# IOT POWERED CHILD SAFETY AND RESCUE SYSTEM FROM OPEN BORE-WELL

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**ABSTARCT-**Borewell accidents have emerged as a serious safety concern in India, particularly in rural regions where many borewells are left uncovered or abandoned. Children are the most affected victims due to accidental falls into these narrow and deep structures. Rescue operations in borewells are extremely challenging because of limited space, poor visibility, and increasing depth. The lack of sufficient oxygen and the possible presence of harmful gases further increase the risk to the trapped individual. Conventional rescue techniques are often slow, unsafe, and highly dependent on manual labour. To overcome these limitations, this work presents an IoT-enabled robotic borewell rescue system designed to enhance rescue efficiency and safety. The proposed system uses an ESP8266 microcontroller for real-time data collection and communication. Environmental parameters such as temperature, humidity, and oxygen concentration are continuously monitored using appropriate sensors, while an MQ2 sensor is employed to detect hazardous gases. An ESP32-CAM module provides live video streaming from inside the borewell, allowing rescue teams to assess the victim's position and condition accurately. An IPID web interface displays real time sensor data and display the live video streaming facilitating informed decision-making.

A motor- driven robotic arm mechanism is integrated to safely grip and lift the trapped individual. By combining real-time sensor monitoring, live visual feedback, and remote-controlled actuation, the proposed system reduces rescue time, minimizes risk to rescue personnel, and improves the success rate of borewell rescue operations.

**Keywords:** Borewell Rescue System, Internet of Things (IoT), Robotic Rescue Mechanism, ESP8266, ESP32- CAM, Environmental Monitoring, Gas Detection, Real-Time Video Streaming, Child Safety, Embedded System.

## 1.INTRODUCTION

Uncovered and unused borewells continue to pose a serious danger in many parts of the country, especially in rural and semi-urban areas where safety regulations are often overlooked. These narrow and deep shafts

shaftsare difficult to detect and can easily lead to accidental falls, particularly among children. Once trapped inside a borewell, the victim faces life-threatening conditions such as limited oxygen supply, darkness, restricted movement, and delayed access to rescue assistance. Due to these challenges, conventional rescue practices frequently fail to deliver timely results.

Traditional rescue techniques mainly depend on manual excavation, rope-based lifting, or improvised tools, all of which require significant time and expose rescuers to high risk. The absence of real-time information about the internal environment of the borewell further complicates rescue planning and decision-making. These limitations highlight the urgent need for a technology-driven rescue solution that can operate effectively in confined and hazardous conditions.

With the advancement of Internet of Things (IoT) technology, embedded controllers, and robotic systems, it is now possible to develop intelligent rescue mechanisms capable of monitoring and operating remotely. IoT-based systems enable continuous observation of critical environmental parameters, while robotic components allow controlled movement and manipulation without direct human involvement. This integration significantly enhances both rescue speed and operational safety.

The proposed project focuses on the development of an IoT-powered child safety and borewell rescue system designed to support emergency rescue operations. An ESP8266 microcontroller acts as the core processing unit, interfaced with sensors that track temperature, humidity, oxygen concentration, and harmful gas presence inside the borewell. Visual monitoring is achieved using an ESP32-CAM module, which provides real-time video feedback to help rescuers locate and assess the trapped child.

To facilitate safe recovery, the system incorporates motor-driven mechanisms and a robotic arm capable of controlled vertical motion and secure lifting. Alert functions are also included to notify rescue teams when dangerous environmental conditions are detected. By combining sensor-based monitoring, live video streaming, and remote robotic control, the proposed system aims to reduce rescue delays, improve safety conditions, and increase the likelihood of successful borewell rescues.

Overall, the system offers a practical, affordable, and efficient solution for addressing borewell related emergencies addressing borewell-related emergencies and enhancing child safety.

## 2. LITERATURE SURVEY

Patel & Mehta (2021) implemented environmental monitoring using ESP8266 with MQ2 gas and DHT11 temperature and Humidity sensors. The system reliably detects hazardous gases and environmental changes to issue safety alerts. This work focuses on the role of ESP8266in IoT-based monitoring systems. The microcontroller is paired with MQ2 and DHT11 sensors to measure oxygen, humidity and temperature The authors argue that continuous monitor- ing of borewell environments can prevent fatalities by alerting rescuers to unsafe conditions. The system is cost-effective and suitable for rural deployment.

Sharma R. & Gupta A. (2022) proposed an IoT-based borewell rescue system integrating the ESP8266 microcontroller with gas and temperature sensors to monitor internal borewell environments. A motor-controlled robotic arm serves to lift trapped persons while live environmental data aids decision-making. The study emphasizes that IoT monitoring enhances response safety and speed compared to traditional manual digging methods.

Singh, P., & Kumar, S. (2021) explored the use of the ESP32-CAM module for real-time video monitoring in hazardous environments. The paper explores the use of ESP32 microcontrollers for live video streaming in hazardous environments. ESP32-CAM modules are deployed to capture visuals in confined spaces such as borewells.The study demonstrates how real-time video enhances decision-making during rescue operations, allowing rescuers to remotely assess conditions before deploying mechanical interventions.

Mishra A.(2020) analyzed robotic systems for disaster management, particularly mechanical rescue in confined spaces. The study describes low-RPM motor-driven arms for controlled movement but lacks IoT integration for real-time monitoring. The book discusses the application of robotics in disaster recovery, including borewell rescues. Robotic arms powered by low RPM motors are highlighted as effective tools for controlled movement in narrow shafts. The author emphasizes the combin- Ing robotics with IoT technologies to achieve safe and efficient rescues.

Kumar,R.,&Verma, N.(2020) investigated IoT applications for underground mining safety through continuous sensing of oxygen and hazardous gases. This paper examines IoT-based monitoring systems in underground mining, which share similar challenges with borewell rescues such as oxygen depletion and confined spaces. The authors propose integrating sensors with microcontrollers to continuously monitor environmental conditions. Their findings validate the feasibility of applying similar IoT solutions to borewell rescue operations Although conceptually applicable to borewell scenarios, this work is oriented toward preventive worker safety rather than immediate rescue operations.

## 3.PROPOSED SYSTEM

The proposed system presents an IoT-enabled borewell rescue solution aimed at enhancing child safety during emergency situations in narrow and hazardous borewell environments. The system integrates environmental sensing, wireless communication, live video monitoring, and robotic actuation into a unified and modular architecture. This design ensures reliable operation, scalability, and remote supervision while minimizing direct human intervention and associated operational risks.By combining real-time data aquistion

with mechanical rescue mechanisms, the system enables efficient and coordinated rescue operations under constrained under-ground conditions.

The overall system architecture follows a modular IoT framework consisting of environmental sensors, an embedded control unit, wireless communication modules, a camera subsystem, and motorized rescue components. All subsystems are coordinated through a central microcontroller, which ensures seamless data flow, real-time monitoring, and precise actuator control. The architecture is specifically designed for safe deployment within borewells, allowing continuous surface-level monitoring and remote operation without requiring manual entry into hazardous zones.

The environmental sensing unit continuou-sly monitors critical borewell parameters, including temperature, humidity, oxygen concentration, and the presence of hazardo-

-us gases. These parameters provide real-time insight into the internal atmospheric conditions of the borewell. Continuous monitoring enables assessment of survive

ability conditions and supports timely, data-driven rescue decisions. The sensing mechanism plays a vital role in ensuring both victim safety and operational reliability.

An ESP8266 microcontroller functions as the central embedded control unit of the system. It interfaces with all environmental sensors to acquire real-time data and performs preliminary preprocessing tasks such as signal conditioning, noise filtering, and threshold evaluation. In addition to data processing, the controller manages communication with the remote monitoring interface and coordinates the operation of motors and robotic actuators, thereby serving as the core intelligence of the rescue system.

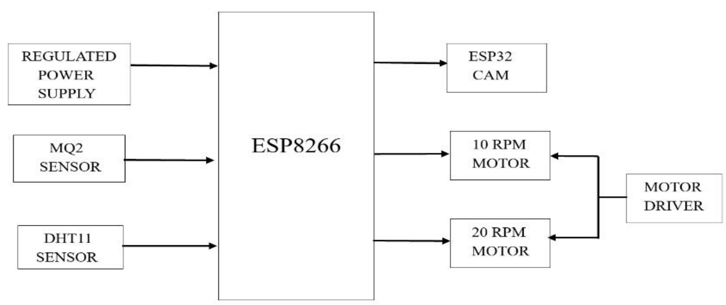
Wireless communication is implemented using Wi-Fi technology to transmit processed sensor data to a remote monitoring dashboard. This enables rescue personnel to receive continuous real-time updates without physically accessing the borewell interior. The communication module is designed to provide reliable and low-latency data transmission, ensuring uninterrupted monitoring and control throughout the rescue operation.

To enhance situational awareness, an ESP32-CAM module is integrated into the rescue unit to provide real-time video streaming from inside the borewell. The live video feed delivers continuous visual information regarding the trapped child's condition and surrounding environment. This visual feedback assists rescue teams in accurate robotic positioning, controlled movement, and safe execution of extraction procedures.

The robotic rescue mechanism consists of motor-driven vertical movement units and a robotic arm designed to stabilize and securely hold the trapped child. The motors enable controlled descent and ascent of the rescue device, while the robotic arm ensures firm yet safe handling within the confined borewell space. All mechanical operations are remotely controlled to achieve smooth, precise, and coordinated movement, thereby reducing the risk of injury during extraction.

To further enhance operational safety, predefined threshold values are established for critical environmental parameters such as oxygen concentration and hazardous gas levels.If any parameter exceeds permissible limits, the system immediately generates alert notifications to rescue personnel. This safety and alert mechanism facilitates prompt corrective action, reduces the operational hazards, and improves the overall effectiveness and reliability of the rescue process.

**Fig 1: Block Diagram**



## 4.COMPONENTS DESCRIPTION

### 1. ESP32 CAM MODULE:

The ESP32-CAM module is used for real-time video streaming inside the borewell. It integrates an ESP32 microcontroller with an OV2640 camera module, enabling live image capture and wireless transmission.

This module provides continuous visual monitoring of the trapped child and surrounding borewell conditions. The live video feed assists rescue personnel in accurately positioning the robotic arm and ensuring safe extraction.


Fig2: ESP-32 CAM

### 2. ESP8266 MICROCONTROLLER:

The ESP8266 is a low-cost Wi-Fi-enabled microcontroller that serves as the central control unit of the system.

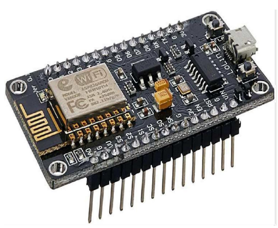


Fig3: ESP8266 Micro controller

It is responsible for collecting data from environmental sensors, performing basic data processing, and transmitting the information to the remote monitoring interface.

### 3.MQ2 GAS SENSOR:

The MQ2 sensor is used to detect hazardous gases such as LPG, methane, propane, hydrogen, and smoke. It operates based on changes in resistance when exposed to combustible gases.

In borewell rescue scenarios, the detection of toxic or flammable gases is crucial to assess the survivability conditions of the trapped child. The sensor continuously sends analog signals to the ESP8266 for processing and threshold evaluation.

Fig4:MQ2 sensor

### 4. DHT11 SENSOR:

The DHT11 sensor measures ambient temperature and relative humidity inside the borewell. It provides digital output, making it easy to interface with the microcontroller.

Monitoring temperature and humidity is essential to evaluate the environmental comfort and stress condition affecting the trapped child. The sensor periodically transmits real-time data to the control unit for analysis.

Fig5: DHT11 Sensor

**5. L298N MOTOR DRIVER:**

A motor driver module (such as L298N) is used to control DC motors that operate the robotic arm and vertical movement system. Since microcontrollers cannot directly drive high-current motors, the motor driver acts as an interface between the ESP8266 and the motors.

The driver enables bidirectional control and speed regulation, allowing smooth and precise movement within the confined borewell space.

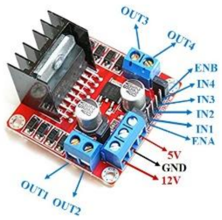



Fig6: L298N MOTOR DRIVER

**6. ROBOTIC ARM MECHANISM:**

The robotic arm is designed to securely hold and stabilize the trapped child during extraction. It is controlled via the motor driver and operated remotely through the monitoring interface.

The arm is constructed to provide firm grip strength while ensuring safe handling to prevent injury. Its design allows operation within narrow borewell diameters.

Fig7: Robotic Arm

**7. DC MOTORS:**

DC motors are used for vertical movement of the rescue device and operation of the robotic gripping mechanism. These motors ensure controlled descent and ascent of the system inside the borewell.

Proper speed control is maintained to prevent sudden jerks or instability during rescue operations.

Fig8: DC Motors

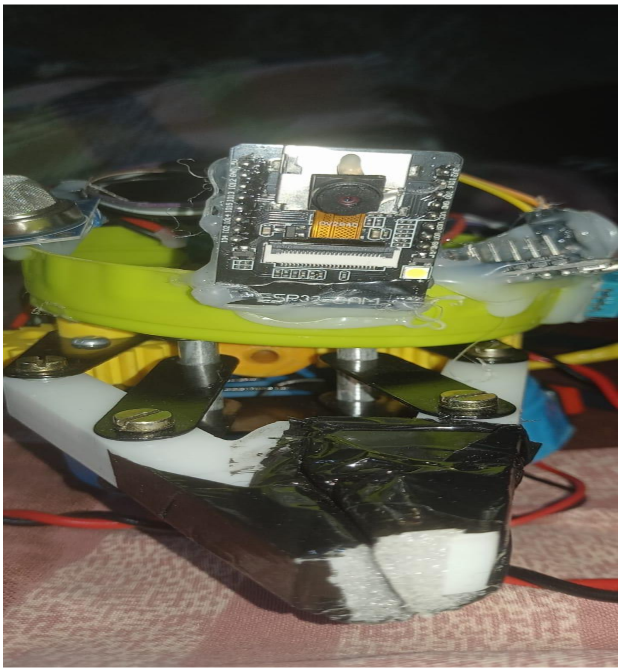
**8. POWER SUPPLY UNIT:**

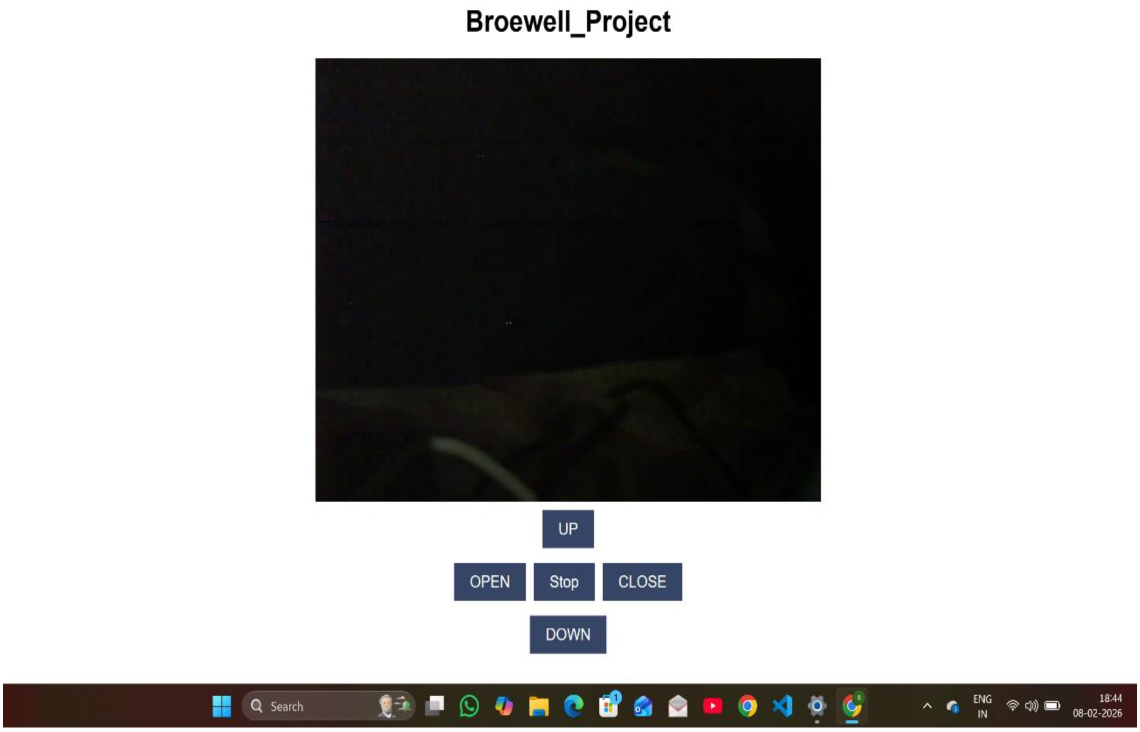
The power supply unit provides regulated voltage to all system. Typically, a 5V–12V DC supply is used depending on motor and controller requirements. Stable power delivery is critical to ensure uninterrupted operation during rescue missions. Voltage regulators and protection circuits are included to prevent over current and voltage fluctuations.

Fig9: Battery

## 4.RESULTS AND DISCUSSION

**Fig10: Kit Working**




Broewell_Project
UP
OPEN
Stop
CLOSE
DOWN
Search
ENG
IN
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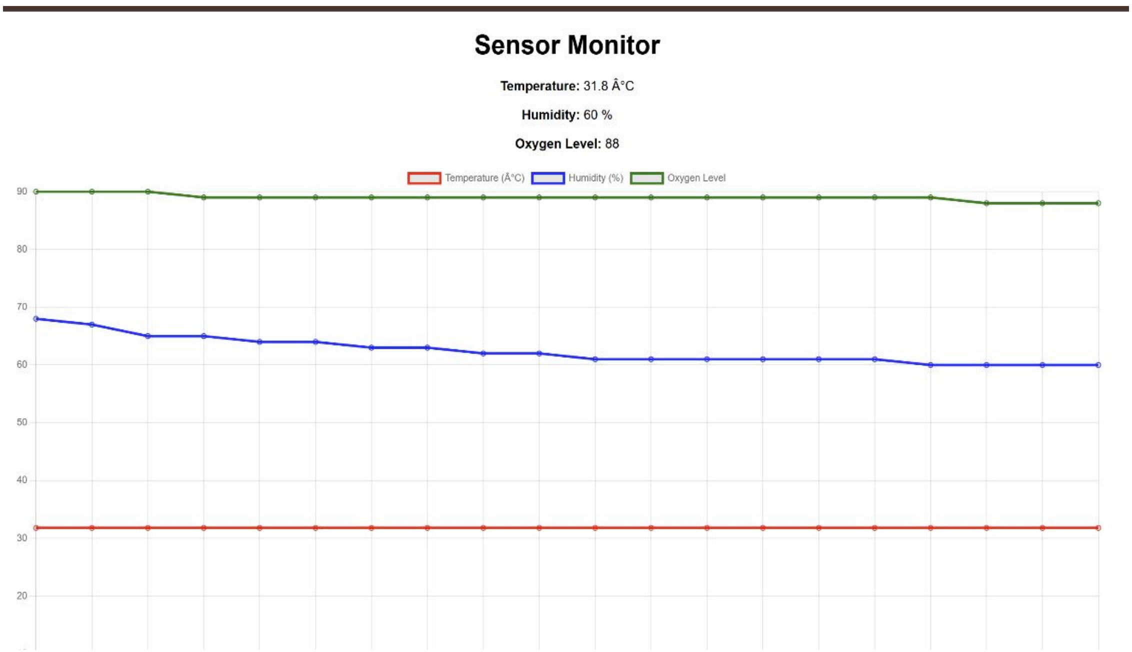
Sensor Monitor
Temperature: 31.8 Â°C
Humidity: 60 %
Oxygen Level: 88
Temperature (Â°C)
Humidity (%)
Oxygen Level
90
80
70
60
50
40
30
20

The proposed project is an IoT-enabled borewell rescue system designed to safely monitor and rescue a child trapped inside a borewell.

The system integrates environmental sensing, live video monitoring, wireless communication, and a robotic rescue mechanism into a single coordinated unit.

The rescue device is carefully lowered into the borewell using a controlled motor mechanism. Once deployed, the environm--ental sensing unit begins monitoring critical parameters such as temperature, humidity, oxygen level, and the presence of hazardous gases using sensors like MQ2 and DHT11.These sensor readings are continuously transmitted through the ESP8266 microcontroller to a remote monitoring dashboard via Wi-Fi, allowing rescue personnel to assess internal borewell conditions in real time.

Simultaneously, the ESP32-CAM module provides live video streaming from inside the borewell. The visual feed enables operators to observe the trapped child's position and surrounding environment, ensuring accurate alignment and controlled operation of the rescue mechanism.

Based on the real-time sensor data and live video feedback, the robotic arm mechanism is remotely operated. The motor-driven arm gently stabilizes and securely holds the child. After proper positioning and secure gripping, the vertical motor system carefully lifts the child to the surface.

In addition, the system includes a safety alert mechanism that triggers notifications if oxygen levels drop or hazardous gas concentrations exceed predefined threshold

This ensures timely intervention and enhances operational safety.

Overall, we built a modular, IoT-based intelligent rescue system that combines monitoring, communication, visualization, and mechanical extraction into a single platform.The integration of these components significantly improves rescue efficiency, reduces risk to human rescuers, and increases the chances of survival compared to traditional manual rescue methods.

## 5. CONCLUSION

In conclusion, the IoT-based borewell rescue system using ESP32 and ESP8266 provides an efficient, automated solution for addressing borewell accidents. The system leverages sensor technologies to monitor oxygen, temperature, and humidity in real time, while the ESP32 camera delivers live video streaming for situational awareness. By integrating motorized robotic arms, the system enables safe and precise rescue operations without requiring human entry into the borewell.

The use of affordable components such as ESP32, ESP8266, MQ2, and DHT11 makes
the solution cost-effective and practical for deployment in rural areas where borewell accidents are most common. Real-time monitoring, remote control, and centralized dashboards enhance operational efficiency, ensuring rescuers can act quickly and effectively.

This project not only automates the rescue process but also offers scalability, safety assurance, and adaptability for future enhancements. Ultimately, the system reduces manual effort, minimizes risks to rescuers, and increases the chances of survival for trapped individuals. By combining IoT, robotics, and sensor technologies, the borewell rescue system exemplifies how modern innovations can be harnessed to solve life-critical challenges, contributing to safer communities and more effective disaster management.

## 6. FUTURE SCOPE

The proposed IoT-based borewell rescue system demonstrates a promising solution to one of the most critical safety challenges faced in rural and urban areas. While the current prototype integrates ESP32 cameras, ESP8266 microcontrollers, MQ2 and DHT11 sensors, and motorized robotic arms, there are several opportunities for future enhancement:

- Advanced Robotics:
  Future versions can incorporate multi-axis robotic arms with enhanced gripping mechanisms to improve precision and safety during rescue operations.

- AI-Based Decision Support:
  Artificial Intelligence can be integrated to analyze sensor data and video feeds, providing predictive alerts and automated decision-making during rescue missions.

- Improved Sensor Technology:
  More advanced sensors (e.g., infrared, thermal imaging, or $CO_2$ detectors) can be added to monitor borewell conditions more comprehensively.

- Cloud Integration:
  A cloud-based monitoring platform can be developed to store rescue data, provide real-time dashboards, and enable remote collaboration among rescue teams.

- Drone Assistance:
  Drones can be used to quickly deploy rescue devices and provide aerial monitoring of the accident site.

- Portable and Modular Design:
  The system can be redesigned to be more compact and modular, allowing rapid deployment in diverse borewell environments.

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