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Bluetooth Enabled System for Bore-Well Child Rescue Operations

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Abstract

In recent times, incidents of children falling into open borewells have increased due to the negligence of individuals in society. The rescue systems currently available are often costly and less effective. Therefore, there is an urgent need for a more efficient and reliable solution. Traditionally, rescue operations involve digging a parallel hole and creating a horizontal passage to reach the trapped child. This method is not only time-consuming but also poses significant risks. The depth and narrow diameter of borewells make the rescue process extremely challenging. Any delay in rescuing the child can result in serious injury or even loss of life. To address this critical issue, we have developed a project titled "Bluetooth Enabled System for Borewell Child Rescue Operations". This system is designed to be deployed within the same borewell where the child is trapped, allowing for direct access and rescue. It aims to save the child before they descend further into the borewell, significantly reducing the risk and time involved.

Keywords: *Arduino UNO; Bluetooth; DC Motor; Motor Driver; Bluetooth App;*

1. Introduction

Open and abandoned borewells have become a significant safety hazard, particularly in rural and semi-urban areas. These wells, typically drilled to depths ranging from 150 to 1500 feet with diameters between 4.5 to 12 inches, are often left uncovered after they dry up or are no longer in use. Constructed primarily for agricultural or industrial water extraction, these borewells are lined with PVC casing in loose soil but remain open in rock strata, making them dangerous. Numerous tragic incidents have been reported where children, unaware of the open pits, fall into these narrow shafts. Rescue operations in such situations are extremely challenging and time-sensitive. Factors such as geological constraints (e.g., rocky terrain), delayed arrival of rescue machinery, lack of specialized equipment, and uncoordinated response significantly reduce the chances of survival. Currently, there is no standardized or efficient method for executing such rescues. Traditional methods like parallel digging are time-consuming and hazardous even for the rescuers. In many cases, the lack of communication with the child during the rescue further complicates the situation, leading to psychological distress or even fatality. The need for a compact, reliable, and rapidly deployable system is paramount. Our project, titled "Bluetooth Enabled System for Borewell Child Rescue Operations," is designed to address these issues by enabling faster, safer, and more effective rescue missions. The system aims to bridge the critical gap in communication and rescue precision, improving the overall response strategy in borewell accident scenarios.

2. Literature Review

Several projects in the past have attempted to address borewell rescue using robotic systems. However, most lacked compactness and effective wireless control. A study by Kumar et al. [1] highlighted the challenges of deploying bulky equipment in narrow shafts. Sharma [2] explored Bluetooth-based control for small-scale robots, though not specifically designed for rescue applications. Maheshwari [3] proposed smart rescue devices tailored for confined spaces, which laid foundational concepts for borewell-specific adaptations. Similarly, Aravinth et al. [4] presented an early model of a borewell rescue

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robot, focusing on mechanical retrieval techniques. Our work builds upon these studies to create a compact, wireless rescue system specifically tailored to borewell conditions.

3. System Design and Methodology

The system comprises the following components:

- Arduino UNO
- Bluetooth Module (HC-05)
- Robotic Arm
- DC Motor
- Motor Driver

3.1.Arduino UNO

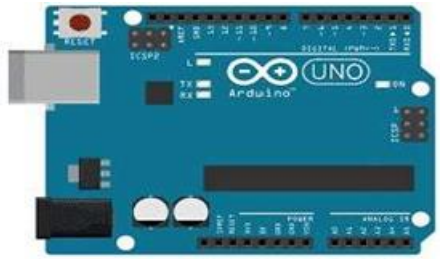

Figure 1 Arduino UNO

The Arduino UNO (Figure 1) is a highly popular microcontroller board, favored by beginners and hobbyists for its ease of use, extensive community support, and vast library resources. It is equipped with 14 digital input/output pins (6 of which support PWM), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button. Programming is done via the Arduino IDE, which supports C and C++ and provides a simple, intuitive interface. The board can be powered through multiple sources and easily integrates with various sensors and electronic modules, making it well-suited for developing and managing embedded systems and automation projects.

3.2.Bluetooth Module (HC-05)

Figure 2 Module (HC-05)

The HC-05 is a Bluetooth module designed for wireless serial communication, commonly used in embedded and IoT projects (Figure 2). It supports both master and slave configurations, allowing serial-enabled devices to communicate wirelessly over Bluetooth. The module features a red LED that indicates its connection status blinking rapidly when not connected and slowing to a 2-second interval once a connection is established. Although the HC-05 operates at 3.3V logic level, it includes an onboard voltage regulator, allowing it to be safely powered with a 5V supply. This makes it compatible with a wide range of microcontrollers and easy to integrate into various applications.

3.3.Robotic Arm with DC Motors

Figure 3 Robotic Arms

Robotic arms play a crucial role in safely lifting the child from the borewell, controlled remotely based on user commands. These arms are typically connected to DC motors with gear head combinations, enabling smooth up-and-down motion. Designed for ease of integration and operation, robotic arms often feature versatile grippers for handling various rescue scenarios. One such gripper is the 3-Finger Adaptive Gripper, which is highly compatible with Universal Robots (UR). It can be installed within minutes and supports quick, intuitive configuration through UR+ interfaces. The 3-Finger Gripper also works with a wide range of industrial robotic systems. Grippers come in various forms some resemble human hands with two or three fingers, while others mimic claws, suction cups, or even soft, ball-shaped ends. There are also grippers with magnetized tips. Depending on the application, grippers may be powered electrically, pneumatically (using compressed air), or hydraulically (using fluid pressure), making them adaptable for diverse tasks

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3.4.DC Motor

Figure 4 DC Motor

A DC motor (Figure 4) is a device that converts electrical energy into mechanical energy. It operates on the principle that a current-carrying conductor placed within a magnetic field experiences a force, causing it to rotate from its initial position. A typical DC motor consists of field windings, which generate the required magnetic flux, and an armature, which serves as the current-carrying conductor. This interaction between the magnetic field and the current in the armature produces the rotational motion essential for various mechanical applications.

3.5.Motor Driver

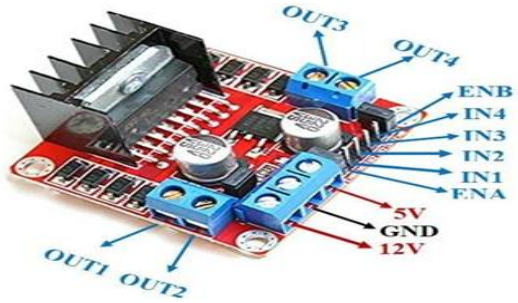

Figure 5 Motor Driver

The L298N Motor Driver Module (Figure5) is a high-power motor driver designed to control DC and stepper motors. It integrates several key components, including the L298 dual H-Bridge motor driver IC, a 78M05 voltage regulator, resistors, capacitors, a power LED, and a 5V jumper all within a compact circuit. This module can control up to four DC motors (without speed control) or two DC motors with both directional and speed control. It is ideal for robotics and automation projects where motor control is essential (Figure 6).

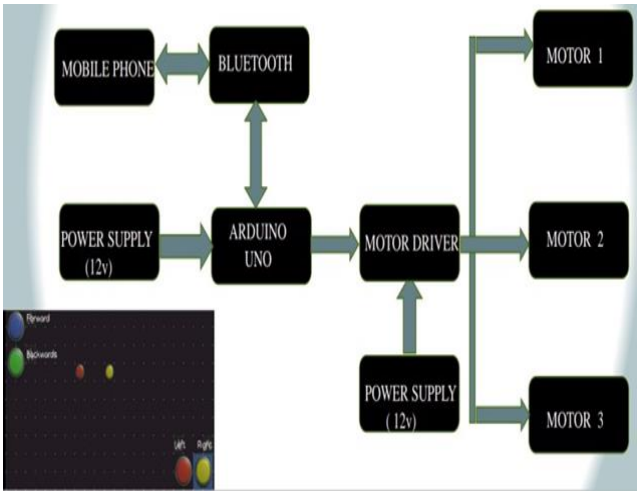

Figure 6 Block Diagram of Child Rescue from Bore-well from Bluetooth

4. Results and Discussion

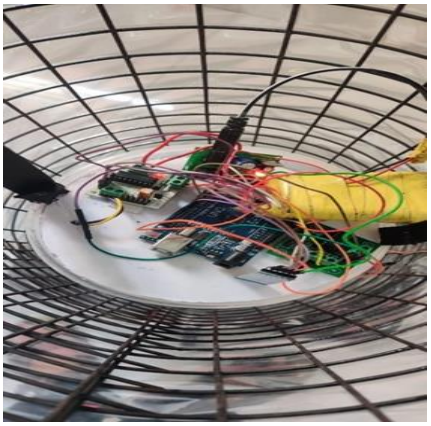

Figure 7 Prototype of a Baby Rescue System for Bore-well Operations

Figure 8 Lowered Position of Baby Rescue

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Figure 9 Child Rescue Demonstrating Victim Pick-Up Mechanism

(Refer Figures 7 to 9) This system offers a safer and more time-efficient solution compared to traditional rescue methods. It's simple and compact design allows for quick deployment, which is critical in emergency situations. Unlike existing technologies that are often expensive and complex, our project is both cost-effective and practical. The use of lightweight DC motors makes the system easy to operate and control, while also keeping the overall structure manageable in terms of weight. This innovative approach enhances the chances of saving a child trapped in a borewell in a shorter time frame.

Conclusion

The developed system provides a reliable and efficient solution for rescuing children trapped in borewells. By utilizing lightweight DC motors and a simple mechanical design, the system ensures ease of operation, safety, and reduced rescue time. It eliminates the need for complex and costly equipment used in traditional methods, offering a cost-effective alternative suitable for real-time deployment. This project demonstrates a practical approach to addressing a critical issue and has the potential to save lives by enabling quicker and safer rescue operations in the future.

Future Scope

In the future, the system can be enhanced by integrating wireless communication for remote operation, adding live video feedback for better monitoring, and incorporating advanced robotic arms for improved precision. Sensors such as temperature, gas, and heart-rate monitors can be included to assess the child's condition and environment. The design can be further optimized to be more compact and lightweight for easier deployment in narrow or deep borewells. With suitable modifications, the system can also be adapted for use in other rescue operations like trench collapses or mining accidents. Additionally, AI- based object recognition and automation can be implemented to make the rescue process more intelligent and efficient.

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