

IoT Based Smart Borewell Accident Rescue And Remote Monitoring System

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Abstract: Human life is seriously threatened by borewell accidents, particularly in rural and semi-urban areas where open or abandoned borewells are prevalent. An IoT-based Smart Borewell Accident Rescue System that combines rescue and preventative techniques is suggested as a solution to this problem. A buzzer system is placed close to the borewell opening as a preventative measure to warn those in the vicinity and lower the possibility of unintentional falls. The system uses a variety of sensors, including DTH sensors for precise depth measurement during rescue operations, gas sensors to track oxygen levels and dangerous gases, and ultrasonic sensors to determine the presence and depth of a trapped person.

LoRa technology, which offers long-range, low-power, and dependable data transmission even in deep borewells, facilitates communication between the subterranean transmitter and surface receiver. A robotic arm is used to delicately rescue the victim in the event of an accident. The system increases the effectiveness and safety of rescues by enabling real-time monitoring and prompt action. All things considered, the suggested approach is affordable, dependable, and able to lower fatalities while improving emergency response and public safety.

Keywords: IoT-based Borewell Rescue System, LoRa Communication, Robotic Arm Rescue Mechanism, Ultrasonic and Gas Sensors, Borewell Accident Prevention.

I. INTRODUCTION

Because abandoned or exposed borewells are frequently found in rural and semi-urban areas, borewell accidents have become a serious public safety concern. Particularly for youngsters, these small, deep structures are extremely dangerous and frequently lead to life-threatening circumstances. Because of the small area, poor visibility, and lack of real-time information regarding the victim's status, traditional rescue techniques are extremely difficult. The likelihood of survival may be decreased by the large number of personnel, specialised equipment, and time needed for rescue efforts. These drawbacks show how urgently a dependable, cutting-edge system that can guarantee both prevention and effective rescue is needed.

The creation of intelligent systems for real-time monitoring and control in crucial applications has been made possible by recent developments in Internet of Things (IoT) technologies. To solve this problem, the suggested IoT-based Smart Borewell Accident Rescue System combines preventative measures with a successful rescue procedure. The system uses LoRa connectivity for long-range, low-power data transmission between subterranean and surface components, as well as sensors as gas, DTH, and ultrasonic sensors for monitoring and detection. To help with safe rescue operations, a robotic arm mechanism is also included. In addition to improving operating safety and reaction times, this integrated method offers a dependable and affordable way to reduce the number of fatalities resulting from borewell accidents.

II. LITERATURE SURVEY

IoT and robotic technologies have been used in a number of research projects to overcome the difficulties related to borewell rescue operations. An IoT-enabled rescue system with an emphasis on monitoring and child rescue methods was presented by Bhagyalakshmi V. et al. in 2025. Although the device offers real-time data, sensor limitations in deep borewell conditions limit its efficacy. Similar to this, Nandini S. B. et al. introduced a smart rescue system in 2024 that makes use of IoT technology to improve rescue efficiency. However, the device's high power consumption makes it unsuitable for long-duration operations.

An IoT-based borewell rescue system with SMS alert feature was created in 2023 by Mudunuru Suneel et al. to facilitate communication during emergencies. The device has a limited payload capacity for rescue missions, despite the fact that it enhances alarm mechanisms. Neelavathi and K. Krishnakumar created an IoT-based kid rescue system in 2022 that prioritises automation, however its performance is hampered by a lack of hardware precision. An Arduino-

based rescue system with sensors and GSM connection was previously proposed by Padhmaloshani P. et al. in 2021. This method is easier to install but causes response time delays.

A system utilising pneumatic actuators and sensors to support borewell rescue operations was introduced by Sriramireddy K. et al. in 2020. Although the system provides mechanical support for rescue, it is not capable of remote monitoring or IoT integration. A pneumatic kid rescue device that offers a mechanical solution was proposed by M. V. Ravi et al. that same year, but it has a complicated design and does not provide for real-time feedback. Overall, current systems emphasise the value of IoT integration, real-time monitoring, and effective communication; yet, they still have drawbacks such as excessive power consumption, imprecise control, and poor remote control, which the suggested solution seeks to address.

III. EXISTING SYSTEM

The microcontroller-based architecture of the current borewell rescue system combines mechanical parts for rescue operations, sensing, and communication. An Arduino or ESP32 microcontroller is used to control the system, which is powered by a battery or external source. Alerts and status updates are sent over cellular networks using a GSM module (SIM800/SIM900). A camera unit helps operators evaluate the situation by providing real-time visual surveillance inside the borewell. Temperature, gas, oxygen, and ultrasonic sensors are all included in the sensor unit to monitor environmental variables and ascertain the trapped person's presence and depth. The motor driver (L298N/H-bridge) that drives the winch motor system to lower and retrieve the rescue mechanism is controlled by the microcontroller based on sensor inputs. Monitoring and manual control are done via a local display with control buttons.

Nevertheless, in borewell settings, the GSM-based system has a number of drawbacks. It depends on the availability of cellular networks, which are frequently inadequate or nonexistent in remote and subterranean locations, resulting in inconsistent connectivity. Additionally, GSM modules may cause data transmission delays and use more power. In deep borewells, signal attenuation significantly lowers communication effectiveness. LoRa technology, on the other hand, improves system performance and reliability by providing long-range, low-power communication with improved signal penetration.

IV. PROPOSED SYSTEM

In order to address the crucial problem of borewell accidents, the suggested IoT-based Smart Borewell Accident Rescue System is intended to offer an integrated solution that incorporates both preventive and rescue features. The surface unit and the subsurface unit are the two primary components of the system. In order to prevent unintentional falls, a buzzer alarm is placed close to the borewell opening. This alarm notifies anyone in the vicinity if any movement or dangerous condition is detected. The underground unit is made up of a microcontroller that is connected to several sensors, including a DTH sensor to measure the precise depth position during rescue operations, a gas sensor to monitor oxygen levels and identify dangerous gases, and an ultrasonic sensor to detect the presence and depth of a trapped person. These sensors continuously gather data from within the borewell environment in real time.

LoRa technology, which is ideal for long-range and low-power communication even in deep and narrow borewells where conventional communication systems fail, is used to establish communication between the underground transmitter unit and the surface receiver unit. Rescue crews can monitor the victim's status and environmental characteristics in real time thanks to the receiver unit's display of the gathered data. Appropriate rescue measures can be swiftly implemented based on this knowledge. The technology incorporates a robotic arm mechanism that is gently lowered into the borewell to securely grasp and lift the trapped person. The arm is made to function precisely and with the least amount of disturbance in small areas.

The system is also made to be easy to implement in rural and semi-urban settings, economical, and energy-efficient. LoRa ensures dependable communication over vast distances while consuming less power. Decision-making is enhanced and rescue delays are reduced with real-time monitoring. All things considered, the suggested system improves safety, raises survival rates, and offers a cutting-edge way to lower the number of people killed in borewell accidents.

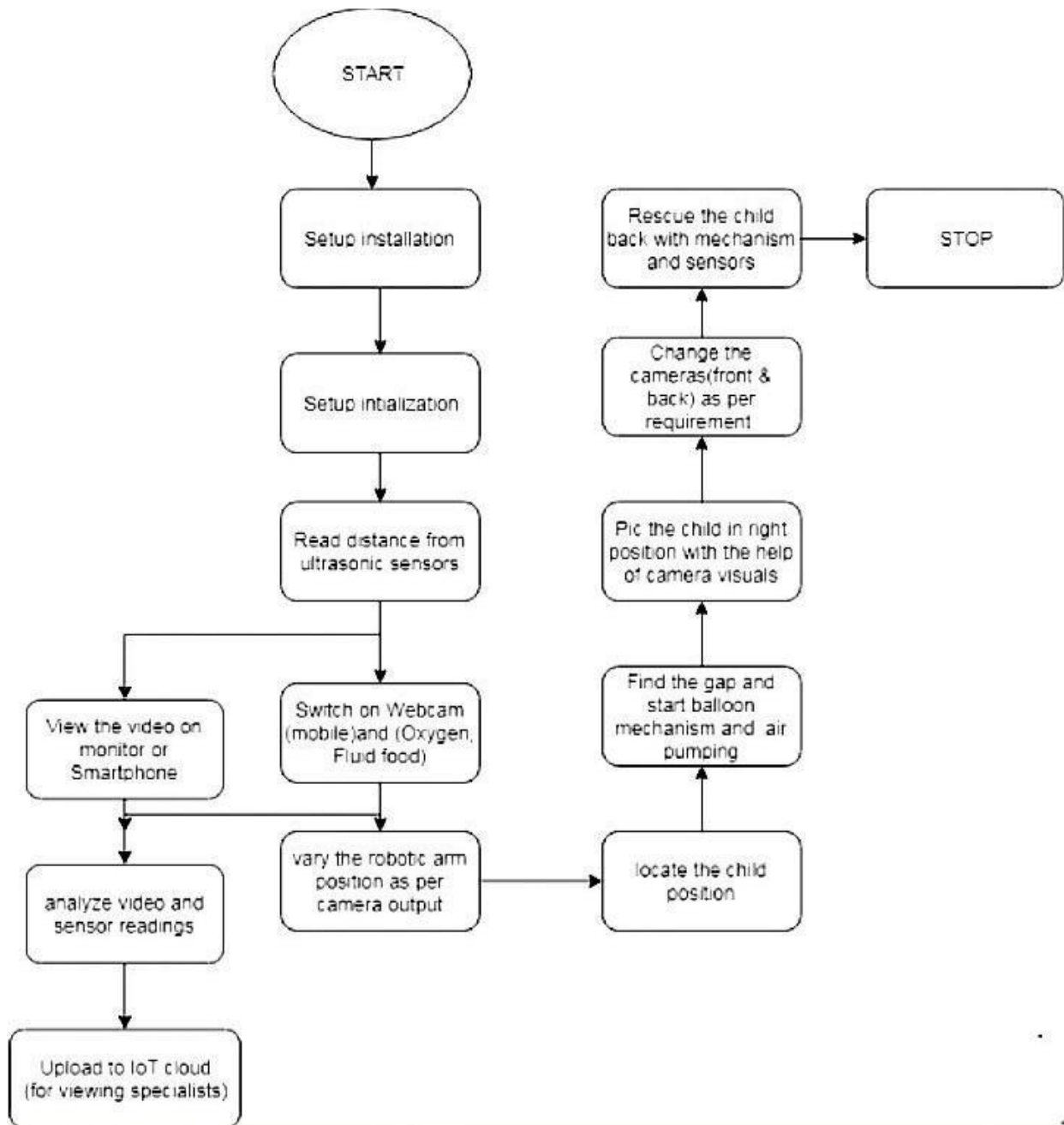
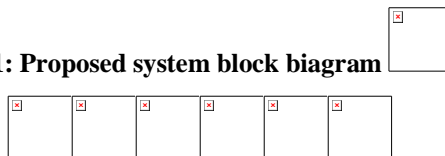


Fig 1: Proposed system block diagram



Hardware components

1. DHT11 SENSOR:

The DHT11 sensor is a digital sensor that measures the ambient temperature and humidity. It is made up of a capacitive sensor to measure humidity and a thermistor to detect temperature. Microcontrollers such as Arduino or ESP32 can readily read the sensor's calibrated digital output. In order to guarantee safety during rescue operations, this device assists in monitoring the environmental conditions inside the borewell.

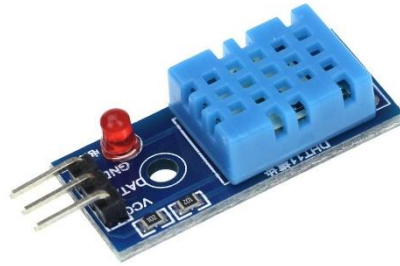


Fig 2: DHT11 SENSOR

2. ULTRASONIC SENSOR:

By producing high-frequency sound waves and seeing their reflection off objects, an ultrasonic sensor is a tool for measuring distance. Together, the transmitter and receiver determine the distance by measuring how long it takes for the echo to return. The purpose of this technology is to determine whether a human is there and how deep they are inside the borewell.



Fig 3:ULTRASONIC SENSOR

3. GAS SENSOR:

The presence and concentration of dangerous gases in the surroundings can be found using a gas sensor. When exposed to gases like carbon monoxide, methane, or other harmful gases, it detects changes in electrical resistance. The gas sensor in this device keeps an eye on the borewell's air quality and assists in determining whether the trapped person is in danger. Timely action to guarantee safety during rescue operations is made possible by this knowledge.



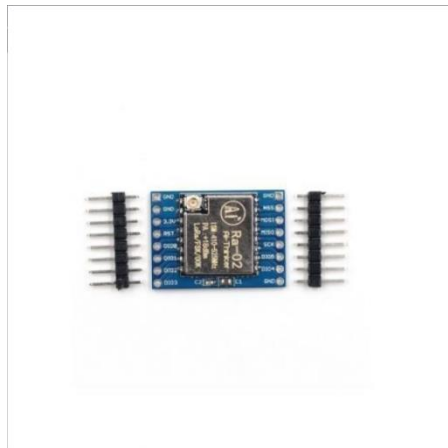
Fig 4:gas sensor:

4. ESP32 cam:

Based on the ESP32 microprocessor, the ESP32-CAM is a small, inexpensive microcontroller module with an embedded camera. It facilitates wireless picture and video transfer by supporting Bluetooth and Wi-Fi connectivity. The module is appropriate for remote monitoring applications because it can stream live video or take pictures in real time. This device helps rescuers monitor the situation and efficiently direct the rescue effort by providing real-time visual feedback from inside the borewell.

**FIG 5: ESP32 CAM****5. LoRa module:**

The LoRa module is a wireless communication device that uses LoRa (Long Range) technology to transmit data over long distances at little power. It uses very little power and can send data over several kilometres using sub-GHz frequency channels. Chirp spread spectrum modulation, which the module employs, offers robust signal penetration even in obstructions and subterranean settings. The LoRa module in this system facilitates dependable communication between the surface unit and the borewell unit, guaranteeing ongoing observation throughout rescue operations.

**FIG 6: LORA MODULE**

EXPERIMENTAL RESULTS

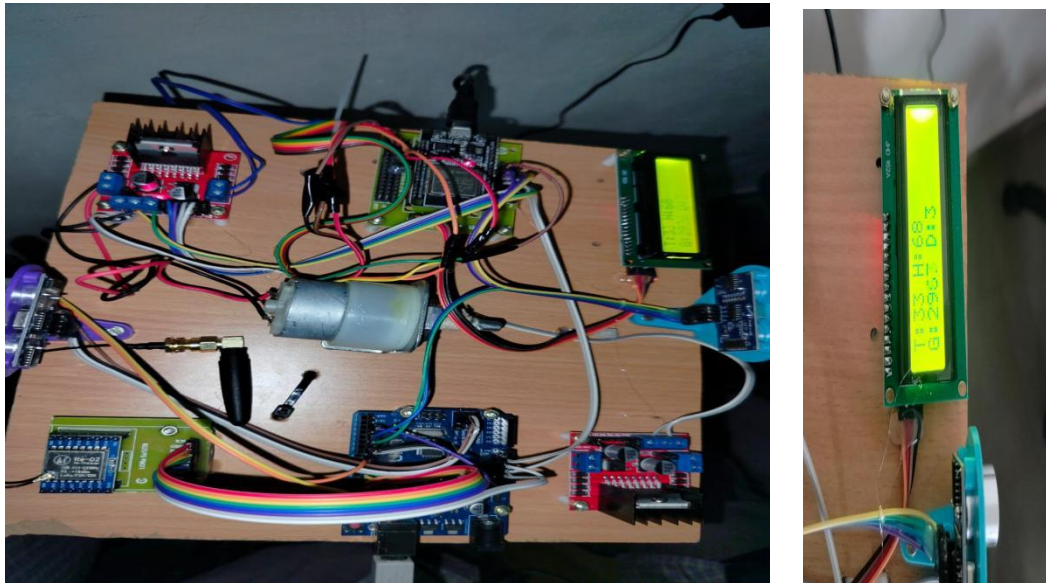


FIG 7: Transmitting block of borewell rescue system

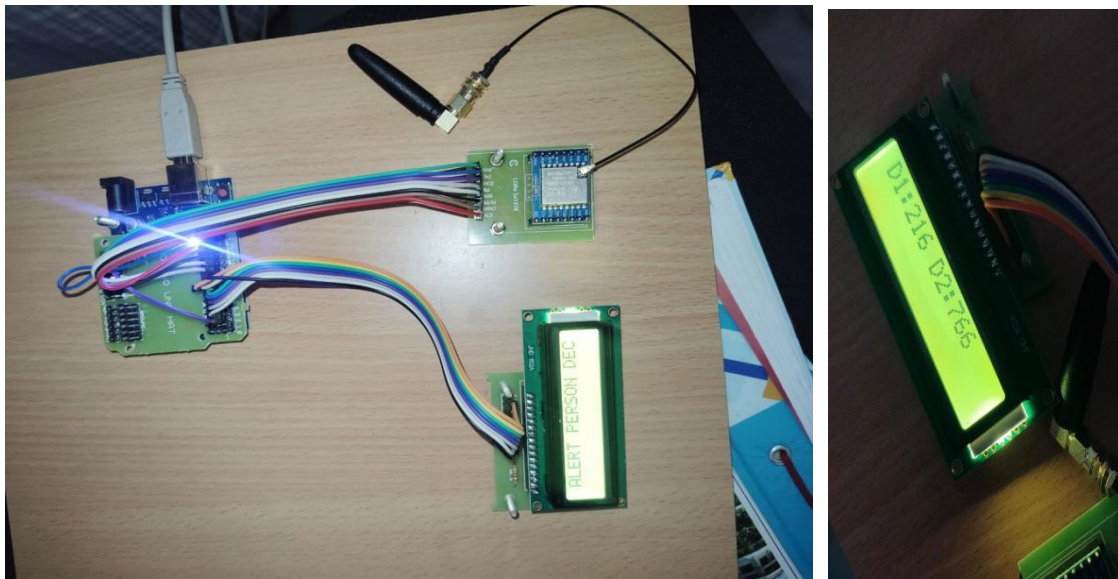
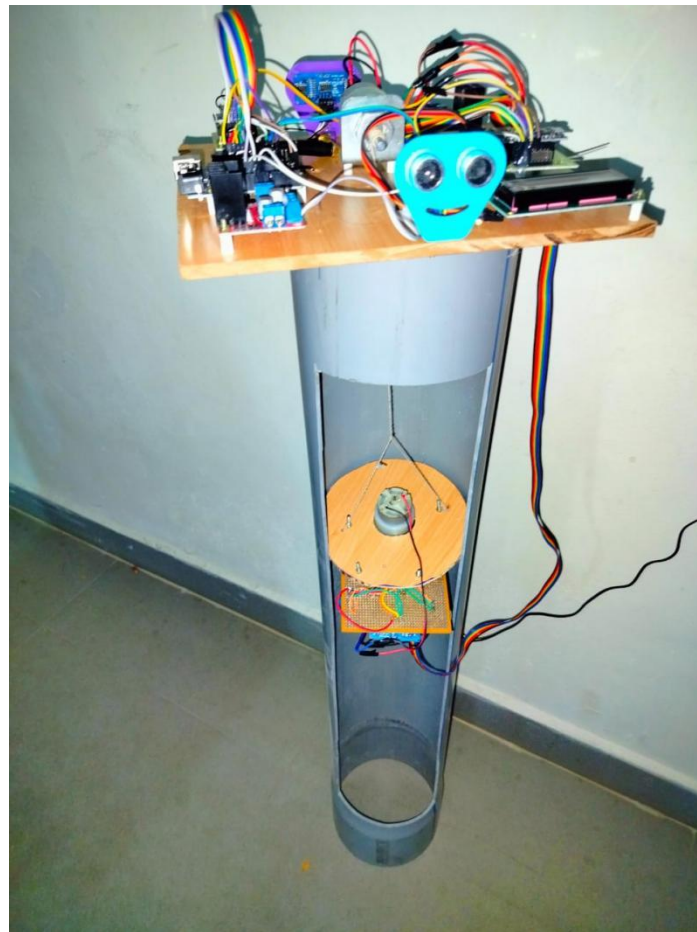


FIG 8:Receiving block of borewell rescue system

**FIG 9: Equipment of borewell rescuing system**

V. CONCLUSION

The suggested IoT-based Smart Borewell Accident Rescue System combines rescue and preventative techniques to offer a practical solution. In deep borewells, real-time monitoring and dependable data transmission are made possible by the employment of sensors and LoRa connectivity. The robotic arm guarantees the effective and safe rescue of people who are stuck. All things considered, the system is economical, energy-efficient, and contributes to both public safety and a decrease in fatalities.

VI. FUTURE SCOPE

By incorporating cutting-edge technology like artificial intelligence and machine learning for automated decision-making and increased rescue accuracy, the suggested method can be further improved. Deep borewell visibility can be enhanced by using night vision and high-resolution cameras. Real-time tracking and remote monitoring by authorities can also be made possible by integrating GPS and mobile application support. Additionally, autonomous robotic mechanisms and increased battery efficiency for extended operation can be added to the system.

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