ROBOTIC DEVICE FOR CHILD RESCUE OPERATION FROM BOREWELL

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ABSTRACT

A child stuck in a borewell must be rescued quickly and with great care, as it is a race against time and the elements. It entails sending out specialised teams with cutting-edge equipment, such as cameras and drilling rigs, to securely reach and remove the youngster while negotiating difficult terrain and psychological strain. In the present work, A Wi-Fi module linked to the BLYNK program which enables a voice input feature allowing for communication with the trapped youngster is used. It also gives remote control over the robotic arm's movements and reassurance during the rescue effort. This two-way communication channel not only enables rescuers to assess the child's condition but also offers emotional support, alleviating distress in critical situations. Furthermore, the integration of an ESP32 Cam enhances situational awareness by providing continuous surveillance of the borewell environment. This real-time visual feedback enables rescuers to make informed decisions and adjust their approach as necessary, enhancing the overall effectiveness of the rescue operation. Overall, the proposed system represents a comprehensive and technologically sophisticated approach to borewell rescue, addressing the multifaceted challenges posed by such incidents. By combining robotics, IoT, and sensory technologies, it offers a holistic solution that prioritizes safety, efficiency, and effective communication, ultimately increasing the likelihood of successful outcomes in critical situations.

Keywords — Open borewell, Child Rescue operation, Robotic arm, ESP32, BLYNK IoT Application

I. INTRODUCTION

Children have fallen into abandoned bore wells on several occasions in the past few years. A few abandoned bore wells have been converted into kid death traps. The issue is global in scope. Rescue teams try in vain to save these young toddlers for hours or even days at a time [1]. Money can be spent a lot on missions. Most of the time, they are powerless to save the kids. These kinds of incidents have occurred numerous times in the past, and each time the blame has fallen on the bureaucracy or the government. These days, the procedure to save the youngster from the bore well is drawn out and difficult [2]. It takes the rescue crew between twenty and sixty hours to dig a parallel well from which they attempt to approach the sufferer.

This work introduces an integrated solution for rescuing children trapped in borewells, amalgamating robotics, IoT, and sensory technologies. The main component of the device is a robotic arm that is controlled by an ESP32 microprocessor and intended to precisely negotiate the tight areas found in boreholes [3].

Augmented with a gas sensor and oxygen supply, it ensures safety underground. The inclusion of voice input via a WiFi-connected module and continuous surveillance from an ESP32 cam further enhances rescue operations showcasing a comprehensive approach to addressing the challenges of borewell incidents[4]. The purpose of this project is to use a robotic arm equipped with an oxygen supply and voice input to safely recover children who are stuck in bore wells. Integrating a light for visibility and a camera to monitor the child's condition are the goals. Other objectives include detecting the child's oxygen levels and putting in place an oxygen supply system, as well as controlling a robotic arm with precise and controlled movements using the BLYNK program to reach the youngster.

II. RELATED WORKS

Manual rescue operations are time-consuming where a parallel well is to be dug. This is tedious and the percentage of risk rates is higher comparatively. This is where technology helps in saving the victim. Initially, the robotic arms design had many limitations. Gradually along with technology new features were added. Different technologies were used for controlling the robotic arm like Arduino, ESP8266, Raspberry Pi, and BLYNK Application.

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Also integrating the robotic arm with sensors and IoT, continuous observation and controlling the operations became much more effective.

Ravi Patel et al [1] proposed mathematical calculations like space in the back of the child, elliptical rib cage, and space in front of the child, and also used a robotic arm to lift the child for the borewell. The rescue time will be much less than the conventional time, Actuators and sensors can be added to a robot to enhance its performance and save operating time. In the future, a system to give the child thrust could be designed to counteract the high lifting force. Shaik et al [2] suggested 1:25 scale simulation model provides results for three scenarios of horizontal, vertical, and diagonal objects with a maximum deviation of 1 cm. Human resources are scarce following disasters. can be applied to calamities like earthquakes. This is merely an experiment that hasn't been put into practice yet. Anirudh et al [3] explained a project that ensures medical safety for the victim along with the rescue operation using sensors to sense oxygen, heartbeat, etc. The medical condition of the child is continuously monitored in this system. But it requires many hardware components which increases the overall cost of the system. Dr. Ashwinee et al [4] proposed a gripper design that safely and effectively holds and raises a child without endangering them. Time is of the essence and efficiency is critical in rescue operations. As a result, the system effectively saves the child within the allotted time. Both the system's effective cost and size can be decreased with effort. Ashwinee, and Vedant Sabde [5] proposed a model of compact size. The main problem is the size and the diameter of the borewell. ARDUINO UNO, IR sensor, ultra sensor, servo motor along with WIFI module with LCD display are used in designing the model. ESP 8266 is a very popular Wi-Fi model in IOT which is playing a major role. We get video surveillance, less manpower is required, and easily operatable with high reliability are the merits of the model. It requires more power dependency, and security risks these are demerits.

Savitha et al [6] conveyed a work that used a robot with the help of Arduino uno (ESP8266) for child-helping purposes. BLYNK app is introduced here where a wireless camera is attached to the robot. Reliability is high Also, there is an Automatic closing borewell tunnel using plates. The time required for the rescue operation of the victim is higher. Savitha et al [7] proposed a model that integrates a gas sensor. The components used in this paper are a Temperature sensor, gas sensor, and LCD to display are used in designing the robotic arm. Arduino Uno (ATMEGA 328P) is a microcontroller used. Less manpower required, easily operable. Can be added smoke sensors to detect poisonous gases and can be advanced using hand gestures.

Magibalan and Elango [8] proposed a model with a better ergonomic design. Current rescue operations where another well is dug parallel to the victim take 20 to 60 hours making 64% of the rescue operations fail. So, the child should be rescued from the same well. Hence, the work aims at building a system that constitutes the best ergonomic design and must perform the safest rescue operations. This proposed design is compact making it easily portable. Also, the effective cost is much more reduced. But this system can be improvised by adding balloons for the safe uplift of children. Akhil Nair and Babu [9] explained a model integrated with artificial intelligence technology. The bore wells dug for agriculture purposes reached about 700 feet depth. In this case, the rescue of children from such deep bore wells is quite challenging. Therefore, a portable real-time AI-based child rescue system is designed. This module makes use of a camera and VGGNET algorithm that analyses a child's facial expressions. VGGNET algorithm can detect facial emotions and recognize a child's voice. These can be more accurately used to promote cutting-edge child safety technology and inexpensively converted to computerized production. Akhil Nair et al proposed [10] the usage of metal plates to prevent the child from falling very deep in the borewell. Since borewells constructed are so deep which becomes difficult, we try to prevent children from falling deep by inserting metal plates. Ultrasonic sensor to detect movement near borewell that will send alert message to authorized person. Metal plates close at 5 feet deep. It prevents from falling deep into the borewells.

III. METHODOLOGY

A. Block diagram

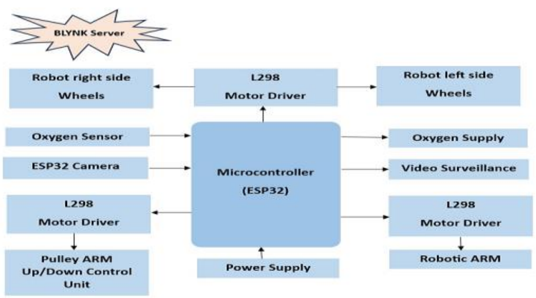

Fig 1: Block diagram of robotic device for child rescue operation from borewell

Firstly, the microcontroller ESP32 acts as the central control unit. Two Motor drivers which control the DC motor for wheel movement, pulley, and robotic arm movement are connected as shown in Fig 1. An ESP32 cam is used for continuous monitoring of a child's condition and to provide video surveillance. An oxygen sensor is integrated into the system which detects harmful gases and correspondingly the oxygen supply is provided to the child based on sensor input. A voice module is embedded in the system which records the voice and can be played to the trapped child. All of these operations can be controlled through virtual switches in the BLYNK IoT application. Utilized a Wi-Fi module connected to the ESP32 microcontroller to establish communication with the BLYNK application, enabling remote control of the robotic arm's movements. Implemented voice input functionality to facilitate communication between rescuers and the trapped child, providing reassurance and enabling the assessment of the child's condition. Incorporated an ESP32 Cam into the system to provide continuous surveillance of the borewell environment, offering real-time visual feedback to rescuers. Ensured seamless integration of the camera feed with the BLYNK application for remote monitoring and situational awareness.

B. Hardware and Software requirements

Hardware Requirements:

- **ESP32 with Camera**

Fig 2: ESP32 with camera module

Numerous IoT applications can make use of the ESP32 cam, as depicted in Fig 2. It is appropriate for Internet of Things applications such as wireless positioning system signals, industrial wireless control, wireless monitoring, QR wireless identification, and smart home devices.

- **L298N Motor Driver**

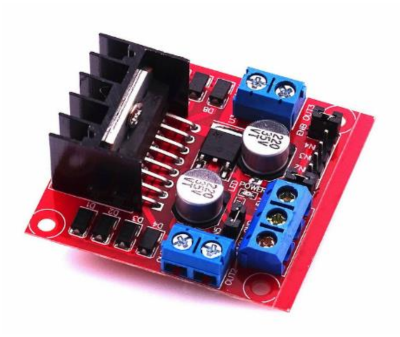

Fig 3: L298N motor driver module

As illustrated in Fig. 3, it is composed of an integrated circuit. One bipolar stepper motor or two DC motors can have their speed and direction adjusted by the dual H-bridge module L298N motor driver.

- **Power Supply**

Fig 4: Power Supply Unit

Reversible cell reactions are what make a battery rechargeable; they enable the battery to regain its electrical potential when exposed to electric currents that are passing through it as shown in Fig 4. Put differently, a reversible battery is all that is meant to be recharged.

- **Oxygen Sensor**

Fig 5: O2 sensor

A liquid or gas's oxygen content can be measured by an electronic device called an oxygen sensor, or O2 sensor, as it is depicted in Fig 5.

- **Pulley**

Fig 6: Pulley

Pulley systems as shown in Fig 6. A robotic arm's pulley system can offer a gearbox's mechanical advantage. Wheels with teeth or grooves that a belt can catch on are called pulleys. The friction created by the rotating pulley drives the belt, which in turn drives the pulleys that are attached to the same belt.

- **Voice Recording module**

Fig 7: APR 33A3 voice recording module

A device that can record and replay voice messages is called a voice recording module as shown in Fig 7. These modules feature push buttons, an analog flash memory that stores messages even in the event of a power outage, and an electric microphone. The push buttons on the module allow for manual control, or a microcontroller can be used to control them automatically.

- **Miniature speaker**

Fig 8: Miniature speaker

A speaker is an electrical audio signal converter, sometimes referred to as a loudspeaker or speaker driver is as shown in Fig 8. It's a kind of transducer that generates sound waves via electromagnetic waves. In addition to being connected to other sound systems, speakers are common output devices for computers.

Software Requirements:

- **BLYNK application**

Fig 9: BLYNK application

BLYNK application as shown in Fig 9 is a versatile IOT platform, enabling users to build and control custom projects through a user-friendly interface. BLYNK simplifies the development of internet of Things applications, making it accessible even for beginners. With its cloud connectivity, real-time data monitoring, and customizable dashboards, BLYNK empowers users to create innovative and connected solutions effortlessly.

C. Flowchart

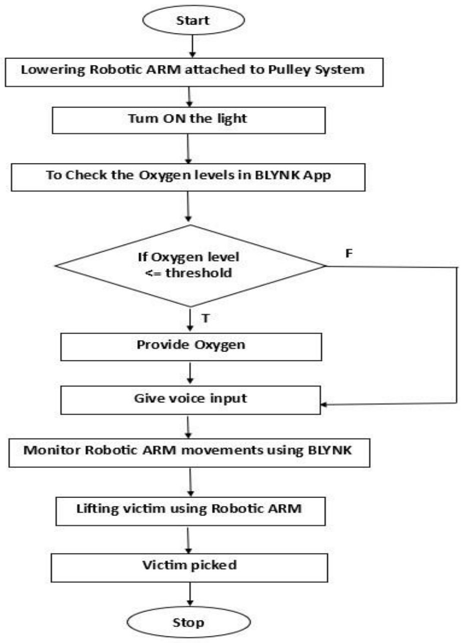

Fig 10: Flowchart of a robotic device for child rescue operation from borewell

The steps as shown in Fig 10, which involved in rescuing the child from the borewell with the aid of a robotic arm integrated with ESP32 are:

- Lowering of the robotic arm attached to the pulley system.
- Turn on the light to provide visibility.
- To check oxygen levels, if the levels are less than or equal to the threshold value, then
- provide oxygen.
- To make the child comfortable, give the voice input of the parents.
- After considering all these parameters, monitor the robotic arm using the BLYNK
- application to reach the child and pick up the child carefully.
- Finally, the child or victim is picked up successfully.

IV. RESULTS

In the proposed system we use ESP32 microcontroller which is connected to the internet from Wi-Fi or from a mobile hotspot and then robot movements are controlled from the BLYNK application. The commands are given from the mobile application and commands are received on the IOT controller and the robots act as the commands given from the mobile application for example when the command is received for the robot's forward direction movement then is moved forward with the help of L298N motor driver circuit which will drive the robot in the given direction and rest of the movements and robotic arm control will be similar to this command and we use oxygen unit which supplies the oxygen and ESP32 camera will provide the live video.

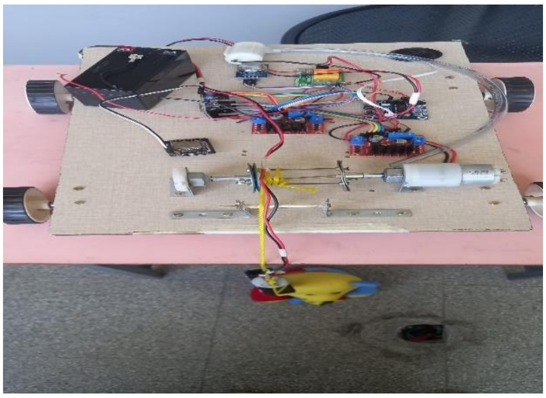

Fig 11: Top view of the proposed model

The above image Fig 11 represents the top view of a robotic device for a child rescue system that consists of ESP32 microcontroller with the integration of motor drivers, gas sensor, and voice module.

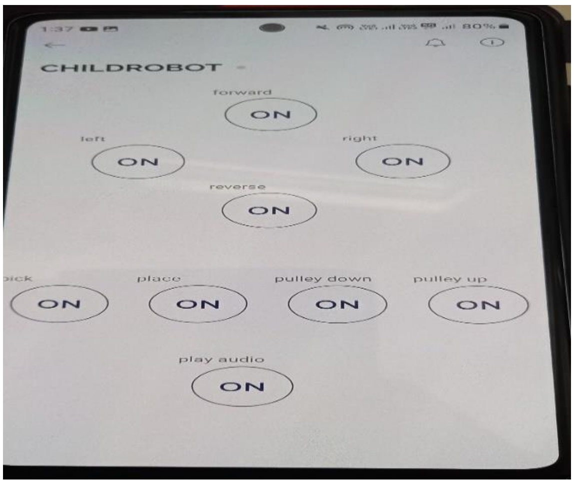

Fig 12: Virtual switches in the BLYNK IoT application

Fig 12 shows the user interface of the BLYNK application that represents the virtual buttons for the movement of wheels, pulleys up and down, and also the pick and place operation of the robotic arm. Moreover, the play audio button enables the recorded audio to be played to the victim.

Fig 13: Releasing the pulley down

The above image Fig 13 represents the pulley down operation, which enables the robotic arm to reach the victim's location to be picked.

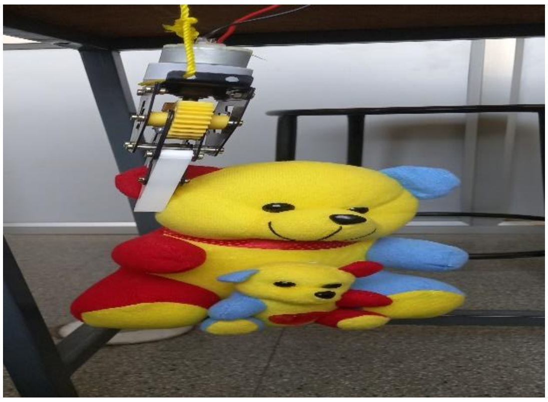

Fig 14: Picking the trapped child by robotic arm

Fig 14 represents the pick operation of the robotic arm to safely pick the trapped victim.

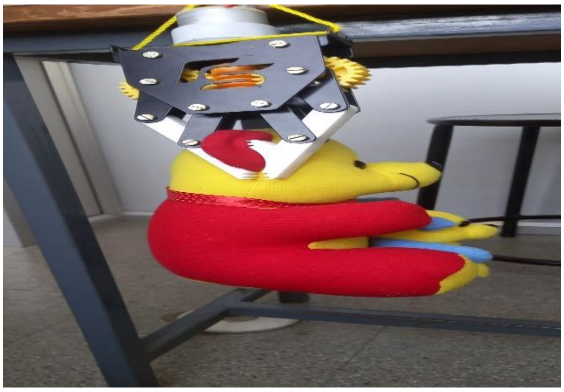

Fig 15: Pulley-up operation to lift the trapped child

The above image Fig 15 represents the pulley-up operation, which enables the robotic arm to pick up from the victim's location.

Fig 16: Gas sensor and gas cylinder with a pipe connected

Fig 16 depicts an integration of a gas sensor to detect the presence of harmful gases and a gas cylinder to supply oxygen which is supplied to the victim through a pipe.

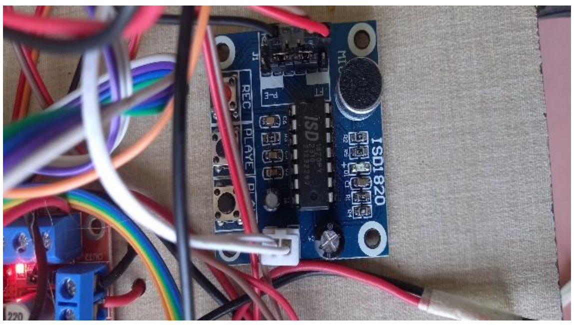

Fig 17: APR 33A3 voice recording module

The voice recording module along with the playback module is shown in Fig 17. It has a voice recorder through which voice messages can be sent to the victim.

Fig 18: Miniature speaker to play recorded voice

The miniature speaker as shown in Fig 18, is used to transmit the voice message that has been recorded to the trapped victim in the borewell.

V. CONCLUSION

To sum up, the creation and application of a robotic tool for borewell rescue operations marks a noteworthy advancement in the application of technology to emergencies. This specialized robot has demonstrated its efficacy in navigating the confined and challenging environments of borewells, enabling swift and precise rescue missions. The incorporation of advanced sensors, real-time communication capabilities, and features enhances its operational efficiency. As a result, this robotic not only mitigates risks associated with traditional rescue methods but also significantly reduces response time. As we continue to refine and expand the capabilities of such devices, the future holds promise for further improvements in rescue operations, ultimately contributing to enhanced safety and successful outcomes in challenging scenarios.

The future scope for robotic devices in borewell rescue operations is promising, offering innovative solutions to enhance efficiency and safety. These devices can be equipped with advanced sensors andimaging technologies to provide real-time data on the well's conditions. Integration of artificial intelligence algorithms could enable autonomous navigation and decision-making, improving the chances of successful rescue missions. Collaboration with rescue teams and ongoing research in robotics will further refine these devices, making them indispensable tools in emergencies, ensuring swift and effective borewell rescues while minimizing risks to human responders. Additionally, incorporating remote operation features and communication systems can facilitateseamless coordination between rescue teams and robotic devices. Cloud-based data storage and analysis can further enhance the post-rescue assessment, aiding in refining the robotic systems forfuture deployments. The ongoing research and development in this field hold the potential to revolutionize borewell rescue efforts, minimizing risks to both rescuers and those trapped in these environments.

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