

Smart Bore-Well Emergency Rescue Robot with Real-Time Camera and Control

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ABSTRACT: Bore well accidents are a major safety concern, particularly in rural areas where open or unused bore wells pose serious risks, especially to children. Traditional rescue operations are often time-consuming, complex, and hazardous due to the narrow and deep structure of bore wells. To overcome these challenges, a Smart Bore well Emergency Rescue Robot with real-time camera and control is proposed to assist rescue teams in locating and saving victims quickly and safely. The system consists of a robotic mechanism equipped with a live camera, lighting system, sensors, and a robotic gripping arm. The camera provides real-time video to operators, enabling clear observation of the victim's condition and the bore well environment. Using a remote control interface, the operator can precisely maneuver the robot and position the rescue arm to secure the victim. Additional features such as oxygen supply, temperature monitoring, and proper illumination help improve the victim's survival chances during rescue operations. By integrating robotics, real-time monitoring, and wireless communication, the proposed system reduces rescue time, improves operational accuracy, and minimizes risks. This approach offers an effective technological solution for bore well emergencies, significantly enhancing the chances of saving lives in critical situations.

KEY WORDS: ESP-CAM, Arduino Micro controller, Robotic ARM, Internet of Things

1.INTRODUCTION

Borewell accidents represent one of the most tragic and time-sensitive emergency situations that occur primarily in rural and semi-urban areas across developing countries. A borewell, typically drilled for agricultural irrigation or drinking water purposes, becomes a death trap when left uncovered or improperly sealed after abandonment. These narrow, deep vertical shafts, often ranging from 100 to 500 feet

in depth with diameters as small as 6 to 8 inches, pose severe risks especially to young children who may accidentally fall into them while playing in agricultural fields or open areas. The confined space, limited oxygen supply, and difficult accessibility make rescue operations extremely challenging and time-critical. Traditional rescue methods involve manual digging of parallel borewells or the use of conventional ropes and hooks, which are

not only time-consuming but also pose risks of further injury to the trapped victim. Statistics indicate that survival rates decrease dramatically with each passing hour, making rapid detection and rescue absolutely critical.

The advancement of Internet of Things (IoT) technology and microcontroller platforms has opened new possibilities for addressing complex real-world problems through intelligent, interconnected systems. The Arduino Uno (ATmega328P) is a reliable and cost-effective platform for emergency embedded systems, offering easy programming and multiple I/O pins for sensor and actuator integration. With IoT technology, it enables real-time monitoring, victim detection, and control of rescue mechanisms in borewell accidents, along with data processing and visual support using modules like ESP-CAM.

The application of computer vision through ESP-CAM modules enables visual detection and assessment of the victim's condition, while environmental sensors like DHT11 can monitor critical parameters such as temperature and humidity within the bore well.

develop robust embedded software with fail-safe mechanisms and error handling to ensure reliable operation during critical rescue missions, create a cost-effective

solution accessible to rural communities and local governments by leveraging the affordable Arduino Uno platform and readily available sensors, and establish a modular system architecture that allows for easy maintenance, component replacement, and future upgrades, ultimately transforming borewell rescue from a manual, time-intensive, high-risk process into an automated, efficient, safe, and life-saving operation that can be deployed across vulnerable regions to prevent tragic losses and save precious lives.

2.LITERATURE SURVEY

Kumar, S., & Verma, A. (2021) - The authors developed an integrated system combining Arduino, IoT sensors, and mobile application interfaces via Bluetooth for real-time monitoring and control of rescue operations. Their work emphasized user interface design for enabling non-technical personnel to operate complex rescue systems effectively through smartphone applications.

Nair, P., & Pillai, R. (2019) - This research investigated the use of ESP-CAM modules interfaced with Arduino for low-latency image capture and transmission in confined space rescue operations. The study addressed image quality optimization and power management techniques for extended operation in deep borewells.

Joshi, M., & Kulkarni, P. (2018) - The paper presented a comprehensive safety framework for borewell accident prevention through Arduino-based automated monitoring and motorized covering mechanisms. The research emphasized proactive safety measures to prevent accidents rather than solely focusing on reactive rescue operations.

3. PROPOSED SYSTEM

The proposed IoT-based bore well victim detection and rescue system is an intelligent and automated solution centred around an Arduino Uno microcontroller. It integrates sensors, a camera module (ESP-CAM), and a Bluetooth module to detect the presence of a victim through environmental data and real-time visual monitoring, while enabling remote control and communication. The system processes sensor inputs to automatically initiate rescue operations using a robotic arm and motor mechanism. An LCD displays real-time status, and LED indicators provide quick visual feedback. This integrated approach ensures faster detection, efficient rescue, and improved safety compared to traditional manual methods.

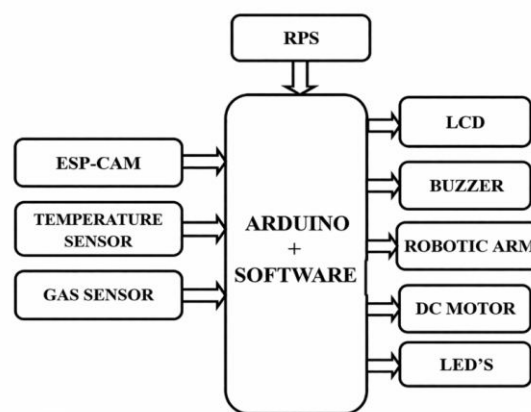


Fig.1: Proposed System

3.1 Block Diagram Explanation

The block diagram represents an Arduino Uno-based bore well rescue system where the microcontroller acts as the central unit, managing all sensors and devices. Input components such as the DHT11 sensor, ESP-CAM, and HC-05 Bluetooth module collect environmental data, capture images, and enable wireless communication for monitoring and control.

The Arduino processes this data and controls output devices including an LCD display, robotic arm, DC motor, and LED indicators to assist in rescue operations. The system enables real-time monitoring, automated decision-making, and remote control, ensuring an efficient and safe rescue process.

4. RESULTS AND DISCUSSION

The IoT-based system uses sensors and cameras to detect the presence and condition of a victim trapped in a bore well in real time. It enables quick rescue

operations by transmitting location and status data to authorities, improving response speed and safety.



Fig 2: Hard ware Implementation

A sensor-based automated dispensing system is implemented using a microcontroller, sensors, motor/servo, and power supply mounted on a vertical stand for compact operation. When the sensor detects a user/object, the controller activates the motor mechanism to dispense the item/liquid automatically

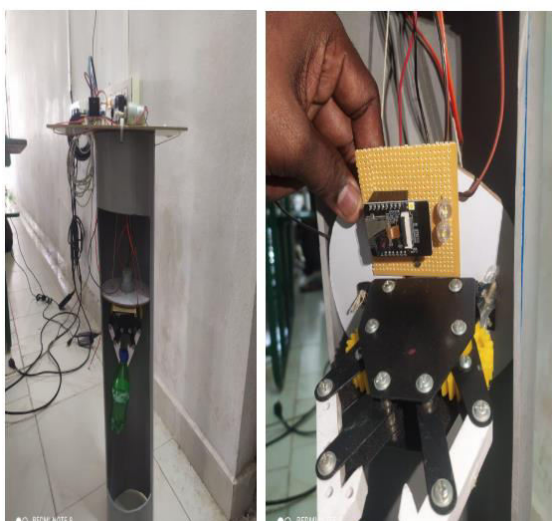


Fig 3: Bluetooth-Based Lift-and-Down Video Surveillance System

This figure shows the hardware prototype of a Bluetooth-controlled vertical surveillance system, designed to move the camera/object up and down for flexible monitoring. The setup integrates a microcontroller, Bluetooth module, motorized lifting mechanism, and support frame, enabling wireless control and real-time surveillance positioning.

5. CONCLUSION

The Bore well Rescue System provides an effective, safe, and technologically advanced solution to address the critical problem of borewell accidents. By integrating robotics, sensors, camera surveillance, and oxygen support, the system minimizes rescue time and reduces risks associated with traditional rescue methods. It enables real-time monitoring and precise control, ensuring safer victim handling and improving rescue success rates. The implementation of such systems can significantly assist emergency response teams such as the National Disaster Response Force in performing faster and more reliable rescue operations. Overall, this system represents a life-saving innovation that can prevent fatalities, enhance rescue efficiency, and contribute to public safety by providing a dependable and modern rescue solution.

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