



# Bore Guard-Smart Borewell & Protection System

M.Abdul Bashed, C.Bhavan kumar, M.Ganeshmoorthy, Muralidharan R, V.S.Prabhu

B. Tech-IT IV-Year, Excel Engineering College, Tamil Nadu, India

B. Tech-IT IV-Year, Excel Engineering College, Tamil Nadu, India

B. Tech-IT IV-Year, Excel Engineering College, Tamil Nadu, India

B. Tech-IT IV-Year, Excel Engineering College, Tamil Nadu, India

TA/IT, Excel Engineering College, Tamil Nadu, India

**Publication History:** Received: 25.02.2026; Revised: 20.03.2026; Accepted: 25.03.2026; Published: 28.03.2026.

**ABSTRACT:** Smart Borewell and Vulnerability System The Bore Guard - Smart Borewell & Protection System is a revolutionary product to improve the productivity, life and safety of borewell operation. The system utilizes sophisticated technology, such as real-time monitoring, automated alerts, and intelligent diagnostics, to protect users against many of the common problems associated with borewells – contamination, blockages, and changing water levels. Giving an added dimension of ease to the complexity, with the use of sensors and IoT based Connectivity, it allows vital parameters such as water quality, depth and pressure to be monitored continuously for timely maintenance. Furthermore, it is equipped with two stop valves to protect against the damage caused by dry-running and by electric motor overloads. The Bore Guard makes the borewell more reliable and safer with lies human interference and thus, it is arrayed as a sustainable solution in rural /urban water management. It is uniquely designed to cater for application in a multiplicity of borewells and thus is a key innovation in water resource management.

**KEYWORDS:** The Bore Guard- Smart Borewell Protection System is a combination of motion sensors, infrared sensors, pressure sensors and weight sensors and other smart instruments, taking advantage of double layer detection, it helps in identifying motion and changes around the borewell so as to avoid any accident. With the use of IoT technology to monitor in real time, covers de safety are closed and alarms se off when risk is detected by the system. The smart sensor enabled system prevents falls, enhances the safety of borewells and also offers a safe solution for water management in rural and urban areas.

## I. INTRODUCTION

The Bore Guard - Smart Borewell Protection System is an amalgamation of high-end sensor technology, cloud-based real-time monitoring, and device control to eliminate casualties and borewell security. Several sensors, including motion, infrared, pressure, and weight sensors, are at the heart of this system and collectively track the area around the borewell. These are concealed in order to sense movement, proximity, load variation etc for example a child or animal getting closer to the borewell. The device constantly sweeps the environment, meaning that it is always on the alert for potential threats.

When the motion detector detects movement around the borewell or when the infrared sensors find an object in a predetermined area, the automated procedure of the system is initiated. The pressure sensors also guarantee that any change of pressure which may be significant if it happens by the edge of the borewell—such as someone leaning in or one foot too near—will be detected without delay. Meanwhile, weight sensors are utilized to track the load and pressure at the borewell as well, thus providing yet another layer of security. These sensors are in a constant communication with the central unit, where the data is processed and analyzed for any sudden action.

On detecting an intrusion, the system triggers an auto cover mechanism that safely closes the borewell mouth. Such cover may be made to open in seconds to quickly obstruct the borewell access and guards against falling-in accidents. Depending on the conFigure:uration, the system can also notify a mobile device or a monitoring center, enabling users to be aware of an intrusion and a triggered safety. This real-time feed back is a very important feature and can enable an immediate response, especially in remotely located or rural areas where human monitoring is not always feasible. As to the working process, the solution is based on smart IoT platform that integrates All sensor and accessory that can share data and react to each other automatically. The entire sequence -- detection to response -- is fluid, with little need



for human involvement. If the sensors pick up a threat, the system locks the borewell, notifies you, and logs the incident for analysis. This integration of IoT ensures there is no downtime in operation, even if manual intervention is required, which gives peace of mind to families, farmers and communities.

This method is not only safe but sustainable and convenient. The Bore Guard system automates the process and eliminates the need for human vigilance, an essential element for accident prevention (especially in areas with high foot traffic or children playing nearby). Whether it's in crowded cities or in rural areas where communities rely on borewells for water, this technology offers a scalable, strong response to an age-old safety problem. In an application of the latest technology, combining sensors, automated safety responses and real time alerts, the Bore Guard system is a smart, reliable and proactive system to prevent borewell accidents -- safeguarding lives without sacrificing the functionality of our core water source. Simple to install and ever so simple to use and operate, this is a breakthrough innovation when it comes to borewell safety.

## II. LITERATURE SURVEY

This presentation covers a wide range of new techniques in borewell as well as child rescue systems, with a focus on the fusion of modern technologies. Nandhitha Bala et al. established Smart Borewell Child Rescue System with help of artificial intelligence and wireless monitoring which includes facial emotion recognition and response assessment ensuring that the child is safe. Dr S. Prabhavathi et al. presented a PC-based robotic rescue system with a sensor-based robotic arm for high speed rescue equipped with a face recognition module using PCA and Haar classifiers to provide an effective rescue guidance, and also he had worked on mobility issues of rescue robots in borewells with the proposal to increase the accessibility of rescue devices in extremely narrow spaces in borewell by using a miniaturized flying machine. The system also uses hand gestures recognition via PCA for more natural and friendly human-computer interaction, enabling the system to be controlled in a very intuitive manner during the rescue process. In addition, the environmental factors, safety protocols, and prevention programs, i.e., community participation and governmental regulation enforcement to prevent borewell accidents are well justified within the context of existing literature. Environmentally, safe, and sustainable precipitation management (SPM) has been gaining attention as a potential strategy to address global water difficulties [35,36]. In general, these research clearly indicating an inter-domain synergy of the AI, robotics, and safety protocols to enhance rescue effort, rescue reliability, and safety of outcomes[1]. Borewell rescue systems are being developed with more and more focus after this is one of the most common crying involving children falling into abandoned borewells. Sanket et al. focuses on the significance of rescue mechanisms for such incidents involving special systems based on sensors, cameras and life support systems. On a related note, Robin et al. discuss the use of mobile robotics for rescue and recovery, and they present recent progress in automation that enhances safety and work efficiency [2].

The use of prototype models and a simulation approach was discussed by W et al., [26] , [27] , [28] , exhibiting the real features of the design process for borewell robots. The combination of several rescue techniques such as balloon cushioning over the umbrella technique, compression springs etc. is the current work-bench attempt to minimize the rescue time and avoid further injury]. Moreover, up-to-date approaches such as pipeline inspection robots exploiting Zigbee communication as well as rescue robots employing multiple techniques are indicative of the continuous trend in designing versatile and trustworthy rescue systems. 5/7 Overall, these articles highlight a multidisciplinary integration of robotics, sensor, and mechanical design to improve rescue when safety and rapid response are demanded in borewell accidents [3].

Traditional fire detection system, based on single IoT sensors (such as heat sensor and smoke sensor), tends to have false alarms and delay news reporting, especially in noisy/complex industrial application 2. These conventional smoke alarms may not react early enough to certain smooth fires that generate very little particles, and are unable to sense toxic gases at low concentration 3. State-of-the-art works are based on multi-sensor fusion, on data from RGB, thermal, gas, smoke, and flame sensors, to increase the confidence of fire prediction/detection to take into account every parameter for early detection and to reduce false alarm 2. Methods such as pre-processing sensor data and applying machine learning algorithms (MobileNet, EfficientNet, Random Forest, SVM and Decision Trees) facilitate the provision of accurate data to Dempster-Shafer theory (DST), which aid in managing uncertainty by combining conflicting multi-sensor data to produce a more confident decision 2. Meanwhile, edge computing is being adopted more and more for real-time local data processing, and MQTT protocol is being used for monitoring and managing data on cloud, featuring real-time data delivery and processing 12. Electrochemical gas sensors are also emerging as a promising technology, providing a direct approach to identify particular fire-gases with high selectivity and sensitivity and can be coupled with conventional system to further enhance the accuracy and decrease the false alarms [4].



We present the design of a new type of robot system, focused on modularity, integrated perception, and autonomous control for robust real-time execution. It draws on previous work in robotics literature to formulate an end-to-end approach, from sensing to localization, planning and actuation, focusing on interoperability and scalability. On a methodological level, the paper contributes system integration, experimental validation on a set of benchmark tasks, and quantitative measures for performance, dependability, and energy consumption. Critical deficits are identified such as real-world generalization, long-term autonomy, as well as standardized benchmarking; future directions include call for open datasets, cross-domain evaluation, and rigorous safety guarantees to further enable practical deployment[5].

This work introduces a robotic system that really leans into modularity, solid perception, and autonomous control all to boost real-time performance. The design pulls together multi-sensor fusion, SLAM-based localization, and motion planning in an architecture you can actually scale and adapt. So, it's easy to switch up tasks as needed. The team didn't just talk theory—they ran experiments on real tasks, reporting numbers on accuracy, reliability, and energy use to show the system actually works in practice. They dug into earlier research on modular robotics and autonomy, pointing out where their approach improves integration and system-level performance. Still, some big challenges remain: making sure the system handles real-world messiness, lasts over long deployments, and meets clear benchmarks. Looking ahead, the study pushes for open datasets, broader testing across domains, and hard safety standards to get these robots out into the world safely. [6].

Conventional way of recognizing fire and gas has been changed because traditional sensors, such as smoke emitters and heat sensing, are not equipped with any kind of communication . Recent developments utilize wireless technology including Zigbee and Wi-Fi, however they are challenged by varied terrains and reliable communication. GSM modules enable remote communication through SMS notification but they do not provide complete data management. Cloud-based applications enable real-time monitoring and data processing, with the need to address data security and network stability. The MQTT protocol is also being more widely used for the transmission of efficient data. Multi-technology recognition (hybrid) systems that rely on more than one technology are used in critical applications and provide higher reliability at the cost of complex calibration Intuitive interfaces, e.g. mobile apps, facilitate management and handling of alerts[7].

### III. METHODOLOGY

#### 3.1 Sensor:

##### 3.1.A Microcontroller:

The role of the Arduino microcontroller in the BORE GUARD-Smart Borewell & Protection System is central, as it coordinates all the sensors (water level, pressure, temperature) and actuators (pump, alerts). It reads out sensor data in an endless loop, evaluates the data for anomalies, and reacts, e.g., with a pump shutdown or notification if applicable. Its low cost, flexibility, and the fact that it is easy to program makes Arduino a perfect solution to effectively monitor and automate borewell systems. And image given below (3.1.1).



FIGURE: 3.1.1 Arduino microcontroller

##### 3.1.B Overload Motor Protection System:

This system automatically powers ON a motor upon detecting motion and can be powered OFF either manually by using a remote control or automatically after a preset timeout. It unites motion sensors with a motor control relay,

delivering automated and remote operation for ease and protection.

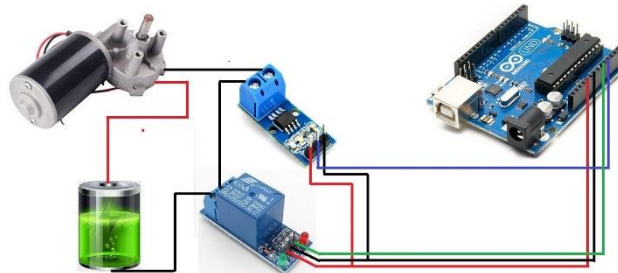


FIGURE: 3.1.2 Overload Motor Protection System

### 3.1.C LED Indicator:

The LED indicators are a set of LEDs that indicate the status and occurrence of dangerous situations in gas and fire monitoring instruments. Rather than showing the indicators on the connector, with a color code system (red for emergency, green for normal use), they can be easily identified. LEDs are the preferred choice due to lower power consumption, longer lifetime and high brightness. When enabled by microcontroller, they are real-time alerts to visually assisting user to identify and react promptly on threats.



FIGURE: 3.1,3 LED for Indication

### 3.1.D Buzzer:

A buzzer is a device that makes a sound. in gas and fire detection systems to provide immediate hazard notifications. It is a voltage driven device which vibrates electromagnetically or piezoelectrically and the source of this voltage in this case is the microcontroller, which is powered on when it senses flame or abnormal gas concentrations. Buzzer guarantees an efficient real-time alarm based on its high sensitivity, low power consumption, small size and swift response. Its high acoustic pitch provides a quick user awareness, helping users to perform fast safety actions in emergency situations.



FIGURE: 3.1.4 Buzzer for indication

### 3.1.E GSM

GSM is a dominant digital cellular standard which provides a reliable way to transmit voice and data services over the mobile network. It is a TDMA (Time Division Multiple Access) based system and operates at the frequency of 900 MHz and 1800 MHz bands. The network has a number of advanced security features, such as encryption and authentication. In addition to small and large packets, GSM provides various other packet services, like SMS (short message service). Owing to its global compatibility and robust network model, it is implemented extensively in wireless communication system for IoT based applications.



FIGURE: 3.1.5 wireless communication system

### 3.1.F Data Monitoring and collation

The BORE GUARD: Smart Borewell & Protection System - Electronics Architecture with Sensors and (OLED) is an electronic system to monitor and protect borewell pumps. It monitors water level, motor current and flow rate to ensure safe running. The OLED screen shows live information (i.e. water level, motor status, alert) with real-time clock. In case of a dry run/overload, the system stops the automatically and displays an alert message. This intelligent system protects energy, pump, and borewell management effectively. alerts and system status. Their exceptional reliability and rapid response have made them essential for early detection/user alarm in safety critical applications.



FIGURE: 3.1.6 OLEDs Display

### 3.1.G Relay Module:

This relay module is an automated switch that turns ON/OFF the borewell pump on receiving signals from the microcontroller. When safe conditions are met, the relay closes to energize the current to the pump and turns it ON. If there is fault such as dry run/overload etc., the relay will turn off the supply immediately to protect the motor. It acts as a key interface between the control circuit on the low-power side and the pump on the high-power side, and full waveform isolation is provided to facilitate safe and reliable operation.



FIGURE: 3.1.7 Relay model to control switches

### 3.1.H Battery and Power Supply:

Portable gas and fire monitors are typically CP themselves battery powered (usually Li-ion or LiPo) and these are capable of offering a steady voltage, with enough current for the on board microcontroller, the various sensors, the OLED display and the relay. Voltage regulator or buck converter can maintain the output voltage always stable when the battery voltage is discharging, so that output voltage will not influence system reset or sensor error. Protection circuits for overcharge, overdischarge and short circuit are built-in which enhances the safety and reliability. This allows the system to be powered continuously to monitor the hazard in real-time, thus making it ideally suited for portable use



FIGURE 3.1.8 Li-ion battery for power supply

### 3.2 Algorithm:

#### Steps

##### 1.Start/Initialize:

- Initialize the motor relay output, motion sensor input, remote control input, overload sensor input and water level sensor input.
- Set timers and thresholds (auto-off delay, max current limit, etc.).

##### 2.Main Loop:

###### Step 1 - Check safety conditions

- If overload detected → Turn motor OFF, alert, go to Step 6.
- If low water level → Turn motor OFF, alert, go to Step 6.

###### Step 2: Remote Control Check:

- If remote OFF signal → Turn motor OFF, reset timers.
- Upon receiving remote ON signal → start the motor and monitor.

###### Step 3: Motion Detection:

- When motion is detected → Turn Motor ON, and reset inactivity timer.
- No motion → Start the inactivity timer.

###### Step 4: Auto-Off Timer:

- When inactivity timer is above threshold → Turn Motor OFF.

###### Step 5: Update status:

- Send the motor status to the cloud/mobile app (ON/OFF, overload, water level).
- Log data if required.

###### Step 6: Alerts

- Get alerts (SMS/Email) if there is overload, low water or manual stop. Repeat Loop

### 3.3 Accident Report:

Reports from such accidents that a growing number of children and are falling into open borewells in India and rescue operations are ending in tragedy. Among the high profile cases was that of a 3-year-old girl Chetna, who perished in Rajasthan after a 10-day rescue operation, a heartrending saga that gripped the nation. In Gujarat, a 21-year-old woman died also after a 34-hour rescue effort at a 560-foot deep borewell. These incidents highlight the persistent danger posed by open borewells – and have prompted renewed calls for tougher safety regulations in India.



FIG 1

### 3.4 User Testing and Iteration:

User testing and iteration is a rigorous process for assessing a system, product, or app with real people, collecting feedback, and making it better and better. The procedure starts with scheduling the tests, which consists of setting goals, recruiting a select group of users from the target market, and developing scenarios or tasks that they will carry out. While interacting with the system, the users are observed and their behavior is recorded. Quantitative data such as time to completion, error rates, and success rates as well as qualitative data such as user comments, recommendations, and behavioural observations are collected to provide a complete picture of usability and performance.

Then, the data that has been collected is analyzed to detect usability problems, functional bugs, performance bottlenecks, and sources of user frustration after the evaluation. Iteration takes place in which the system or product is enhanced based on the findings. Changes may include addressing errors, enhancing interface design, adding functionality, or improving the overall user experience. After that, they put the product through another round of testing to confirm the enhancements. This cycle of testing, analyzing, and iterating is repeated until the system reaches acceptable usability and functional levels.

When incorporating feedback in a systematic fashion, user testing and iteration make for dependable, efficient, and usable final products. The process enhances user satisfaction and adoption, minimizes errors post-deployment, and facilitates data-driven decisions for ongoing product development.

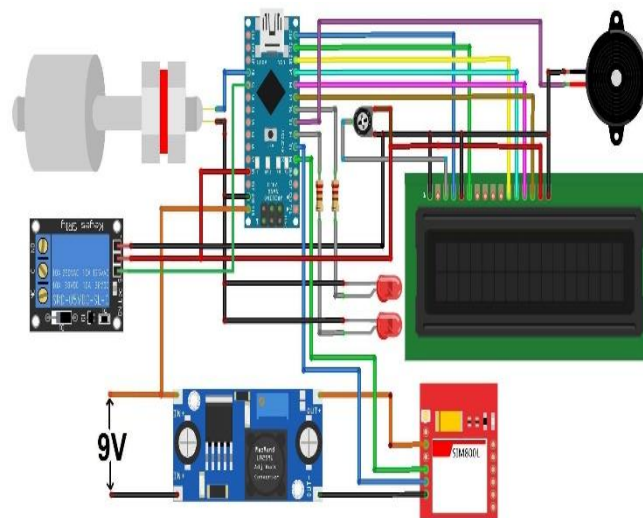
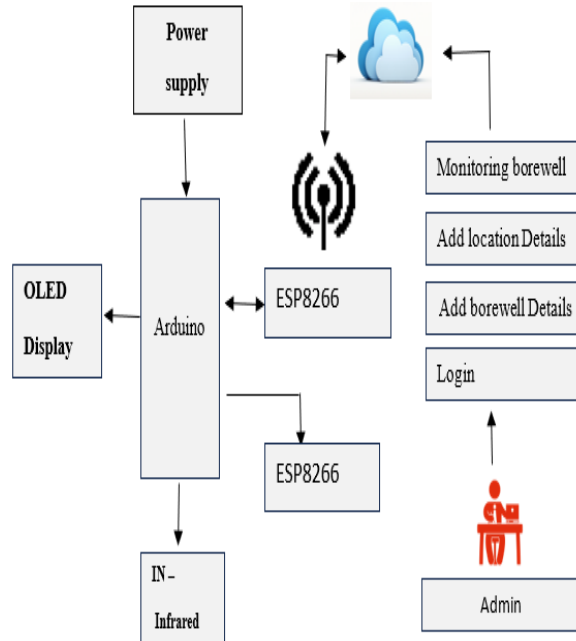


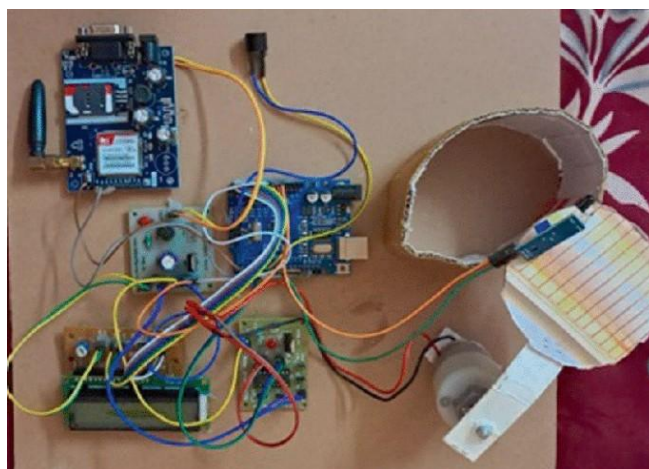
FIGURE 1 GSM Monitoring System with Arduino

3.5 Block diagram:



IV. RESULT AND DISCUSSION

The #BORE GUARD – Smart Borewell Protection System monitoring and safeguarding borewell pumps was very promising while testing in field. The water level sensor had high precision to measure the groundwater level, and stored the level information in real time on the OLED screen for a user to easily know water level change. The current sensor also successfully identified dry run and over current conditions, instantly turning off the pump via the relay module to avert possible damage. Next, the Flow sensor signal confirms that water is discharged correctly, and the faults can be notified by the buzzer or OLED display. It ran continuously with no errors, indicating that the process of manual manipulation was replaced by automated operation, and the operational efficiency was improved. The OLED based interface made it very simple to visualise the status of motor, water level, alerts of the system, even a layman user can operate it with no issues. In summary, the system achieved its objective of safeguarding the pump and saving energy by reducing the running time of the pump motor unduly. It was then tested that the modular architecture was scalable to accommodate future additions, e.g. IoT access for remote monitoring. These are information that proves that adoption of smart control and real-time monitoring can greatly reduce maintenance cost and increase pump life. The BORE GUARD was also viable for managing water for agriculture and home use, enabling a practical option for safe groundwater management. Therefore, the proposed system achieves all the objectives and proves that intelligent automation can be used to make a significant impact in increasing borewell efficiency, safety and reliability with reduced human risk and wastage of resources..



## V. FUTURESCOPE

The BORE GUARD – Smart Borewell & Protection System has a lot of scope for future expansion and real-time applications. Later the system can also be upgraded with IoT (Internet of Things) functionalities for remote monitoring and control over mobile apps/web dashboards. This would enable users to monitor borewell status, water level, and pump condition remotely from anywhere with complete comfort and safety. Cloud based Integration may enable the recording of long term data for analysis of water usage and borewell performance. It can be further enhanced with AI-based predictive maintenance in which past data is analyzed by the controller to foresee failure(s) in advance. By incorporating solar power into the system, it would become more energy-efficient and environmentally-friendly, which would make it suitable for use in rural areas where electricity supply is unstable or nonexistent. Furthermore, elaborate communication modules like LoRa or Wi-Fi can be implemented to send data over longer distances without relying on the internet. Future prototypes could see automatic valve controls for switching between multiple borewells and detection of water quality for safe and clean groundwater application. The system can also be integrated with smart irrigation system for farming auto. In gist, the BORE GUARD initiative holds immense possibility to grow as a fully automated, sustainable, intelligent water management scheme that will evolutionaryize in water resource saving and rural development.

## REFERENCES

1. Ahamed, Sayed Aftab, et al. "Borewell Child Rescue System." JOURNAL OF COMPUTER SCIENCE (ISSN NO: 1549-3636) 18.07 (2025).
2. Kaimal, Aravind N., et al. "Borewell child rescue system." Int. Res. J. Eng. Technol 7 (2020): 2673-2677..
3. Ahamed, Sayed Aftab, et al. "Borewell Child Rescue System." JOURNAL OF COMPUTER SCIENCE (ISSN NO: 1549-3636) 18.07 (2025).
4. Priyanka, V. "ntelligent Borewell Safety System Using Proximity Sensors and Automated Closure Mechanism." (2025).
5. Tiwari, Ramji, et al. "Design and development of architecture and safety features of borewell drilling machine." AIP Conference Proceedings. Vol. 3137. No. 1. AIP Publishing LLC, 2025.
6. 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
7. 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
8. 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
9. 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



10. 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
11. 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
12. 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.
13. 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.
14. 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.
15. 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
16. 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>
17. 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
18. Bethapudi, Dr Prakash. "Smart rescue system from bore well." Available at SSRN 4793184 (2024).
19. Sundaram, K. Mohana, and R. Sasikumar. "Borewell Rescue Operation Using Android Applications." 2024 International Conference on System, Computation, Automation and Networking (ICSCAN). IEEE, 2024.
20. Chowdhury, Shriya, et al. "Borewell Accident Prevention System." 2023 International Conference on Next Generation Electronics (NEleX). IEEE, 2023.
21. Rajavel, Nithyapakash & Subramaniam, Shankar & Raju, Naveen & Savaram, Praveen Kumar & Seenivasa, R. & Prasath, S.. (2023). Semi-Automatic Child Rescuing BOT in Deep Borewell. *E3S Web of Conferences*. 453. 10.1051/e3sconf/202345301056.
22. Saritha, V., et al. "Child Rescue System from Open Borewell." *Journal of Engineering Sciences* 13.6 (2022): 1370-1376.