Advanced Borewell Retrieval Solution for Child Protection

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***Abstract* — The proposed system aims to address the With many borewells left uncovered, rescue operations pose significant risks to both the trapped child and rescue teams. Delays in the process and challenges such as rocky terrain can reduce the chances of a successful rescue. Current methods lack efficiency and depend heavily on factors like transportation time, human resources, and government response times. Borewell depths can reach up to 700 feet, further complicating rescue efforts. This project offers a promising alternative to improve the effectiveness and safety of borewell rescue operations.**

challenge of rescuing children trapped in abandoned borewells, which has been a recurring issue in India due to negligence and lack of effective rescue techniques. The system features a robotic arm with two degrees of freedom, controlled remotely via RF technology. Key components include two DC motors for controlling the gripper mechanism and movement within the borewell, an RF communication system operating at 433 MHz for remote control up to 60 feet away, and additional features such as a gas sensor (MQ-2) and a wireless video camera (ESP32 cam) connected to the gripper mechanism.The system's advantages lie in its ability to efficiently rescue trapped victims without major risks, as it allows for video monitoring and remote control operation. Moreover, it can be adapted for various applications beyond borewell rescues, such as retrieving small objects from hazardous areas.

***Index Terms*— Microcontroller, ESP32 Cam, Gas Sensor, and Battery.**

I.INTRODUCTION

The issue of children getting trapped in abandoned borewells has become increasingly concerning due to the risk of fatalities. Traditional rescue methods involving parallel pit digging are complex, lengthy, and risky. This project proposes a simple yet effective solution using a robotic arm mechanism to rescue trapped children directly from the borewell. The mechanical system moves within the borewell channel and employs a gripper mechanism to safely retrieve the child.

II. LITERATURE SURVEY

This project encompasses a thorough exploration of existing research, studies, and technologies pertinent to borewell rescue operations, robotic systems, remote sensing, and safety measures. This involves delving into past borewell rescue efforts to understand common challenges, employed techniques, and lessons learned. Concurrently, an examination of robotic systems tailored for search and rescue operations, particularly in confined spaces like borewells, aids in identifying key features necessary for successful deployment. Additionally, a review of remote sensing technologies, including RF communication, wireless cameras, and gas sensors, provides insight into real-time monitoring and situational awareness during rescue missions. Integral to the survey is an investigation into safety measures and risk mitigation strategies, focusing on protecting both victims and rescue teams. Moreover, exploring humanitarian engineering principles and societal impacts underscores the importance of developing effective borewell retrieval solutions. Lastly, staying abreast of emerging technologies and innovations, such as drones and AI-based systems, informs potential collaboration opportunities and ensures the project remains at the forefront of advancements in the field.

III. DESIGN OF PROJECT

The advanced borewell retrieval solution for child protection project is a comprehensive endeavor aimed at addressing the pressing issue of rescuing children trapped in abandoned borewells, a scenario that has unfortunately led to tragic outcomes in the past. The design of this solution involves an intricate interplay of mechanical, electrical, and sensing

components to ensure not only the successful extraction of the child but also the safety of all involved parties. Central to this design is the development of a highly capable robotic arm mechanism, meticulously engineered to navigate the narrow and often treacherous confines of borewell channels. This robotic arm is equipped with a sophisticated gripper mechanism, meticulously designed to securely hold the child without causing harm during the extraction process.

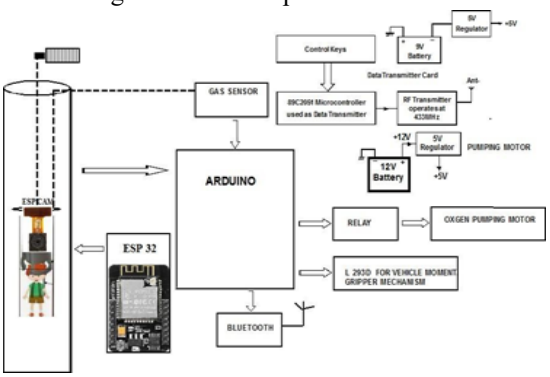

Fig. 1 Block Diagram of the System

Complementing the mechanical aspects of the solution is a sophisticated remote control system, leveraging RF technology to enable wireless operation of the robotic arm from a distance of up to 60 feet. This remote control capability empowers rescue teams to orchestrate the delicate operation with precision and efficiency, minimizing risks and maximizing the chances of a successful rescue. Moreover, the inclusion of advanced sensing and monitoring devices adds an extra layer of safety and situational awareness to the operation. A gas sensor, such as the MQ-2, is integrated into the system to detect any harmful gases present within the borewell, triggering automatic safety measures, such as the pumping of fresh air, if necessary. Additionally, a wireless video camera, such as the ESP32 cam, provides real-time visual monitoring of the rescue operation, allowing rescue teams to assess the situation and make informed decisions.

Ensuring the safety of both the child and the rescue team is paramount in the design of this solution. As such, robust safety features are incorporated, including emergency stop buttons and fail-safe mechanisms that can halt the operation instantaneously in case of emergencies or unforeseen circumstances. Furthermore, the system is designed to withstand the harsh environmental conditions and rugged terrain typically encountered during rescue missions, guaranteeing reliability and resilience in the face of adversity.

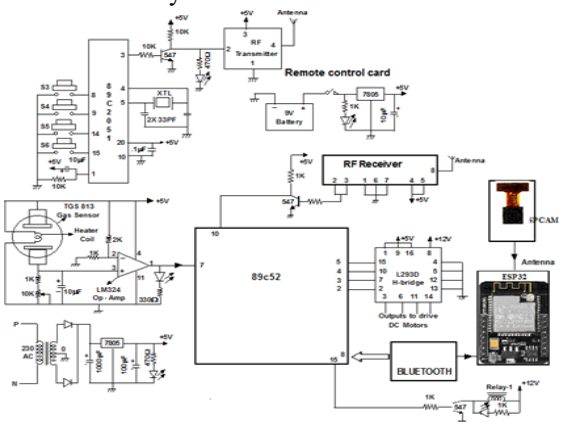

Fig. 2 Circuit Diagram

Beyond the technical aspects, the project also emphasizes user training and interface design to facilitate seamless operation and ensure that rescue personnel are proficient in utilizing the system effectively. Through comprehensive training programs and user-friendly interfaces, rescue teams are equipped with the knowledge and tools needed to navigate the complexities of borewell rescue operations with confidence and competence.

IV. OPERATING PROCEDURE

The procedure to be carried in the operation of the bore well rescue system:

Stage 1: The borewell rescue operation begins with the assembly of manipulator parts followed by fixing the system with necessary components. It is then connected to a rope running through pulleys inside the narrow borehole and supported by a tripod stand on the ground. An oxygen concentrator is positioned nearby for emergency use. The system is slowly lowered into the borehole while monitoring virtual images on a PC or mobile device. Upon detecting the trapped child, the system halts just above them, providing information on depth and position. A stabilizing mechanism is then activated, securing the system in place. Finally, a stabilizing fork mechanism is released from the top plate to further stabilize the setup.

Stage 2: During the borewell rescue operation, position images of the child are transmitted to a mobile or PC via a Wi-Fi camera connection. Simultaneously, a protective casing is extended to

the borewell side walls for added safety. A fourth motor assists the lifting rod in screwing its way through the gap towards the bottom of the child, facilitating the rescue process.

Stage 3: Upon reaching a safe position under the trapped child, an air compressor is activated to pump air into a balloon cushion attached to the end of the lifting rod. This cushion provides a secure seating arrangement for the child, ensuring their safety during the rescue process. Concurrently, the first motor is operated in reverse to unclamp the system, enabling the lifting rod to release its grip on the child. Subsequently, the entire system is raised to a predetermined level until the child is safely inside the protective casing. This sequential operation ensures a controlled and safe extraction of the child from the borewell, minimizing the risk of injury or discomfort.

Stage 4: Once the child is safely inside the protective casing, it is released from the borewell sidewalls, and the lower U clamps are also released. This ensures that the child is completely contained within the retrieval system, protected from further falls, scratches, or harm. Using the controls, the system slowly lifts the child to the surface. Upon reaching the top, the child is immediately attended to and provided with necessary medical treatment and care. This final stage of the rescue operation prioritizes the well-being and safety of the rescued child, ensuring prompt and appropriate care after their extraction from the borewell.

V. RESULTS AND DISCUSSION

RESULT

The successful design and fabrication of a prototype for the borewell retrieval project mark a significant milestone, addressing various constraints and practical considerations. Comprehensive testing revealed satisfactory performance, notably outperforming traditional methods in terms of speed and safety features, a critical concern. Key life-supporting systems, including oxygen supply, as well as assisting equipment such as cameras and lighting, were seamlessly integrated and proven to function effectively. The project's overall efficiency and alignment with objectives underscore its potential to significantly improve borewell rescue operations, providing a robust solution to a pressing societal

APPLICATIONS

1.Improved Efficiency: Advanced technologies such as robotic systems or specialized drilling equipment can enhance the efficiency of borewell retrieval operations. These tools can navigate narrow passages more effectively and retrieve trapped individuals with greater speed and precision.

2.Enhanced Safety: Utilizing advanced borewell retrieval solutions reduces the need for manual intervention in potentially hazardous environments. This minimizes the risk of injuries to rescue personnel and increases overall safety during rescue operations.

3.Increased Success Rate: Advanced technologies can improve the success rate of borewell rescue missions by providing better access to trapped individuals and enhancing the effectiveness of extraction efforts. This can significantly increase the chances of saving lives in critical situations.

Fig. 3 Top View of Prototype

Fig 4 Extracting the Child From Borewell

CONCLUSION

Human life is precious. Our bore well child recue system is a significant attempt to save the life of the victim of bore well accidents. In the current design of bore well child saver machine has been made to suit every possible situation may occur in rescuing operation. The project is mainly designed to save many lives of children who fall inside the bore well. In the past 10 years, lots of lives had been lost by falling in to the bore well because digging a pit beside the bore well is very tedious and time consuming process. By using bigger motors, arms and advanced technology this project can be implemented successfully. This can be concluded that the proposed system can retain the lives of many children who fall into the bore well in future in short time.

The project work "Smart child rescue system from borewell" is designed and developed successfully. For the demonstration purpose, a prototype module is constructed; and the results are found to be satisfactory. Since it is a prototype module, a simple module is constructed, which can be used save lives of the children falling into borewell in quick time.

FUTURE SCOPE

The future scope for advanced borewell retrieval solutions in child protection projects holds significant promise, with several potential avenues for further development and implementation. Continued technological advancements in robotics, sensing technology, and materials science are expected to lead to the creation of more sophisticated and specialized equipment for borewell rescue operations. Miniaturization and portability will likely play a key role, enabling easier deployment in remote or inaccessible areas. Integration of Internet of Things (IoT) technology and connectivity features can facilitate real-time monitoring and data exchange during rescue missions, improving response times and decision-making. Advanced environmental sensing capabilities will enhance hazard detection and risk assessment, ensuring the safety of both rescue personnel and victims. Collaborative robotics and human-robot interaction techniques will enhance synergy between rescue teams and advanced systems, while predictive analytics can help identify high-risk areas and prioritize preventive measures.

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