

# IoT-Enabled Gas Leakage Detection System Using ESP32

Atul B Jadhav<sup>1</sup>, Saurav S Kamble<sup>1</sup>, Rushikesh D Mohite<sup>1</sup>, Manjeet Kumar<sup>2</sup>, Suhas B Khadake<sup>3</sup>

<sup>1</sup>EE Students, SVERI's College of Engineering, Pandharpur, India

<sup>2</sup>Guide & Assistant Professor, SVERI's College of Engineering, Pandharpur, India

<sup>3</sup>Assistant Professor, SVERI's College of Engineering, Pandharpur, India

**Abstract:** *This project presents the design and implementation of an advanced IoT-enabled gas leakage detection and monitoring system using the ESP32. The primary objective of the system is to enhance safety, reliability, and efficiency in environments where liquefied petroleum gas (LPG) is used, such as residential kitchens, commercial establishments, and industrial facilities. The system integrates a gas sensor to continuously monitor the presence of hazardous gases in the surrounding environment. In the event of gas leakage, when the gas concentration exceeds a predefined safety threshold, the system instantly activates an audible alarm and triggers an exhaust mechanism via a relay module to disperse the gas. Simultaneously, real-time alerts are sent to users through an IoT platform, enabling remote monitoring and quick response. To ensure alert delivery under all conditions, a GSM communication module SIM800L is incorporated to send SMS notifications directly to the user's mobile device. This dual-mode communication (Wi-Fi and GSM) significantly improves system reliability, especially in scenarios where internet connectivity is unavailable or unstable. In addition to gas leakage detection, the system includes a gas cylinder weight monitoring feature using a load cell and the HX711. This allows continuous measurement of the cylinder weight and provides early indication when the gas level falls below a predefined limit, thereby helping users to plan timely refilling and avoid sudden gas depletion. An OLED display unit is integrated into the system to provide real-time visualization of critical parameters such as gas concentration, cylinder weight, and system status (Normal, Gas Leak, Low Gas). The system operates with high sensitivity, fast response time, and low power consumption, making it suitable for continuous operation.*

*The proposed solution is cost-effective, user-friendly, and scalable. It leverages modern IoT technology to provide real-time monitoring, automated safety actions, and reliable alert mechanisms. This system not only helps in preventing potential hazards such as fire accidents and explosions but also improves resource management by tracking gas consumption. Hence, it serves as a comprehensive safety and monitoring solution applicable in smart homes, industries, and laboratories.*

**Keywords:** IoT, Gas Leakage Detection, ESP32, GSM Module, Load Cell, LPG Monitoring, Smart Safety System, Exhaust Fan Control, OLED Display, Real-Time Alerts

## I. INTRODUCTION

Gas leakage is one of the major safety hazards in residential, commercial, and industrial environments. Leakage of gases such as liquefied petroleum gas (LPG), methane, and propane can lead to serious consequences including fire accidents, explosions, and health issues. Early detection of gas leakage is therefore essential to ensure safety and prevent loss of life and property.

Traditional gas detection systems are generally limited to local alarm mechanisms and lack the ability to provide real-time remote monitoring and alerts. With the rapid advancement of the Internet of Things (IoT), smart systems can now be developed to continuously monitor environmental conditions and transmit data over the internet. These systems enhance safety by enabling timely alerts and automated responses [1-11].



The ESP32 microcontroller plays a vital role in IoT-based applications due to its built-in Wi-Fi and Bluetooth capabilities, low power consumption, and high processing performance. In this work, an IoT-enabled gas leakage detection system is proposed using the ESP32 and the MQ-6 Gas Sensor. The system is capable of detecting gas leakage, generating local alerts through a buzzer, activating safety mechanisms such as an exhaust fan using a relay module, and sending real-time notifications to users via cloud platforms [12-65].

The proposed system aims to provide a low-cost, reliable, and efficient solution for gas leakage detection with enhanced safety features. By integrating sensing, control, and IoT communication, the system ensures quick response and continuous monitoring, making it suitable for modern smart safety applications.

## II. PROBLEM STATEMENT

Gas leakage remains a significant safety challenge in residential, commercial, and industrial environments. Leakage of combustible gases such as LPG often goes undetected until it reaches dangerous levels, leading to accidents like fire outbreaks, explosions, and health hazards. Existing conventional gas detection systems primarily rely on standalone sensors with local alarm mechanisms, which are insufficient in situations where immediate human intervention is not possible.

Moreover, traditional systems lack real-time monitoring, remote alert capabilities, and automated safety responses. In many cases, users are unaware of gas leakage when they are away from the location, increasing the risk of severe damage. Additionally, delayed detection and response can result in critical consequences, including loss of life and property.

Although modern solutions exist, they are often expensive, complex, or not easily scalable for widespread use. Therefore, there is a need for a cost-effective, reliable, and intelligent system that can continuously monitor gas levels, provide instant alerts, and enable remote monitoring.

This paper addresses these challenges by proposing an IoT-based gas leakage detection system using the ESP32 and the MQ-6 Gas Sensor. The system aims to detect gas leakage in real time, alert users both locally and remotely, and initiate automatic safety measures to minimize risks.

## III. LITERATURE SURVEY

Gas leakage detection has been an active area of research due to its importance in ensuring safety in residential and industrial environments. Various approaches have been proposed using sensors, microcontrollers, and Internet of Things (IoT) technologies. A study by Susilo et al. (2025) developed an IoT-based fire and LPG leakage detection system using an ESP32 and MQ-6 sensor. The system achieved high detection accuracy and enabled multi-user notifications through cloud platforms, demonstrating the effectiveness of combining sensing and IoT communication for real-time monitoring. Similarly, Baiti et al. proposed an IoT-based gas detection system integrating MQ-6, flame, and temperature sensors, achieving an overall accuracy of 93.33% and providing automated responses such as buzzer activation and ventilation control. Earlier work by Alshammari et al. (2020) introduced an IoT gas leakage detection system using Arduino and MQ-series sensors, where detected gas data was transmitted to a cloud platform. The system included a buzzer alarm, LCD display, and exhaust fan activation, highlighting the importance of combining detection with immediate response mechanisms. Recent research has focused on smart home integration and mobile-based monitoring. Studies using ESP32 and applications like Blynk have shown that real-time alerts and remote monitoring significantly improve safety in household environments. Similarly, IoT-based systems using NodeMCU ESP8266 and mobile applications enable users to monitor gas leakage remotely and take preventive action. Additionally, modern approaches emphasize real-time detection, automation, and cloud connectivity. Advanced systems combine gas sensors with automated control mechanisms such as valve shut-off and ventilation systems to reduce risks effectively. Research also highlights the role of sensor technologies like MQ-series sensors, which detect combustible gases based on changes in conductivity, making them suitable for low-cost detection systems. Despite these advancements, several limitations remain. Many systems depend on stable internet connectivity, require proper sensor calibration, and may have limited detection accuracy in complex environments. Furthermore, low-cost sensors may lack precision in identifying specific gases. Based on the



reviewed literature, it is evident that integrating IoT with gas detection systems enhances real-time monitoring, automation, and user safety. However, there is still a need for cost-effective, reliable, and scalable solutions with improved accuracy and faster response time, which motivates the development of the proposed system using the ESP32 and MQ-6 Gas Sensor.

#### **IV. PROJECT DESCRIPTION**

The proposed system is an IoT-enabled gas leakage detection and alert mechanism designed to enhance safety in residential and industrial environments. The system integrates gas sensing, real-time monitoring, alert generation, and automated safety control using the ESP32 as the core processing unit.

The primary sensing component of the system is the MQ-6 Gas Sensor, which is capable of detecting gases such as LPG, propane, and methane. The sensor continuously monitors the surrounding air and produces an analog output proportional to the gas concentration. This signal is read and processed by the ESP32.

The system operates based on a predefined threshold value. When the detected gas concentration exceeds this threshold, the controller initiates multiple actions simultaneously. A buzzer is activated to provide an immediate local alert, and a relay module is triggered to switch ON an exhaust fan, which helps in reducing gas concentration by ventilation. Additionally, the system displays warning messages on an LCD interface to inform users about the hazardous condition. A key feature of the proposed system is its IoT capability. The ESP32 connects to a Wi-Fi network and transmits real-time data to cloud platforms such as ThingSpeak or mobile applications like Blynk. This allows users to monitor gas levels remotely and receive instant notifications in case of leakage, even when they are not physically present at the location.

The system is designed to be cost-effective, reliable, and easy to implement. It combines sensing, processing, communication, and actuation into a single integrated solution. The modular design also allows for future expansion, such as adding more sensors or advanced safety features.

Overall, the project provides a smart and efficient approach to gas leakage detection by leveraging IoT technology, ensuring timely response and improved safety.

#### **V. OBJECTIVES OF SYSTEM**

The primary objective of the proposed system is to develop a smart and reliable gas leakage detection solution using IoT technology. The specific objectives are as follows:

- To design and implement a gas leakage detection system using the ESP32 for efficient processing and communication.
- To detect the presence of hazardous gases such as LPG using the MQ-6 Gas Sensor with high sensitivity and accuracy.
- To provide immediate local alerts through a buzzer and visual indication to ensure quick response in case of gas leakage.
- To enable automatic activation of safety mechanisms, such as controlling an exhaust fan using a relay module to reduce gas concentration.
- To implement IoT-based remote monitoring by transmitting real-time data to cloud platforms or mobile applications.
- To send instant notifications to users in case of gas leakage, even when they are away from the location.
- To develop a cost-effective, scalable, and user-friendly system suitable for both domestic and industrial applications.
- To enhance safety by minimizing the risk of accidents such as fire, explosions, and health hazards caused by gas leakage.



## VI. ADVANTAGES & APPLICATION

### Advantages:

The proposed IoT-enabled gas leakage detection system offers several significant advantages over conventional gas detection methods:

- **Real-Time Detection:** The system continuously monitors gas concentration using the MQ-6 Gas Sensor, enabling immediate detection of leakage.
- **Remote Monitoring:** With built-in Wi-Fi capabilities of the ESP32, users can monitor gas levels from anywhere through IoT platforms.
- **Instant Alerts:** The system provides quick notifications via buzzer and mobile applications, ensuring rapid response to hazardous situations.
- **Automatic Safety Response:** The relay module automatically activates the exhaust fan, helping to reduce gas concentration and prevent accidents.
- **Cost-Effective Solution:** The use of affordable components like the ESP32 makes the system economical and accessible.
- **Easy Installation and Maintenance:** The system is simple to install and requires minimal maintenance, making it suitable for widespread adoption.
- **Scalability:** Additional sensors and features can be easily integrated due to the flexible architecture of the ESP32.
- **Enhanced Safety:** Early detection and quick response significantly reduce the risk of fire, explosions, and health hazards.
- **User-Friendly Interface:** LCD display and mobile applications provide clear and understandable information to users.

### Applications:

The proposed IoT-enabled gas leakage detection system has a wide range of applications across various sectors due to its reliability, real-time monitoring capability, and automated safety features:

- **Residential Safety:** The system can be installed in homes and kitchens to detect LPG leakage and alert occupants, ensuring protection against fire hazards and explosions.
- **Industrial Environments:** It is highly useful in industries where combustible gases are used or stored, providing continuous monitoring and enhancing workplace safety.
- **Gas Storage and Distribution Units:** The system can be deployed in gas storage plants and distribution centers to detect leaks early and prevent large-scale accidents.
- **Commercial Buildings:** Restaurants, hotels, and shopping complexes can utilize the system to monitor gas usage areas and ensure safety compliance.
- **Laboratories:** Research labs handling flammable gases can benefit from real-time monitoring and automatic alert systems.
- **Smart Homes and IoT Systems:** Integration with IoT platforms through the ESP32 enables incorporation into smart home automation systems for centralized monitoring and control.
- **Automated Safety Systems:** The system can be integrated with ventilation systems, alarms, and other safety mechanisms to create a fully automated hazard prevention setup.

## VII. RESULTS AND DISCUSSION

The proposed IoT-enabled gas leakage detection system was developed and tested using the ESP32 and the MQ-6 Gas Sensor under different environmental conditions and gas concentration levels.



### 8.1 Experimental Results

The system successfully detected the presence of LPG gas within a short response time. When the gas concentration exceeded the predefined threshold:

- The buzzer was activated immediately, providing an audible alert.
- The relay module triggered the exhaust fan to reduce gas concentration.
- Warning messages were displayed on the LCD screen.
- Real-time notifications were sent to the user via IoT platforms without significant delay.

The average response time of the system was observed to be within **2–5 seconds**, depending on gas concentration and environmental factors.

### 8.2 Performance Analysis

#### Sensitivity:

The MQ-6 Gas Sensor demonstrated high sensitivity to LPG gas, enabling early detection even at lower concentrations.

#### Accuracy:

The system provided reliable detection; however, accuracy depends on proper calibration of the sensor and environmental conditions such as temperature and humidity.

#### Response Time:

Fast response time ensures immediate action, which is critical in preventing hazardous situations.

#### IoT Communication:

The ESP32 maintained stable Wi-Fi connectivity, and data transmission to platforms like ThingSpeak or Blynk was reliable with minimal latency.

### 8.3 Discussion

The integration of sensing, control, and IoT communication significantly enhances the effectiveness of traditional gas detection systems. Unlike conventional systems that provide only local alerts, the proposed system ensures both local and remote notifications, enabling users to take immediate action even when they are not physically present.

The automatic activation of the exhaust fan via relay adds an additional safety layer by reducing gas concentration without human intervention. This makes the system particularly suitable for smart homes and industrial environments.

However, certain limitations were observed:

- The system performance depends on stable internet connectivity for IoT features.
- Sensor readings may vary due to environmental factors and require periodic calibration.
- Detection is limited to gases supported by the sensor.

Overall, the system demonstrates high reliability, fast response, and efficient operation, making it a practical and cost-effective solution for gas leakage detection.

## VIII. WORKING OVERVIEW

The IoT-enabled gas leakage detection system operates through a sequence of sensing, processing, alerting, and communication stages. The system is built around the ESP32, which acts as the central controller for all operations. Initially, the MQ-6 Gas Sensor continuously monitors the surrounding environment for the presence of combustible gases such as LPG. The sensor outputs an analog signal proportional to the gas concentration in the air. This signal is fed into the analog input pin of the ESP32. The controller processes the incoming signal and compares it with a predefined threshold value programmed into the system. Under normal conditions, when the gas concentration is below the threshold, the system remains in monitoring mode, and the LCD displays a safe status message. When gas leakage is detected and the sensor value exceeds the threshold limit, the system immediately transitions into alert mode. In this condition, multiple actions are triggered simultaneously:



- A buzzer is activated to provide an audible warning
- A relay module is energized to switch ON the exhaust fan for ventilation
- A warning message is displayed on the LCD screen

Simultaneously, the IoT functionality of the ESP32 comes into operation. The controller connects to a Wi-Fi network and transmits real-time data to cloud platforms such as ThingSpeak or mobile applications like Blynk. This enables remote monitoring and ensures that users receive instant notifications about gas leakage, even when they are not present at the location. Once the gas concentration returns to safe levels, the system automatically resets to normal monitoring mode, turning OFF the buzzer and exhaust fan. Overall, the working of the system ensures continuous monitoring, quick detection, immediate response, and real-time communication, thereby significantly enhancing safety and reliability.

### **IX. CONCLUSION**

This paper presents the design and implementation of an IoT-enabled gas leakage detection system using the ESP32 and the MQ-6 Gas Sensor. The proposed system effectively detects the presence of hazardous gases such as LPG and provides both local and remote alerts to ensure timely response. The integration of IoT technology enhances the functionality of conventional gas detection systems by enabling real-time monitoring and instant notification through cloud platforms and mobile applications. The system also incorporates automated safety measures, such as activating an exhaust fan using a relay module, which helps in reducing gas concentration and minimizing potential risks.

Experimental results demonstrate that the system offers fast response time, reliable performance, and efficient operation. Its low cost, ease of implementation, and scalability make it suitable for a wide range of applications, including residential, commercial, and industrial environments. Overall, the proposed system provides a smart, cost-effective, and reliable solution for gas leakage detection, significantly improving safety and reducing the risk of accidents caused by gas leaks.

### **X. FUTURE SCOPE**

The proposed IoT-enabled gas leakage detection system can be further enhanced by incorporating advanced technologies and additional safety features. Some potential areas for future improvement are as follows:

#### **Integration of GSM Module:**

Adding GSM capability will enable SMS and call alerts, ensuring notification even in the absence of Wi-Fi connectivity.

#### **Automatic Gas Valve Shut-Off System:**

The system can be extended to automatically close the gas supply using a solenoid valve when leakage is detected, preventing further hazards.

#### **Multi-Gas Detection:**

Incorporating additional sensors can allow detection of multiple gases such as carbon monoxide (CO), methane (CH<sub>4</sub>), and smoke, improving system versatility.

#### **AI-Based Prediction and Analysis:**

Machine learning algorithms can be used to analyze gas patterns and predict potential leakage before it becomes critical.

#### **Mobile Application Development:**

A dedicated mobile application with a real-time dashboard, historical data analysis, and alert management can enhance user interaction and control.

#### **Integration with Smart Home Systems:**

The system can be integrated with home automation platforms, enabling centralized monitoring and control along with other smart devices.

#### **Improved Sensor Accuracy:**

Using advanced and calibrated sensors can increase detection accuracy and reduce false alarms caused by environmental factors.



**Battery Backup System:**

Adding an uninterrupted power supply or battery backup will ensure continuous operation during power failures.

**Cloud Data Analytics:**

Advanced cloud integration can provide detailed insights, trends, and reports for better decision-making and preventive maintenance.

**REFERENCES**

- [1] M. Zhou, "A Wireless Sensor Network-Based Combustible Gas Detection System," *Sensors (Basel) / PMC*, 2025. Available:
- [2] B. F. Alshammari, "IoT Gas Leakage Detector and Warning Generator," *Engineering, Technology & Applied Science Research (ETASR)*, 2020. Available:
- [3] V. Tsoukas, "A Gas Leakage Detection Device Based on the MQ-135 Sensor," *Technologies*, vol. 11, no. 2, 2023. Available:
- [4] S. Panda, "Comprehensive review on gas sensors: Unveiling recent advances and challenges," *Sensors & Actuators A: Physical*, 2024. Available:
- [5] M. Anitha et al., "Development of an IoT-Enabled Air Pollution Monitoring System," *PMC/MDPI (open access)*, 2023. Available:
- [6] "Development of LPG Gas Leakage Detection using ESP32," *ResearchGate project report*, Jan. 17, 2024. Available:
- [7] "Gas Leakage and Fire Detector Based on Internet of Things (IoT) Network," conference/journal article (ThingSpeak/ESP32 implementations), 2023–2024. Available:
- [8] G. Karuna et al., "Air Quality and Hazardous Gas Detection using IoT," *E3S Conference Proceedings*, 2023. Available:
- [9] "Evaluating MQ Sensors in Gas Leakage Detection Systems," *JSAER (evaluation report)*, 2024. Available:
- [10] M. Ali et al., "A Comprehensive Review of Advanced Sensor Integration for Early Fire Detection," *MDPI Sensors/related journal*, 2025. Available:
- [11] "Gas Leakage Detection System Using IoT and Cloud Technology — A Review," *ResearchGate review*, 2023. Available:
- [11] T. N. V. Krishna, S. V. S. V. P. D. Kumar, S. Srinivasa Rao, and L. Chang, "Powering the future: Advances in EV battery systems," *International Journal of Energy Research*, 2024.
- [12]. V. J. Patil, S. B. Khadake, D. A. Tamboli, H. M. Mallad, S. M. Takpere and V. A. Sawant, "Review of AI in Power Electronics and Drive Systems," 2024 3rd International conference on Power Electronics and IoT Applications in Renewable Energy and its Control (PARC), Mathura, India, 2024, pp. 94-99, doi: 10.1109/PARC59193.2024.10486488
- [13]. A BalkrishnaDudgikar, A Ahmad Akbar Ingalgi, A GensidhaJamadar et al., "Intelligent battery swapping system for electric vehicles with charging stations locator on IoT and cloud platform", *International Journal of Advanced Research in Science Communication and Technology*, vol. 3, no. 1, pp. 204-208, January 2023. DOI: 10.48175/IJARSCT-7867. Available at: <https://ijarsct.co.in/Paper7867.pdf>
- [14]. S. B. Khadake and V. J. Patil, "Prototype Design & Development of Solar Based Electric Vehicle," 2023 3rd International Conference on Smart Generation Computing, Communication and Networking (SMART GENCON), Bangalore, India, 2023, pp. 1-7, doi: 10.1109/SMARTGENCON60755.2023.10442455.
- [15]. V. J. Patil, S. B. Khadake, D. A. Tamboli, H. M. Mallad, S. M. Takpere and V. A. Sawant, "A Comprehensive Analysis of Artificial Intelligence Integration in Electrical Engineering," 2024 5th International Conference on Mobile Computing and Sustainable Informatics (ICMCSI), Lalitpur, Nepal, 2024, pp. 484-491, doi: 10.1109/ICMCSI61536.2024.00076.
- [16]. Suhas B. Khadake, Sudarshan P. Dolli, K.S. Rathod, O.P. Waghmare and A.V. Deshpande, "AN OVERVIEW OF INTELLIGENT TRAFFIC CONTROL SYSTEM USING PLC AND USE OF CURRENT DATA OF VEHICLE TRAVELS", *JournalNX*, pp. 1-4, Jan. 2021.



- [17]. Shraddha S Magar, Archana S Sugandhi, Shweta H Pawar, Suhas B Khadake, H. M. Mallad, "Harnessing Wind Vibration, a Novel Approach towards Electric Energy Generation- Review", IJARSCT, Volume 4, Issue 2, October 2024, pp. 73-82. DOI: 10.48175/IJARSCT-19811.
- [18]. Khadake, S. B., Padavale, P. V., Dhere, P. M., & Lingade, B. M., "Automatic hand dispenser and temperature scanner for Covid-19 prevention", International Journal of Advanced Research in Science, Communication and Technology, 3(2), 362367. DOI: 10.48175/IJARSCT-11364. <https://ijarsct.co.in/A11364.pdf>
- [19]. Seema S Landage, Sonali R Chavan, Pooja A Kokate, Sonal P Lohar, M. K. Pawar, Suhas B Khadake., "Solar Outdoor Air Purifier With Air Quality Monitoring System", Synergies Of Innovation: Proceedings Of Ncstem 2023, Pp. 260-266, September, 2024. Available At: [https://www.researchgate.net/publication/383631190\\_Solar\\_Outdoor\\_Air\\_Purifier\\_with\\_Air\\_Quality\\_Monitoring\\_System](https://www.researchgate.net/publication/383631190_Solar_Outdoor_Air_Purifier_with_Air_Quality_Monitoring_System)
- [20]. Suhas B. Khadake. (2021). Detecting Salient Objects Of Natural Scene In A Video's Using Spatio-Temporal Saliency & Colour Map. Journalnx - A Multidisciplinary Peer Reviewed Journal, 2(08), 30–35. Retrieved From <https://Repo.Journalnx.Com/Index.Php/Nx/Article/View/1070>
- [21]. Khadake Suhas .B. (2021). Detecting Salient Objects In A Video's By Using spatio-Temporal Saliency & Colour Map. International Journal Of Innovations In Engineering Research And Technology, 3(8),1-9, <https://Repo.Ijert.Org/Index.Php/Ijert/Article/View/910>.
- [22]. Prachi S Bhosale, Pallavi D Kokare, Dipali S Potdar, Shrutika D Waghmode, V A Sawant, Suhas B Khadake., "DTMF Based Irrigation Water Pump Control System", Synergies Of Innovation: Proceedings Of NCSTEM 2023, Pp. 267-273, September, 2024. Available At: [https://www.researchgate.net/publication/383629320\\_DTMF\\_Based\\_Irrigation\\_Water\\_Pump\\_Control\\_System](https://www.researchgate.net/publication/383629320_DTMF_Based_Irrigation_Water_Pump_Control_System)
- [23]. Pramod Korake, Harshwardhan Murade, Rushikesh Doke, Vikas Narale, Suhas B. Khadake, Aniket S Chavan., "Automatic Load Sharing of Distribution Transformer using PLC", Synergies Of Innovation: Proceedings Of NCSTEM 2023, Pp. 253-259, September, 2024. Available At: [https://www.researchgate.net/publication/383628063\\_Automatic\\_Load\\_Sharing\\_of\\_Distribution\\_Transformer\\_using\\_PLC](https://www.researchgate.net/publication/383628063_Automatic_Load_Sharing_of_Distribution_Transformer_using_PLC)
- [24]. Suhas B khadake, Pranita J Kashid, Asmita M Kawade, Santoshi V Khedekar, H. M. Mallad ., "Electric Vehicle Technology Battery Management –Review", International Journal of Advanced Research in Science, Communication and Technology, Volume 3, Issue 2, September 2023, pp. 319-325. DOI: 10.48175/IJARSCT-13048. Available at: [https://www.researchgate.net/publication/374263508\\_Electric\\_Vehicle\\_Technology\\_Battery\\_Management\\_-\\_Review](https://www.researchgate.net/publication/374263508_Electric_Vehicle_Technology_Battery_Management_-_Review)
- [25]. Suhas B. khadake, Amol Chounde, Buddhapriy B. Gopnarayan, Karan Babaso Patil, Shashikant S Kamble. (2024). Human Health Care System: A New Approach towards Life, 15th International Conference on Advances in computing, Control, and Telecommunication Technologies, ACT 2024, 2024, 2, pp. 5487-5494.
- [26]. Khadake SB, Patil VJ, Mallad HM, Gopnarayan BB, Patil KB. Maximize farming productivity through agriculture 4.0 based intelligence, with use of agri tech sense advanced crop monitoring system. Grenze Int J Eng Technol. 2024;10(2):5127–5134. Available At: [https://www.researchgate.net/publication/382625572\\_Maximize\\_Farming\\_Productivity\\_through\\_Agriculture\\_40\\_base\\_d\\_Intelligence\\_with\\_use\\_of\\_Agri\\_Tech\\_Sense\\_Advanced\\_Crop\\_Monitoring\\_System](https://www.researchgate.net/publication/382625572_Maximize_Farming_Productivity_through_Agriculture_40_base_d_Intelligence_with_use_of_Agri_Tech_Sense_Advanced_Crop_Monitoring_System)
- [27]. Suhas B Khadake, Santoshi V Khedekar, Asmita M Kawade, Shradhha Shivaji Vyavahare, Pranita J Kashid, Chounde Amol B, H. M. Mallad., "Solar Based Electric Vehicle Charging System-Review", IJARSCT, vol. 4, Issue 2, December 2024, pp. 42-57, DOI: 10.48175/IJARSCT-22705.
- [28]. Akshay B Randive , Sneha Kiran Gaikwad , Suhas B Khadake , Mallad H. M., "Biodiesel: A Renewable Source of Fuel", IJARSCT, vol. 4, Issue 3, December 2024, pp. 225-240, DOI: 10.48175/IJARSCT-22836 Available at: [https://www.researchgate.net/publication/387352609\\_Biodiesel\\_A\\_Renewable\\_Source\\_of\\_Fuel](https://www.researchgate.net/publication/387352609_Biodiesel_A_Renewable_Source_of_Fuel)
- [29]. K. K. Sayyad Liyakat, S. B. Khadake, A. B. Chounde, A. A. Suryagan, M. H. M. and M. R. Khadatare, "AIDriven-IoT(AIIoT) Based Decision Making System for High-Blood Pressure Patient Healthcare Monitoring," 2024 International Conference on Sustainable Communication Networks and Application (ICSCNA), Theni, India, 2024, pp. 96-102, doi: 10.1109/ICSCNA63714.2024.10863954.



- [30]. K. K. Sayyad Liyakat, S. B. Khadake, D. A. Tamboli, V. A. Sawant, M. H. M. and S. Sathe, "AI-Driven- IoT(AIIoT) Based Decision-Making- KSK Approach in Drones for Climate Change Study," 2024 4th International Conference on Ubiquitous Computing and Intelligent Information Systems (ICUIS), Gobichettipalayam, India, 2024, pp. 1735-1744, doi:10.1109/ICUIS64676.2024.10866450.
- [31]. Suhas B khadake, Shraddha S Magar, Archana S Sugandhi, Shweta H Pawar, " A Research Paper on Harnessing Wind Vibration Novel Approach towards Electric Energy Generation", IJARSCT, Volume 5, Issue 4, May 2025, pp. 533-552. DOI: 10.48175/IJARSCT-26466. Available At [https://www.researchgate.net/publication/391857597\\_A\\_Research\\_Paper\\_on\\_Harnessing\\_Wind\\_Vibration\\_Novel\\_Approach\\_towards\\_Electric\\_Energy\\_Generation](https://www.researchgate.net/publication/391857597_A_Research_Paper_on_Harnessing_Wind_Vibration_Novel_Approach_towards_Electric_Energy_Generation)
- [32]. Avinash. A. Suryagan, Arti L Nemte, Kirti D Thorat, Suhas B Khadake, " IoT Based Flood Monitoring System by using Thing Speak Cloud", IJARSCT, Volume 5, Issue 4, May 2025, pp. 666-687. DOI: 10.48175/IJARSCT-26480
- [33]. Sagar M Chavare, Prasad P Nanaware, Shriprasad S Wagh, Ashish T Jadhav, Yeole Yogesh, Suhas B Khadake, " Smart Plant Monitoring and Automated Irrigation System Using IOT", IJARSCT, Volume 5, Issue 4, May 2025, pp. 688-706. DOI:10.48175/IJARSCT-26481
- [34]. Swapnil S Sudake, Suhas B Khadake, Santoshi V Khedekar, Asmita M Kawade, Shraddha S Vyavahare, " Solar Based Wireless Electric Vehicle Charging System", IJARSCT, Volume 5, Issue 5, May 2025, pp. 325-348. DOI:10.48175/IJARSCT-26647
- [35]. Manjeet Kumar, Shubhangi S Sul, Jyoti S Lakhara, Pranita J Kashid, Shravani R Bhinge, Amaraja S Waghmode, Suhas B Khadake, " Small Wind Electric System Energy Saver", IJARSCT, Volume 5, Issue 5, May 2025, pp. 447-466. DOI: 10.48175/IJARSCT-26663
- [36]. Namrata Ganesh Jadhav , Pranjali R Nagane , Akanksha M Khapare , Arvind Pande , Suhas B Khadake, "Identify and Measuring Parameter of PV Module Test Bench with the Ammeter and Voltmeter", IJARSCT, Volume 5, Issue 6, May 2025, pp. 5-24. DOI: 10.48175/IJARSCT-26702
- [37]. Sujit N. Bhandare, Prashant R. Mule, Yogesh A. Yeole, Krushna D More, Suhas B. Khadake, " Vehicle Tracking And Accident Alert System", IJARSCT, Volume 5, Issue 6, May 2025, pp. 234-252. DOI: 10.48175/IJARSCT-26728
- [38]. Manjeet Kumar, Suhas B Khadake, Madhuri S Doke, Shivani D Pujari, Pratiksha B Rupnar, " Sun Track: A Compact IoT System for PV Parameter Monitoring with NodeMCU", IJARSCT, Volume 5, Issue 9, May 2025, pp. 261-280. DOI: 10.48175/IJARSCT-27037
- [39]. Nikita R Bhosale , Sakshi D Shete , Laxmi A Koganure ,Aditi A Gaikwad ,Vedhangi S Sukre , Suhas B Khadake, " Development of a Real-Time Hydrogen Level Detection System for Storage Cylinders", IJARSCT, Volume 5, Issue 4, June 2025, pp. 690-708. DOI: 10.48175/IJARSCT-27666
- [40]. Bhinge Shravani Rajendra, Salunkhe Majushree Jayant, Tarse Mayuri Kundlik, Suhas B Khadake, B. B. Gopnarayan, Manisha P Bidve, " Smart Water Waste Collection System Using Bluetooth Control", IJARSCT, Volume 5, Issue 7, June 2025, pp. 561-578. DOI: 10.48175/IJARSCT-28072
- [41]. K. K. Sayyad Liyakat, S. B. Khadake, P. S. More, R. J. Shinde, K. P. Kondubhairi and S. S. Kamble, "AI-Driven IoT based Decision Making for Hepatitis Diseases Patient's Healthcare Monitoring: KSK Approach for Hepatitis Patient Monitoring," 2025 7th International Conference on Intelligent Sustainable Systems (ICISS), India, 2025, pp. 256-263, doi: 10.1109/ICISS63372.2025.11076213.
- [42]. K. K. Sayyad Liyakat, S. B. Khadake, K. Galani, K. B. Patil, A. Dhavale and S. D. Sarik, "AI-Powered-IoT (AIIoT) based Bridge Health Monitoring using Sensor Data for Smart City Management- A KSK Approach," 2025 7th International Conference on Intelligent Sustainable Systems (ICISS), India, 2025, pp. 296-305, doi: 10.1109/ICISS63372.2025.11076329.
- [43]. Rani N Bhosale , Tejashri M Salunkhe , Sayali S Ghodake , Shruti S Deshpande , Chandani N Kendale , Suhas B Khadake, " Smart Lawn Cutter using Solar and Bluetooth", IJARSCT, Volume 5, Issue 1, august 2025, pp. 158-171. DOI:10.48175/IJARSCT-28618.



- [44]. Ganesh Navnath Surwase, Ashish Tukaram Jadhav, Krushna Dinesh More, Ingudam Chitrasen Meitei, Suhas B Khadake, "Accident Detection and Alerting Using Embedded System", IJARSCT, Volume 5, Issue 2, October 2025, pp. 550-562. DOI: 10.48175/IJARSCT-29269.
- [45]. Rohini Walke, Samarth Mole, Rohan More, Sonali Salunkhe, Rahul Jadhav, Suhas B Khadake, "Automated Canopy System", IJARSCT, Volume 6, Issue 3, January 2026, pp. 438-447. DOI: 10.48175/IJARSCT-30956.
- [46]. Samarth S Mole, Rohini J Walke, Rohan D More, Sonali A Salunkhe, Rahul N Jadhav, Sagar S Kawade, Suhas B Khadake, "Automated Fertilizer Dispensing System", IJARSCT, Volume 6, Issue 4, January 2026, pp. 256-268. DOI: 10.48175/IJARSCT-31034.
- [47]. Khapare Akanksha Mahadev, Jadhav Namrata Ganesh, Kshirsagar Manasi Pravin, Waghmode Amarja Santosh, Dr. Mrinal K. Rajak, Suhas B Khadake, "Paper on Aqua Lift OWS (Oil Water Separator)", IJARSCT, Volume 6, Issue 8, March 2026, pp. 468-477. DOI: 10.48175/IJARSCT-32164.
- [48]. Sujit N. Bhandare, Prashant R. Mule, Yogesh A. Yeole, Suhas B. Khadake, "Vehicle to Vehicle Charging System", IJARSCT, Volume 6, Issue 2, April 2026, pp. 433-442. DOI: 10.48175/IJARSCT-32459.
- [49]. Sujit N. Bhandare, Prashant R. Mule, Yogesh A. Yeole, Suhas B. Khadake, "Vehicle to Vehicle Charging System", IJARSCT, Volume 6, Issue 2, April 2026, pp. 433-442. DOI: 10.48175/IJARSCT-32459.
- [50]. Suyog P Maindarkar, Soham R Salunke, Shriprasad S Wagh, Prathmesh A Dhekane, Sagar S Chaugule, Suhas B Khadake, "Solar-Powered Automated Electrocoagulation System for Sustainable Sugar Mill Wastewater Treatment", IJARSCT, Volume 6, Issue 3, April 2026, pp. 523-536. DOI: 10.48175/IJARSCT-32576.
- [51]. Nikita R Bhosale, Sakshi D Shete, Aditi A Gaikwad, Nikita S Patil, Suhas B Khadake, Vijay A Savant, "Design and Development of a BLDC Motor Test Bench for Performance Evaluation", IJARSCT, Volume 6, Issue 4, April 2026, pp. 654-663. DOI: 10.48175/IJARSCT-32676.
- [52]. Ganesh V Metkari, Rohan K Survase, Ashish T Jadhav, Sagar S Kawade, Suhas B. Khadake, "Design and Implementation of A Real-time Monitoring Platform to check the performance of E2V", IJARSCT, Volume 6, Issue 5, April 2026, pp. 549-563. DOI: 10.48175/IJARSCT-32873.
- [53]. Shravani R Bhinge, Manjushree J Salunkhe, Mayuri K Tarse, Tanjim P Bhaladar, Sagar S Chaugule, Suhas B Khadake, Sagar S. Kawade, "Design and Implementation of an Automated Product Handling Robot for Industrial Applications", IJARSCT, Volume 6, Issue 9, April 2026, pp. 181-195. DOI: 10.48175/IJARSCT-33226.
- [54]. Rani N Bhosale, Tejashri M Salunkhe, Sayali S Ghodake, Shruti S Deshpande, Suhas B Khadake, Vijay A. Savant, "An Evaluation of Battery Using Peltier Module", IJARSCT, Volume 6, Issue 9, April 2026, pp. 583-594. DOI: 10.48175/IJARSCT-33282.
- [55]. Madhuri S Doke, Pratiksha B Rupnar, Pranjali R Nagane, Shivani D Pujari, Manjeet Kumar, Suhas B Khadake, Sagar S Kawade, "Solar Powered Pesticides Sprayer with Multipurpose Application", IJARSCT, Volume 6, Issue 10, April 2026, pp. 186-199. DOI: 10.48175/IJARSCT-33425.
- [56]. Mayuri G Rupnar, Shruti G Parit, Priyanka S Suryawanshi, Sagar S Kawade, Suhas B Khadake, "Design and Implementation of A Real-time Monitoring Platform to check the performance of E2V", IJARSCT, Volume 6, Issue 10, April 2026, pp. 200-218. DOI: 10.48175/IJARSCT-33426.
- [57]. Mr. Pratik D. Nagtilak, Mr. Karanraj B. Pujari, Mr. Rushiprasad A. Nara, Mr. Kiran T. Wadekar, Dr. Mrinal K. Rajak, Suhas B Khadake, "Smart GSM-Based Power Meter with Continuous Load Monitoring", IJARSCT, Volume 6, Issue 10, April 2026, pp. 228-237. DOI: 10.48175/IJARSCT-33429.
- [58]. Ravikiran R khandagale, Prathamesh S Jamdade, Vishwajit V Babar, Suhas B Khadake, "GSM Based Substation Monitoring and Control System", IJARSCT, Volume 6, Issue 10, April 2026, pp. 238-248. DOI: 10.48175/IJARSCT-33430.
- [59]. Ranjit Kadam, Onkar Shinde, Mohit Londhe, Mayur Ingawale, Vijay Karande, Swapnil Bhosale, Suhas B Khadake, "Surveillance Car using ESP32 CAM Module", IJARSCT, Volume 6, Issue 10, April 2026, pp. 522-530. DOI: 10.48175/IJARSCT-33464.



- [60]. Shambhavi R Kurde, Vijayalaxmi A Vhate, Shravani H Pujari , Tejswini T Bhui, Jay S Raut, Misbah J Tamboli, Suhas B Khadake, “Solar Powered Multi-Utility Umbrella”, IJARSCT, Volume 6, Issue 11, April 2026,pp-211-223. DOI:10.48175/IJARSCT-33631
- [61]. Yash D Palkar, Nikhil K Waghachavare, Akash P Mane, Vikram S Rane, Paras P Jadhav, Pratik N Patil, Vijay A Sawant, Suhas B Khadake, “Real Time IoT-Enabled Smart Plant Irrigation and Weather Monitoring System using the ESP32 microcontroller & MATLAB”, IJARSCT, Volume 6, Issue 11, April 2026,pp-420-428. DOI:10.48175/IJARSCT-33660
- [62]. Komal V Anantkawalas, Sakshi K Bhosale, Chandani N Kendale, Khushi S Shaikh, Sujata A Galgunde, Monali S Landage, Suhas B Khadake, “IoT Based Health Monitoring System”, IJARSCT, Volume 6, Issue 11, April 2026,pp-453-462. DOI: 10.48175/IJARSCT-33665
- [63]. Prathmesh R Dulange, Prajwal U Bajantri, Sujal P Bajantri, Vivek D Patkulkar, Suhas B Khadake, Sagar S Chaugule, “Footstep Power Generation Using Piezoelectric Sensors”, IJARSCT, Volume 6, Issue 11, April 2026,pp-434-442. DOI: 10.48175/IJARSCT-33662
- [64]. Dhanashri D. Karande, Diksha S. Shinde, Sonali M. Gandule Smital S. Kumbhar, Dhanraj D. Daphale Suhas B Khadake, “Three Phase Motor Drive System Powered By Parallel Single Phase Rectifier”, IJARSCT, Volume 6, Issue 11, April 2026,pp-497-505. DOI:10.48175/IJARSCT-33671
- [65]. Jay S Raut, Aniket B Shinde, Sanskar S Ambare, Ravikiran S Chavan, Shambhavi R Kurde , S S Chougule, Suhas B Khadake, “Battery Monitoring and Detection System for EVs”, IJARSCT, Volume 6, Issue 12, April 2026,pp-89-98. DOI:10.48175/IJARSCT-33713

