Borewell Rescue Ranger Device

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Abstract- *In response to the pressing issue of child fatalities in borewell accidents in India, a groundbreaking solution is proposed—a cutting-edge innovation named the "Rescue Reach Rover." This revolutionary device aims to address the challenges posed by the narrow borewell diameter and the absence of adequate lighting during rescue operations.*

Unlike conventional rescue methods that require significant resources and space, the Rescue Reach Rover leverages advanced robotics and communication technologies to ensure swift and efficient child retrieval. The key feature of this portable device is its pneumatic arms equipped with a specialized harness, allowing precise and gentle retrieval of the trapped child.

To enhance communication and situational awareness, a state-of-the-art teleconferencing system is integrated into the Rescue Reach Rover. This enables real-time interaction between the rescue team and the child, ensuring a calming presence during the operation.

Acknowledging the limitations of previous rescue attempts, the Rescue Reach Rover addresses the need for a more accessible and cost-effective solution. Its portability and affordability make it deployable to remote locations where accidents occur, ensuring that valuable time is not lost in transporting heavy machinery.

At the core of the Rescue Reach Rover's functionality is the ESP8266 Wi-Fi Module, facilitating seamless communication between the device and the control center. The mechanical lifter, guided by signals from the module, operates with precision to unlock and execute the rescue once the desired position is achieved. The incorporation of a camera further ensures a smooth and stable rescue operation, providing crucial visual feedback to the rescue team.

By introducing the Rescue Reach Rover, we aim to revolutionize borewell rescue operations, mitigating risks and expediting the retrieval of trapped children. This innovative device embodies a commitment to leveraging technology for the betterment of society, especially in rural areas where such accidents are prevalent. The Rescue Reach Rover stands as a beacon of hope, embodying progress in the face of adversity and safeguarding the lives of those most vulnerable in our communities.

Keywords- Rescue Reach Rover, Borewell accidents, Child fatalities, Robotics, Pneumatic arms, Teleconferencing system, Communication technology, Portability, Affordability, ESP8266 Wi-Fi Module, Mechanical lifter, Real-time interaction, Remote locations, Deployment, Accessibility, Cost-effective solution, Innovation, Precision, Visual feedback, Safeguarding lives.

I. INTRODUCTION

Living in the 21st century, our strides in science and technology are undeniable. However, even amidst this progress, numerous challenges persist in the rural regions of India. One glaring concern is the alarming frequency of children falling victim to uncovered borewells, a tragic consequence of water source depletion.

Traditionally, rescue operations for such incidents involve resource-intensive methods, including the excavation of parallel bores, posing substantial risks and delays. The inefficiency of these techniques became evident in multiple heartbreaking incidents, such as the 2006 case of Prince Kumar Kashyap, who captivated the nation's attention during a 55-feet borewell rescue in Haryana.

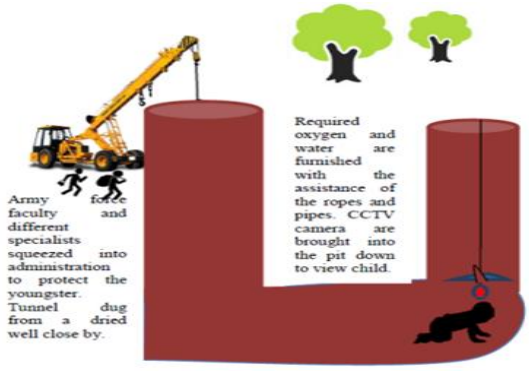

Figure 1.1 Parallel Pit Method

Figure 1.2 Traditional Borewell Rescue Method

In response to these critical shortcomings in rescue efforts, we present the innovative "Borewell Guardian Device." This portable solution utilizes a pulley system to lower a specialized robot into the borewell. Equipped with motors, microcontrollers, sensors, and cameras, the robot ensures efficient monitoring and child retrieval.

Addressing the tragic incidents that have marred recent years, including the unfortunate case of Mahi's demise in a 60-foot borewell, we emphasize the need for a transformative approach. The Borewell Guardian Device seeks to eliminate the hurdles faced by traditional methods, offering a more rapid and secure means of rescuing trapped children.

Examining other distressing cases, like Sai Barhate's incident in Maharashtra and the heart-wrenching fate of Fatehveer Singh in Punjab, it is evident that current rescue strategies are insufficient. The Borewell Guardian Device, with its innovative design and deployment capabilities, aims to be a beacon of hope in such critical situations.

Furthermore, the device's development draws inspiration from the Unified Schedule of Rates for Construction of Tube Wells and Allied Works, ensuring adherence to essential dimensions and safety standards. This unique approach emphasizes a holistic strategy that combines technology, portability, and adherence to established guidelines.

As we strive to address the urgent need for improved borewell rescue solutions, the Borewell Guardian Device stands as a testament to our commitment to safeguarding lives efficiently and minimizing the devastating impact of such incidents. It is time to bridge the gap between technological advancements and the safety of our most vulnerable citizens.

II. LITERATURE REVIEW

This section encompasses our extensive research efforts on the chosen project topic. We have meticulously reviewed numerous articles and journals relevant to our project model, diligently incorporating the insights derived from these scholarly sources into our research. The particularly valuable papers that significantly contributed to shaping our project are outlined below:

Jayasudha.M, et.al, 2019 [1] In India for recent years, water scarcity is the principal inconvenience. To overcome these issues, people initiated to burrow bore well. In our nation, the vast majority of the people are agrarian and they depend on the water for irrigation system. Children involuntarily fall into the bore well which yielded water and left revealed. The process of saving the trapped child into bore well is relatively challenging. At present, the rescuing task is accomplished by the method for burrowing a parallel pit close to the bore well with the same depth of the child and makes a passage that interfaces with the two wells. It takes about 30 hours to burrow the new well. By that period the child would have passed on. To overcome this concern, a well-planned robot is designed in a unique way, that it saves the stuck child and also it observes the child carefully by using web cam within a short time span. It consists of two modules which are rescuing system and protection system. The protection system is with the guide of setting an air sack at the base of the passage and recovers the child at the base of the passage and recovers the child at any rate of gripper disappointment. The safeguarding instrument is about a robot gadget fit for moving underneath the bore well bolstered with their user directions, equipped with robot arm, unrestrained objectives modernized camera, high resolution LED. The robot arm is utilized to fix the belt to the trapped children. The belt is hook.

Rajarathnam D.R.P, et.al 2018 [2] The bore well accidents are now become common everywhere. Frequently we hear news on child stuck in the bore well, some are being rescued and, in some cases, we lose to save the life of the child. The main objective of this project is to design and construct a portable robot which is cost effective, quick in action and accurate. The Bore well Rescue Robot is capable of moving inside the well and performs operations according to the user commands. The proposed model is designed to provide the child with two level of safety achieved by using robotic holding at the top and safety airbag at the bottom. This arrangement ensures that the child does not slip further deep during the rescue operation. The robot is operated by the human manually and monitor in computer. According to the observations made continuously using CCTV camera.

V. Venmathi, E. Poorniya, et.al, 2015 [3] The aim of this project is to give an innovative concept to handle the bore well rescue operations. Nowadays child often falls down in the borehole which is left uncovered and get trapped. It is difficult and also risky to rescue the trapped children to aid in such rescue we proposed a system of designing robots to the rescue of a child in a borehole. The robot structure consists of power supply, switch pad, gear motors, Oxygen concentrator, camera and Microcontroller. The condition of trapped child is captured with CCTV camera and monitored on a TV. A safety balloon is introduced in order to provide extra safety. Once the lifting rod reaches a safe position under the child, an air compressor is operated to pump air to the bladder attached to the end of the lifting rod through an air tube that runs downwards inside the lifting rod. The bladder provides a safe seating to the child. When the child is secure, the lifting rod is contracted to its maximum position. The motor is then reversely operated so as to unclamp the system. Simultaneously, it is lifted out of the well using a chain or rope. The programming language is Embedded C which is executed by MP lab Integrated Development Environment. This robot type machine can rescue trapped body from the bore well in a minimum amount of time and safety.

Elsa Babu, Emily Eldo, et.al, 2015 [4] Nowadays cases of children getting trapped in unused bore wells are increasing. The rescue of such children becomes difficult due to lack of proper awareness about the health condition of the children trapped in bore well. Even the depth at which child is trapped makes the rescue work a difficult. The present system uses releasing cameras into bore wells by means of tugs to get information about the victim which won't give reliable results. 'The Rescue Robot' is a creative innovation that solves these problems in rescue field up to a certain extent. This is a 3-wheel robot capable of moving vertically upwards & downwards by means of motors in bore wells. The motion is controlled by a remote Laptop via ZigBee module. The objectives of the project include wireless controlling of Robot through PC using Zigbee technology, live audio and video reception and implementation of pick and place concept to the robot.

Sridhar, K. P., And C. R. Hema, 2015 [5] Modelling and analysis of gripper arm system for bore well rescue operations and a humanoid model is designed to test the various parameters inside the well at various stages of time and places (humidity, temperature, pressure, oxygen, atmospheric air supply, speech ability, carbon dioxide, carbon level) and the rescue device is tested for its holding capacity.

Manish Raj, G. C. Nandi, et.al, 2014 [6] A technique for rescue task in bore well environment has been proposed. India is facing a distressed cruel situation where in the previous years a number of child deaths have been reported falling in the bore well. As the diameter of the bore well is quite narrow for any adult person and the lights goes dark inside it, the rescue task in those situations is a challenging task. Here we are proposing a robotic system which will attach a harness to the child using pneumatic arms for picking up. A teleconferencing system will also be attached to the robot for communicating with the child.

G. Nithin, G. Gowtham, et.al, 2014 [7] In the past few years, there have been several accidents of children falling into abandoned bore wells in India. Abandoned bore wells that have turned into death pits for children. The problem is all over India. Rescue teams spend hours and sometimes days in futile attempts to save these little kids. A lot of money is also spent in these missions. In most cases they are unable to save the kids. Such events have happened umpteen times in the past, and every time either the government or the bureaucracy is blamed. The rescue process to save the child from bore well is a long and complicated process now. The rescue team tries to approach the victim from a parallel well that take about 20-60 hours to dig. This complicated process makes 70% of the rescue operations fail. Very few of the victims have been saved in such accidents. Recently some autonomous robots came on to screen to take out the trapped body in a systematic way. But the question rises, why these bots are not in action in the real world. This brings out safety that how far the robot handles the child safely. The rescue operation mainly consists of three processes; Approaching the Child, Handling the body, Taking child out of the well. A regular autonomous robot could easily perform the first and third operations. These bots can make up these two steps within few minutes. But there is a great chance for injury of victim as they try hooking up body organs and cloths. Our Project deals with extreme Safe Handling of the victim. The design of handling system is made in such a way that the baby/victim never gets hurt and the robot itself provides some pretreatment to make the baby survive till the end of operation. Our robot design constitutes a best Ergonomic Design and performs safest rescue operation.

J. Casper and R. R. Murphy, 2013 [8] The World Trade Center (WTC) rescue response provided an unfortunate opportunity to study the human-robot interactions (HRI) during a real unstaged rescue for the first time. A post-hoc analysis was performed on the data collected during the response, which resulted in 17 findings on the impact of the environment and conditions on the HRI: the skills displayed and needed by robots and humans, the details of the Urban Search and Rescue (USAR) task, the social informatics in the USAR domain, and what information is communicated at what time. The results of this work impact the field of robotics

by providing a case study for HRI in USAR drawn from an unstaged USAR effort. Eleven recommendations are made based on the findings that impact the robotics, computer science, engineering, psychology, and rescue fields. These recommendations call for group organization and user confidence studies, more research into perceptual and assistive interfaces, and formal models of the state of the robot, state of the world, and information as to what has been observed.

III. METHODOLOGY

3.1 Methodology

The development of the "Borewell Rescue Ranger Device" serves as a crucial solution to mitigate the rising incidents of child fatalities in borewells. This portable setup is designed for ease of transport to accident locations, facilitating swift rescue operations. Key components include the ESP8266 Wi-Fi Module and a mechanical lifter, crucial for signaling and precise positioning during rescue. The incorporation of an ESP32 Camera enhances monitoring within the borewell, ensuring a smooth and stable rescue process following the methodology outlined in Figure 3.1.

3.2 Parts and Specifications

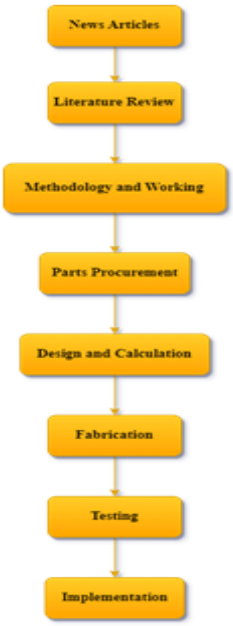

Figure 3.1 Steps Involved in Proposed Methodology

The project utilizes various materials listed in Table 3.1 for construction, including mild steel for plates and pipes, an ESP8266 Wi-Fi Module for wireless connectivity, a 5V Addressable LED Strip for illumination, an ESP32 Camera Module for monitoring, and a 12V DC battery for power. These components are selected based on their suitability and specifications.

3.2.1 Wireless Sensors

The ESP8266 Wi-Fi Module is chosen for its versatility, cost-effectiveness, and compatibility with various programming languages, making it an ideal choice for wireless operations.

3.2.2 LED's

The 5V Addressable LED Strip is selected for its lower voltage, energy efficiency, and compatibility with microcontrollers like ESP32, enhancing visibility inside the borewell.

3.2.3 ESP32 Camera Module

The ESP32 Camera Module is chosen for its built-in Wi-Fi, compact size, and capability to capture high-quality video up to 720p resolution, ensuring effective monitoring during rescue operations.

3.2.4 Battery

A 12V DC battery is chosen for its reliability, rechargeability, and ability to supply power for extended periods, ensuring sustained operation of the device.

3.2.6 Application Developed for Borewell Rescue Ranger Device

The Blynk IoT App is employed for device control, enabling engagement and disengagement of the working disk and LED illumination. Additionally, an IP address-based web server provides live footage from the ESP32 Camera, enhancing monitoring capabilities.

3.3 Calculations

The calculations for the borewell rescue ranger device are as follows. Mild steel material is used for fabricating the main body that includes pipes and plates. The rivet pin that is used to connect the plate and the extended pipe is made of high-speed steel material.

3.3.1 Design for the metal pipe

Force acted (w) = 300 N
σ_yt = 360 〖N/mm〗^2 …….. From PSG. 1.9

σ_t = σ_yt/FOS …….. Assuming FOS = 4
360/4 = 90 〖N/mm〗^2
σ_t = (load(w))/area
90 = 300/(π/4(d^2))
∴d = 2.06 mm

Selecting standard diameter = 12.7 mm or 1⁄2 inch

3.3.2 Design of rivet pin

P = 200 N
n = 1
τ = 125 〖N/mm〗^2
e (eccentricity = 70 mm)
P*e = 300*70
P*e = 21000 〖N/mm〗^2
c = 21000/70^2 = 4.28 N/mm
F = 4.28*70 = 299.6 N
R = √((200^2)+(〖299.6〗^2)+2(200)*(299.6)*cos⁡0)
R = 499.6 N
R = (_4^π)d^2 *τ
499.6 = (_4^π)d^2*125
∴d = 2.25 ≈ 4mm

3.3.3 Design of metal plates

As borewells have a standard size around 8–10-inch diameter, selecting a diameter of 6 inches.
Taking thickness of plate (t) = 4 mm
The material used for the plate is Mild Steel.

3.4 Construction and Fabrication of Borewell Rescue Ranger Device

The construction involves assembling pipes and plates made of mild steel, creating a structure with a working disk and ensuring secure attachment. The electronic circuit includes components like a 12V lead-acid battery, DC to DC buck converter, 2-channel relay, and ESP32 Camera, carefully assembled for optimal functionality.

3.5 Programming of Borewell Rescue Ranger Device

The device is programmed using C++ language through the Arduino IDE software. The ESP8266 Wi-Fi Module controls the working plate, while the ESP32 Camera is programmed for monitoring conditions inside the borewell. Blynk IoT App facilitates user-friendly control through a mobile interface.

3.5.1 Program Code Used for ESP8266 Wi-Fi Module for Working Plate

The C++ code enables the engagement and disengagement of the working plate, controlled by the Blynk IoT App, ensuring precise operation through a solenoid electromagnet.

3.5.2 Program Code Used for ESP32 Camera for Condition Monitoring

The code for the ESP32 Camera facilitates live streaming by generating an IP address when connected to a Wi-Fi server, enhancing monitoring capabilities.

IV. RESULTS

The borewell rescue ranger device is fabricated according to the calculation and materials selected from the calculations and parts procured. Further the output images from the Blynk IoT application and live footage captured from the ESP32 camera are explained here.

4.1 Working of the Borewell Rescue Ranger Device

Working of the borewell rescue ranger device can be explained as, the whole device is connected to the Blynk IoT app through ESP8266 Wi-Fi Module by which the major process will be carried out in such a way that if a child is stuck inside the borewell the device will be sent into the borewell with the help of a rope attached to the hook provided above the device. The rescue ranger device is equipped with a ESP32 Camera which will help in studying the borewell and also observing the conditions inside the borewell and the behavior of the child. To get better vision inside the borewell we have attached a LED strip light alongside the camera controlled by the Blynk IoT app so there will be proper lighting inside the borewell.

The borewell rescue ranger device has an extended rod which will pass through a clearance area from the besides where the child is stuck and will bring the plate attached to the extended rod nearest to the feet of the child. The plate will be at 90 degrees when it goes inside the borewell which is held by a solenoid electromagnet and controlled by Blynk IoT app. As soon as the plate reaches the feet of the child the current passing to the electromagnet will be turned off and the plate will fall from 90 degrees to an angle of 180 degrees and will be bought into contact with the feet of the child and then the child will be pulled up hence completing the rescue operation.

Figure 4.1 Borewell Rescue Ranger Device

4.2 Output from Blynk IoT Application

The figure 5.2 shows the in-app view of the Blynk IoT app which is used to control our device. The app majorly controls to components into our rescue ranger device that are the solenoid electromagnet and the LED strip. As you can see in the figure it shows the on and off status of the components.

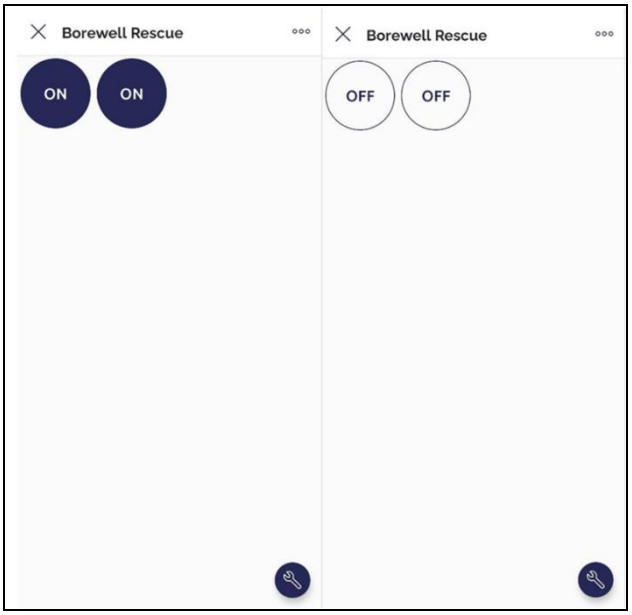

Figure 4.2 Output from Blynk IoT App

4.3 Output from ESP32 Camera

The figure 5.3 shows the of the dummy used as a child that is been rescued from the borewell. The live video footage from the camera can be seen when the ESP32 camera connects to a given network and then generates an IP address which is opened into the browser showing the live video footage of the child dummy been rescued from the borewell.

Figure 4.3 Output from ESP32 Camera

III. CONCLUSION

A novel framework for rescue robotics in the challenging bore-well environment is proposed in this study. Through a thorough examination of past incidents and a current assessment of the prevailing circumstances, it became evident that the development of such a framework is crucial for saving innocent lives. Beyond the technical intricacies, this project opens up an unexplored research frontier, presenting numerous challenges related to mapping in unknown environments, real-time teleoperation under low lighting conditions, and advanced arm manipulation systems. The primary objective of this framework is not just technical innovation but, more importantly, the preservation of human life.

In the project's conclusive phase, the borewell rescue ranger device demonstrated its efficacy in successfully rescuing a child trapped inside a borewell, as corroborated by the comprehensive testing results.

The versatility of the borewell rescue ranger device extends beyond its primary application, making it adaptable for use as a mechanical gripper in various industries such as Oil and Gas or the automobile industry. In the automotive sector, it can lift heavy parts, contribute to oil extraction processes in the oil and gas industries, and find applications in mining for mineral extraction.

To enhance its functionality further, the device includes an empty space designed for attaching an oxygen

cylinder. This addition aims to provide life-sustaining oxygen to a child trapped inside a borewell, where oxygen levels are often insufficient. Additionally, a communication device can be affixed to facilitate direct contact between family members and the child, ensuring emotional support and maintaining the child's stability for a smoother rescue operation. For improved gripping capabilities during rescue operations, a cloth catcher can also be incorporated.

This innovative framework not only addresses immediate rescue needs but also presents a multifaceted solution with potential applications in diverse industrial scenarios.

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