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Comparative Analysis of Bore Well Rescue

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***Abstract*—** At times there have been incidents, in India where children have fallen into open bore wells leading to complex and risky rescue operations. The conventional methods used for these rescues, which involve digging holes are both time- consuming and often ineffective. This paper introduces a solution that presents a real-time child rescue system supported by AI technology and implemented in three stages. The first stage focuses on prevention by identifying risks before a child falls into a bore well. This is achieved through Raspberry Pi and VGGNET algorithms that analyze expressions to detect signs of danger. Additionally, sound stimuli are employed to keep children calm during situations while a web application built with React JS monitors the child's condition. The second stage detects when a child has fallen into the bore well. A live detection camera observes the child's depth and posture, providing information that aids in planning the rescue operation. Finally, the third stage concentrates on retrieving the child from the bore. A proposed robotic system equipped with arms and a teleconferencing system for communication is controlled by Arduino. This mechanical setup navigates through the bore well to attach a harness, to the child ensuring an efficient and timely rescue operation. This comprehensive approach seeks to address the shortcomings of methods providing a more effective and prompt resolution, for rescuing children trapped in bore wells. *Keywords—Ergonomic, Anchorage, Rack & Pinion Geared mechanism, Teleconferencing, Installation.*

I.INTRODUCTION

The increasing water scarcity is a critical challenge faced by human society, exacerbated by factors such as droughts and depletion of underground water. This has led to a surge in the number of bore wells drilled on the Earth's surface, often left uncovered, posing a severe threat to human lives, especially children. Tragically, incidents of children falling into these abandoned bore wells have been on the rise due to the carelessness and playful activities of children. The bore wells, often reaching depths of around 700 feet, present significant challenges in rescue operations, with conventional methods risking the lives of rescuers and victims. In response to this pressing issue, a new system, the Bore Well Rescue System, has been designed to prevent children from falling into bore wells and to enhance the efficiency of rescue operations. The existing rescue methods involve significant risks and can be time-consuming. The formatter will need to create these components, incorporating the applicable criteria that follow. As shown in the figure Abandoned bore wells in India have claimed the lives of numerous children, often due to their carelessness and playful behavior. Rescuing trapped children from these wells, reaching depths of around 700 feet, is a challenging and time-consuming task. In some cases proves impossible to rescue. Since August 2008, India has reported forty-five child deaths in such accidents, with nineteen cases corroborated by newspapers.

Incidents Occurred:

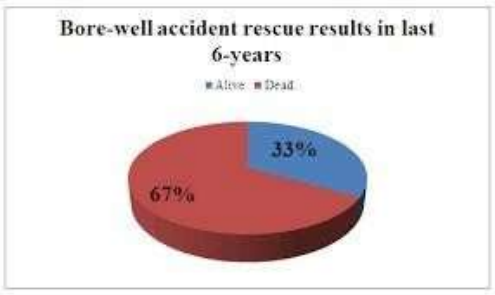

Fig 1: Last 6 years' results for borewell accidents

II. LITERATURE SURVEY

The author, Mayur N has entitled in his work by saying that the developed bore well motor lifting machine represents a significant advancement over manual chain pulley mechanisms by streamlining installation and lifting processes, thereby reducing time and labor requirements. Its key achievements include automation of certain tasks, simplifying assembly and disassembly for easy transportation, and boasting lower initial investment and operating costs compared to larger, more complex machines. However, there are several areas for potential improvement. Further automation could enhance efficiency, such as automating the engagement and disengagement of pipes. Additionally, increasing lifting capacity through more powerful motors or gear systems would broaden its utility[1]

The author P. K. Chidambaram has stated in his work that the document proposes the development of a rescue robot designed specifically for rescuing children trapped in bore wells, aiming to ensure their safe and timely extraction. The system's primary components consist of a cable rope, a deflated airbag, and a camera for continuous monitoring. Its objective is to ascertain the depth and posture of the trapped child using the camera, deploy the deflated airbag to the determined depth, inflate it to provide a stable platform for the child, and gradually lift both the child and the airbag using the cable rope while maintaining visual surveillance via the camera feed.[2]

Kadri Srinidhi Rao "The document outlines the proposed development of a rescue robot tailored to the task of extracting children trapped in bore wells, prioritizing their safe and efficient rescue. Key components include a cable rope, a deflated airbag, and a camera for continuous monitoring. it references papers such as "Virtual Prototype Realization and Simulation for Small-caliber Deep Well Rescue Robot" and "A Novel Design of Robotic System for Rescue in Bore Well Accidents" which may offer further insight into these aspects."[3]

S. Bharathi "The authors present an innovative AI-based smart borewell child rescue system designed to prevent, detect, and rescue children who accidentally fall into borewells. The system encompasses three main objectives: prevention by identifying a child before they fall into a borehole, detection to locate the child after a fall, and rescue by safely retrieving the child from the borewell. Utilizing hardware components such as Raspberry Pi, sensors, actuators, and a robotic arm, coupled with AI algorithms like VGGnet, the system analyzes facial expressions and voice to discern if a child is in danger. In terms of potential improvement, the authors highlight the need for advancements in child safety technology, aiming for greater accuracy in rescue operations while considering cost-effective computerized production methods."[4]

V.SARITHA "The document introduces the "Child Rescue System from Open Bore-wells," which seeks to address the limitations of current manual rescue methods, known for their time-consuming nature, inherent risks, and substantial resource demands. Central to the proposed solution is a clipper robot equipped with a camera, gripper, and controls, designed to execute remote rescues without the need for parallel pit digging. To enhance this system, improvements could focus on boosting the efficiency and speed of the rescue process while prioritizing the safety of the trapped child. Additionally, efforts could be directed toward minimizing resource requirements for rescue operations."[5]

M R Chaitra "The authors of the paper successfully envisioned and proposed an innovative robotic system designed to rescue children trapped in borewells. The proposed system boasts remarkable capabilities, with the ability to navigate inside uncontrolled borewells and employ pneumatic arms to securely attach a harness to the trapped child, facilitating their safe extraction. In addition to the rescue functionalities, a teleconferencing system will be integrated into the robot, enabling communication with the child during the rescue operation. The authors identified the limitations of traditional rescue methods, such as the challenging and time-consuming process of digging parallel pits, as well as the potential for causing wounds when using hooks or grasping devices. In response to these challenges, the proposed robotic system emerges as a promising alternative, offering a quicker and less risky means of rescuing trapped children."[6]

S. Gopinath "The authors successfully designed and implemented a rescue robot system to save children trapped in borewells. Their proposed system, comprising a transmitter unit, ARM8 processor, robot arm, and various sensors, aims to reduce rescue time and risks compared to manual methods. Enhancements could focus on wireless communication, robot arm precision, sensor optimization, and advanced imaging for better navigation."[7]

Manish Raj," Researchers successfully introduced a novel rescue robotic framework designed specifically for the challenging task of rescuing children who fall into bore wells. The proposed system is comprised of a robot equipped with two robotic arms, cameras, lights, and a chest harness, along with a communication system. The primary objective is to lower the robot into the confined bore-well environment, utilizing the robotic arms guided by cameras to attach the chest harness to the trapped child securely. Despite this innovative solution, the researchers identified significant areas for improvement, given the dark, narrow, and unfamiliar conditions within bore wells."[8]

III. PROPOSED METHOD

This paper introduces a hardware module employing a Raspberry Pi for processing and a camera module to detect distress in children. It utilizes the Emotional VG Gnet algorithm to recognize facial expressions when a child is distressed. Initially, the system aims to identify the child before they fall into a borewell, and upon falling, it focuses on locating them. The process involves collecting datasets of facial emotion images for analysis, which are then categorized into training and testing datasets. The training dataset undergoes preprocessing instead of augmentation, where highlights are removed using VGGnet learning. Sound cues are used to approach the child, and their responses are checked using the VG Gish algorithm. Additionally, a temperature sensor is employed to confirm the child's vitality. To monitor the child's emotional state, a mobile application is developed using React JS. Overall, this approach offers an innovative and effective method for rescuing children.

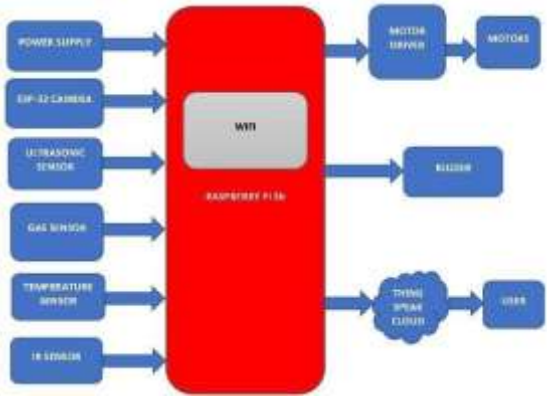

FIG.2 Block diagram of the system

IV. INTERFACE OF HARDWARE

1. Raspberry Pi

The Raspberry Pi connects to a computer or laptop via USB, with each device assigned a unique COM port number that can be adjusted as needed. It's crucial to select the appropriate COM port and know the corresponding board's COM number.

As shown in figure 3 the Raspberry Pi featured a single-core processor and 256MB of RAM, but the latest model boasts quad-core processors clocked at over 1.5GHz and 4GB of RAM. Despite these advancements, Raspberry Pi has consistently maintained its affordability, typically priced around USD 35, with the Pi Zero being notably inexpensive at just $5. Its versatility has led to widespread adoption for various purposes, including programming education, DIY hardware projects, home automation, Kubernetes cluster implementation, and industrial applications.

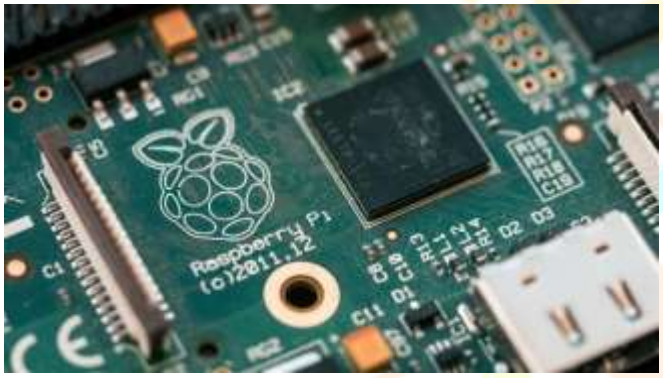

FIG.3 RASPBERRY PI

Raspberry Pi serves as a versatile platform for exploring physical computing and the Internet of Things (IoT) through its GPIO (General-Purpose Input/Output) pins. These pins operate at an operating voltage of 5V, with a recommended input voltage range of 1.8-3.3V. The board includes two 5V pins, two 3.3V pins, and multiple ground pins (0V), which are fixed and cannot be configured. Additionally, the remaining pins are general-purpose 3.3V pins, meaning they output at 3.3 volts and accept inputs within the same voltage range.

2. ESP-32 CAMERA

As shown in Figure 4 the ESP32-CAM is a compact and energy-efficient camera module leveraging ESP32 technology, featuring a built-in OV2640 camera and TF card slot. Its versatility makes it ideal for a diverse array of IoT applications. It enables the control of smart home systems, monitoring of industrial wireless setups, QR code scanning for passenger identification, and wireless transmission of positioning signals. Key specifications include Bluetooth 4.2 with BLE support, along with UART, SPI, I2C, and PWM interfaces for seamless connectivity. It boasts a clock speed of up to 160 MHz and impressive computing power of up to 600 DMIPS, ensuring smooth and efficient operation in various IoT scenarios.

FIG.4 ESP-32 CAMERA (ESP-32 CAM)

3. ULTRASONIC SENSOR

As shown in figure 5 an ultrasonic sensor functions by emitting high-frequency sound waves and then detecting the echoes that bounce back from nearby objects. These echoes are converted into electrical signals, allowing the sensor to measure the distance to the object. Notably, ultrasonic waves travel at speeds faster than audible sound, making them ideal for distance measurement applications where human hearing is not involved. Comprising a transmitter and a receiver, ultrasonic sensors utilize piezoelectric crystals to generate and detect sound waves. Their non-contact nature enables them to detect the position, movement, or characteristics of objects without physical contact, rendering them suitable for a wide range of applications.

FIG.5 ULTRASONIC SENSOR

4. TEMPERATURE SENSOR

As shown in Figure 6 a temperature sensor is an instrument designed to identify and quantify temperature variations, converting these changes into electrical signals. These sensors come in various forms, each suited to different environments and applications. One such example is the DHT11, renowned for its simplicity and affordability. Functioning as a digital temperature and humidity sensor, the DHT11 employs a combination of a capacitive humidity sensor and a thermistor to gauge the temperature and humidity of the surrounding air. It then produces a digital output signal through its data pin, providing easily interpretable data for users.

FIG.6 IR SENSOR

5. IR SENSOR

As shown in Figure 7 an infrared sensor serves as a tool for recognizing infrared radiation within its surroundings, translating this detection into an electrical signal. Its functionality extends to detecting object motion. The IR sensor module comprises five key components: an IR transmitter (IR Tx), an IR receiver (Rx), an operational amplifier, a trimmer pot (variable resistor), and an output LED. Operating at a voltage of 5V DC, it has a detection range of up to 20 centimeters. Its power consumption stands at 20mA.

FIG.7 IR SENSOR

6. BUZZER

As shown in figure 8 an audio signaling device, like a beeper or buzzer, can be created using various designs, including electromechanical, piezoelectric, or mechanical configurations. These devices are responsible for converting electrical signals into audible sounds. They commonly operate on DC voltage for power.

FIG.8 BUZZER

7. MOTOR DRIVER

As shown in Figure 9 a motor driver is a specialized integrated circuit responsible for managing motors within autonomous robots. Raspberry Pi communicates with motors through these motor drivers. Among the widely utilized motor driver ICs are those belonging to the L293 series, such as the L293D and L293NE. The L293D chip, for instance, features 16 pins, with eight of them specifically allocated for motor control. Each motor typically requires two input pins, two output pins, and one enable pin for operation.

FIG.9 MOTOR DRIVER (L293D Motor Driver)

V. INTERFACE OF SOFTWARE

Our project utilizes Python IDLE software for programming tasks and transferring them onto the Raspberry Pi board. We aim to establish control and issue commands through mobile applications such as Thing View Free and VNC Viewer.

1. Python IDLE

Python IDLE, short for Integrated Development and Learning Environment, serves as an integrated development environment (IDE) tailored for Python programming. It comes bundled with the Python installer for Windows, offering a comprehensive suite of tools for Python development. With IDLE, users can execute individual Python statements akin to Python Shell, as well as create, edit, and execute Python scripts. The IDE boasts features like syntax highlighting, autocompletion, and intelligent indentation, facilitating an efficient coding experience. Additionally, it includes a debugger equipped with functionalities such as stepping and breakpoints, simplifying the process of debugging Python code.

2. THINGVIEWFREE

ThingViewFree is a mobile application designed to visualize data from ThingSpeak channels in a user-friendly manner. It enables users to access temperature and distance measurements of objects, displaying these values within the app interface.

3. VNC VIEWER

VNC, or Virtual Network Computing, offers a cross-platform screen-sharing solution intended for remote control of computers. It enables users to interact with a computer's screen, keyboard, and mouse from a remote location using another device. VNC Viewer, specifically, facilitates graphical desktop sharing, allowing users to remotely control the desktop of a target computer (running VNC Server) from their device. This setup enables seamless interaction with the remote computer as if the user were physically present in front of it. In our project, we leverage such mobile applications to oversee and manage

VI. RESULT

As shown in Figures 10a,10b, and 10c the study employed diverse evaluation parameters, assessing changes in children's facial emotions linked to pneumonia through VGG NET algorithms and training/validation accuracy. The AI model implementation, conducted in Python, led to the successful deployment of monitors and rescuers for borewell-trapped children. The developed system, with facial emotion detection and child voice recognition capabilities, played a crucial role in potential life-saving scenarios. The Bore Well Child Saver's unique ability to navigate various pipes broadens its applicability to manufacturing industries. Its robust yet flexible design caters to different bore diameters, emphasizing adaptability in rescue situations, acknowledging the critical role of time in operations, and ensuring meticulous consideration of potential challenges for the safe rescue of the child.

FIG. 10a

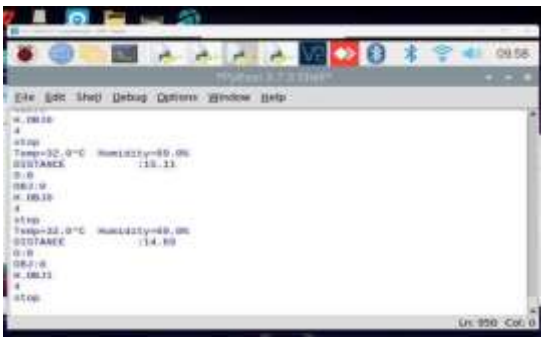

FIG. 10b

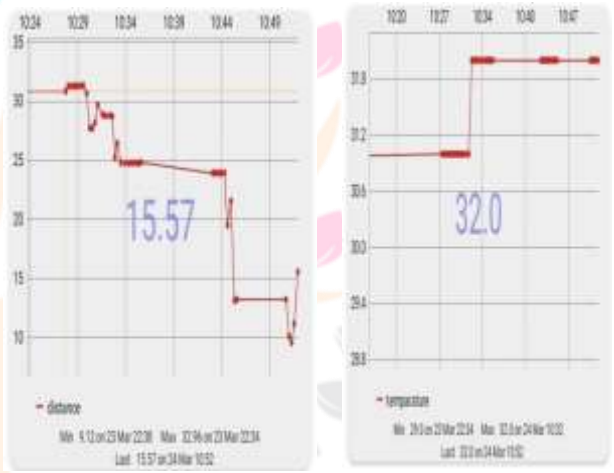

FIG. 10c

FIG.10 WORKING MODEL RESULTS

VII. CONCLUSION

In conclusion, the Bore Well Child Saver is a crucial initiative to rescue victims from bore well accidents, demonstrating its adaptability in various fields. The design addresses potential challenges in rescuing operations, emphasizing the importance of timely interventions. The system's flexibility accommodates different bore diameters, ensuring effectiveness.

The project's success is measured by its ability to rescue without harm, making it a valuable asset in saving lives. Future applications may include integrating temperature and smoke sensors for remote monitoring in hazardous zones. The study underscores the prevalence of borewell accidents, particularly affecting young children, necessitating preventive measures and rapid rescue strategies.

Furthermore, a proposed robotic framework for bore-well rescue emphasizes the need for ongoing research to address challenges in mapping unknown environments and real-time teleoperation. The ultimate goal remains the preservation of innocent lives. Additionally, the study highlights the significance of accurately estimating investment costs in borewell drilling, particularly in hard rock areas, for informed decision-making in government programs like the '100 Wells Scheme' and 'Ganga Kalyan Yojana'. The recommendation is to base unit costs on the total investment concept, aiding farmers in optimal loan utilization for borewell irrigation. Ultimately, the focus is on the humanitarian aspect of saving lives rather than solely on technical advancements.

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