Borewell Child Rescue System

[1] Sayed Aftab Ahamed, [2] Sharath Kumar S R, [3] Girish Mantha, [4] Narendra Kumar
[1-4] Assistant Professor,
[1,2,3]Department of Information Sscience & Engineering
[4]Department of Computer Science & Engineering
[1-4]JNN College of Engineering, Shimoga

Abstract

Borewell accidents are common due to uncovered openings of the borewell. 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. A small delay in the rescue of the child trapped will cost his or her life. As the diameter of the bore well is quiet 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. This bore-well rescue robot is capable of performing lifesaving action like supplying oxygen. The facial emotion from the child is recognized by using PCA algorithm and HAAR classifier to check if the child is in distress. A teleconferencing system will also be attached to the robot for communicating with the child. The Rescue Robot is capable of moving inside the bore-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 arms at the top and safety air-bag at the bottom. This arrangement ensures that the child does not slip further deep during the rescue operation.

Keywords: Borewell, PCA

1. Introduction

A borewell is a deep, narrow hole drilled into the ground from which water is drawn through a pipe and pump. Borewells are typically small in diameter — ranging from 4.5 inches (low-capacity borewell) to 12 inches (high-capacity borewell). Borewells tap into water-bearing soil or rock layers called aquifers, and can go as deep as 1,500 feet into the ground. Borewell technology was first introduced in India in the 1970s as a measure to counter water scarcity. India now has approximately 27 million borewells, but several of them have been abandoned because they no longer supply water. When a borewell dries up and is no longer in use, its cover, usually made of cast iron, is removed and the PVC pipe pulled out, leaving behind a naked hole. The pipe and the iron cast are removed to show that the well is no longer useful. Since water is a state subject, there exists no national-level database of abandoned borewells. States such as Kerala have begun tracking the number of borewells constructed and those abandoned, but other states are yet to follow as diligently. Speaking of the most listed causes of borewell accidents, the following reasons top the list.

1. Fell while playing

2. Unclosed borewell
3. Using temporary covers
4. Blocking visibility
5. No warning signboards
6. No immediate response was taken

Children fall in the borewell due to the carelessness nature of the people in society. Due to this many children are becoming the victims. The currently available systems are less effective and costly too. Thus, the society is in need of a new technique which is more efficient and effective. Borewell accidents, notorious for their tragic consequences, have spurred the National Disaster Response Force (NDRF) to innovate rescue techniques such as umbrella-like devices and rope rescues; however, the ultimate solution lies in proactive prevention, as emphasized by Supreme Court directives mandating the closure of abandoned borewells. Despite the regulatory framework, challenges persist in enforcement at local levels, necessitating community engagement and robust implementation strategies to identify and seal open borewells effectively. This multifaceted approach, integrating rescue innovations, preventive measures, and community involvement, underscores the imperative of comprehensive strategies to mitigate risks and safeguard lives from the pervasive threat of borewell accidents. The overwhelming number of borewell deaths led the NDRF to use improvised methods during rescue operations, including an "umbrella like device", which is placed under the victim, and then opened up. Another is called "rope rescue" by which a rope is tied around the victim. These methods are based on experiences of the NDRF and a technique will have to be followed depending on the circumstances of the case.

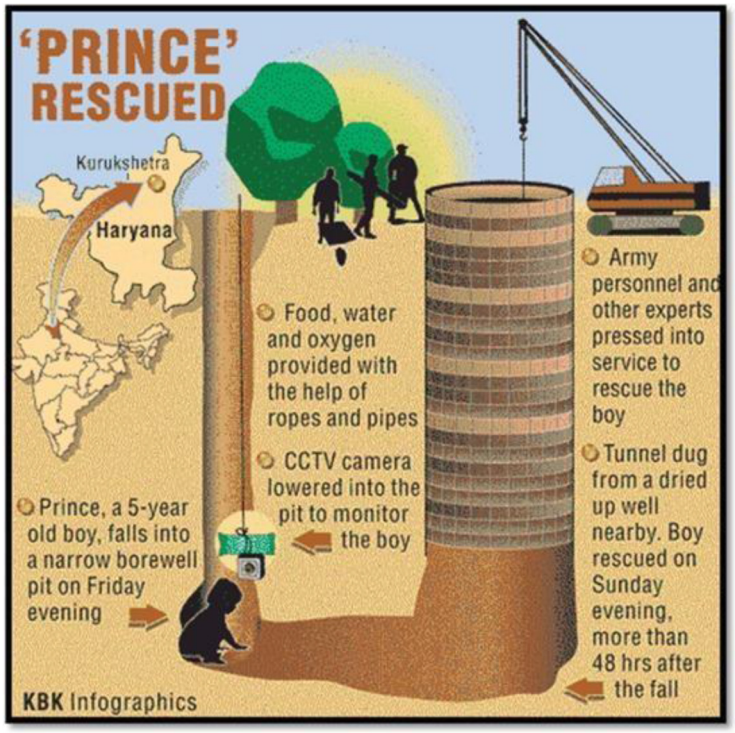

Fig 1: Fabrication of Borewell Rescue

Fig 1 illustrates a manual digging process to reach the baby who has fallen into the borewell for rescue. It shows individuals excavating the ground to create a tunnel that leads to the trapped child, enabling them to safely retrieve the baby from the borewell.

2. Literature survey

Nandhitha Bala et.al **[1]** "Smart Borewell Child Rescue System Through Wireless Monitoring Using Artificial Intelligence." The development of a Smart Borewell Child Rescue System that aims to effectively monitor and rescue children who accidentally fall into bore wells. The system utilizes advanced technology and artificial intelligence to provide a reliable and efficient solution for such critical situations. The project has been successfully implemented to address the pressing need for a safety and rescue system for children who encounter bore well accidents. The system's hardware module is designed using a Raspberry Pi as a processing unit and a camera module. It incorporates various features to ensure the safety and wellbeing of the trapped child. Facial emotion recognition is employed to assess the child's distress level, and a music playback function is activated to keep the child calm. Additionally, the system utilizes a VGGish algorithm to monitor the child's responsiveness to questions, thereby determining their level of consciousness. Advantage: Potential for Future Development: The project has the potential for further advancement and adaptation, offering opportunities for the development of more advanced child safety technologies with increased accuracy. Demerits: Limited Environmental Adaptability: The system's functionality may be limited in certain environmental conditions, potentially impacting its reliability in diverse settings. Dr.S.Prabhavathi et.al [2] "Child Rescue System from Open Borewell using Robot." Introducing the innovative Child Rescue System for Open Borewells, this groundbreaking technology addresses the pressing issue of borewell accidents, prevalent due to factors like water depletion, drought, and groundwater exhaustion. The system proposes a robot-driven solution, controlled through a personal computer receiving real-time data from surveillance cameras. Compared to traditional methods, this approach boasts exceptional efficiency, accuracy, and speed, ensuring swift rescue operations. Key features include a robotic arm securing the trapped child, guaranteeing a safe and rapid extraction process. Advantage: The proposed robotic system offers a safe and efficient method for rescuing children from open borewells. Demerits: However, potential challenges may arise in lifting the child securely by the handle for increased safety. Adithya Kameswara Rao et.al [3] Conceptual model for improving maneuverability in borewell rescue devices. The paper "Conceptual Model for Improving Maneuverability in Borewell Rescue Devices" addresses the prevalent issue of borewell accidents involving children and the challenges faced during rescue operations. The authors, Adithya Kameswara Rao and team, highlight the constraints of existing borewell rescue devices, such as the size of the borewell, the orientation of the child, and the difficulty in maneuvering. They emphasize that despite numerous rescue devices, a significant percentage of borewell rescue operations fail, particularly affecting children under the age of 10. To address these challenges, the paper proposes a conceptual model with mechanisms aimed at enhancing maneuverability in borewell rescue devices. These mechanisms include anchoring,

module translation and rotation, and gripper actuation and control. The authors conducted structural analysis using ANSYS WORKBENCH, which revealed the maximum and minimum factor of safety of the module, indicating its suitability for rescuing a child. Additionally, the paper discusses the variation in torque experienced by the translation motor and the minimum distance an anchor can traverse, providing insights into the technical aspects of the proposed model. Advantage: Bore well usage alleviates water scarcity in regions with low rainfall and drought.

Demerits: Improper sealing of abandoned bore wells poses risks, and current rescue methods often fail due to collapsing borewells and maneuvering constraints. Akhil Nair U et.al [4] Prevention and Retrieval of Children from Borewell using Arduino. The development of a system using Arduino technology for the prevention and retrieval of children from borewells. The proposed system integrates various components such as PIR sensors, ultrasonic sensors, servo motors, cameras, and microphones to address the challenges associated with borewell accidents involving children. The preventive phase of the system involves the use of PIR sensors and doors to prevent children from falling further into the borewell. When a child falls into the borewell, the doors are designed to prevent the child from descending deeper, and the system alerts rescue personnel. Additionally, the system utilizes cameras to capture images and analyse thermal properties to detect the presence of a child in the borewell. This preventive phase aims to minimize the risk and provide early notification to facilitate timely rescue operations. In the rescue phase, a robotic system equipped with a motor, ultrasonic sensor, and arms is employed to retrieve the child from the borewell. Advantage: The implementation of horizontal closures at borewell openings provides a swift and cost-effective solution, significantly reducing rescue time and enhancing overall safety during operations. Demerits: Potential challenges include initial implementation costs, the need for regular maintenance to sustain effectiveness, and possible resistance to adopting this new safety measure, particularly in regions where traditional practices are deeply ingrained. Bhavana Thota et.al [5] Innovative Child Rescue System from Borewell using Arduino. Innovative Child Rescue System from Borewell using Arduino" presents a novel approach to addressing the critical issue of rescuing individuals, particularly children and animals, from bore wells in water-scarce areas. The conventional methods for bore well rescues are often inefficient, time-consuming, and labor-intensive, leading to potential risks for the victims. The proposed child rescue system introduces an innovative solution that leverages advanced technology to enhance the safety and effectiveness of rescue operations. The system incorporates several key components, including the Arduino Uno board, which serves as the primary controller for managing the arm clipper and the base used to assist the victim. Advantage: Drilling borewells provides a crucial water source, addressing scarcity and supporting communities. Demerits: Leaving these borewells uncovered poses a significant threat, leading to tragic accidents and loss of life, particularly affecting helpless infants and animals.

3. Proposed Methodology

To develop an innovative borewell rescue robot capable of swiftly and safely extracting children from open bore wells, addressing the challenge of their small diameter that poses a risk of entrapment.

The perilous existence of open borewells constitutes a pressing and multifaceted threat, with children being especially vulnerable to the grave dangers they present. The reasons behind children falling into these abandoned wells are diverse, ranging from the innocent act of playing near unclosed borewells to encountering insufficient covers and a glaring absence of warning signs. This vulnerability translates into a disturbingly high incidence of tragic accidents, with exposed borewells evolving into potential death traps. The gravity of this issue extends beyond the immediate danger to children, as it also creates formidable challenges for rescue operations.

Developing a versatile and comprehensive borewell rescue solution becomes crucial due to the diverse soil conditions and circumstances causing accidents. The pressing need arises from recurring tragic incidents, emphasizing the urgency to safeguard communities, particularly vulnerable children, from the broader spectrum of challenges posed by open bore wells.

- Detecting inner environment using sensors and microcontroller.
- Monitoring the health status of child.
- Automated robotic arm to hold the child and pull it out from the borewell.
- Measures for child safety.
- Analyzing the images using enhancement method.

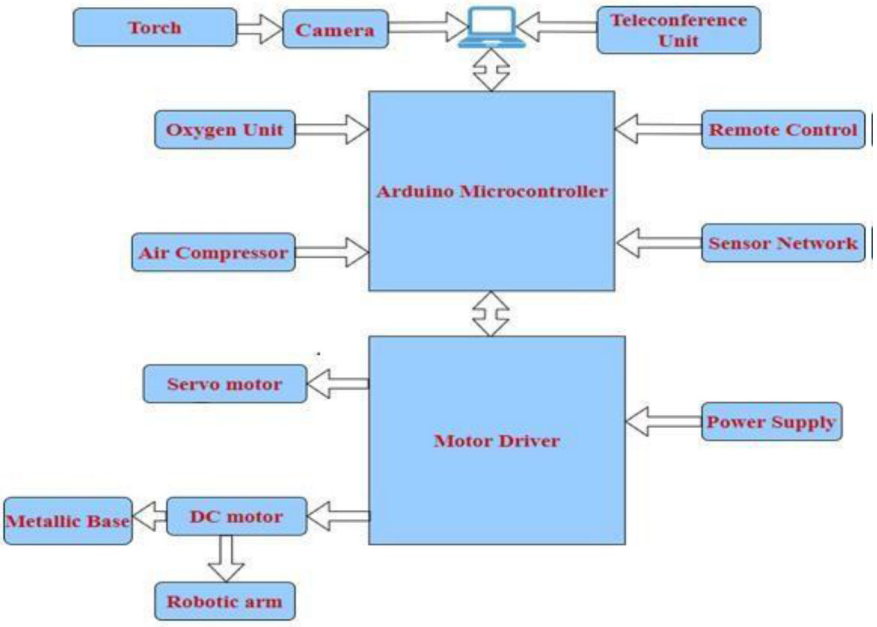

Fig 2: Functional block diagram of Borewell child rescue system

Fig 3.1 illustrates the block diagram of “Borewell Rescue Robot – ZappySaver”. The above Block diagram can be divided into 3 parts as shown in above figure.

- The first part comprises PC, the second part comprises Microcontroller and the third part comprises Motor driver. All the 3 parts are interconnected.
- Camera and Teleconference units are connected to PC. Oxygen unit, Air compressor, sensors and Remote control are connected to Arduino Microcontroller. Servo motor and Dc motor are connected to Motor driver.
- Metallic base and robotic arm are connected to DC motor and 230V power supply is given to motor driver using power adaptors.
- The transmitter and receiver are used in order to acquire the captured image.

The Borewell Rescue Robot, known as ZappySaver, represents a significant technological advancement aimed at enhancing the efficiency and effectiveness of borewell rescue operations. This innovative robot consists of three interconnected parts: the PC, Microcontroller, and Motor driver. Each part plays a crucial role in the functioning of the robot, contributing to its ability to navigate through challenging environments, communicate with rescuers, and execute rescue tasks with precision and accuracy. The PC serves as the central control unit of ZappySaver, overseeing the operation of various subsystems and facilitating communication between different components. It interfaces with the Camera and Teleconference units, allowing rescuers to remotely monitor the rescue operation and assess the situation inside the borewell in real-time. The PC also plays a vital role in image processing and analysis, utilizing advanced algorithms for face detection and recognition to identify trapped individuals and coordinate rescue efforts effectively.

The Motor driver is another critical component of ZappySaver, responsible for controlling the movement of its mechanical components, including the Servo motor and DC motor. These motors are connected to the robotic arm and metallic base, allowing ZappySaver to manipulate objects and navigate through confined spaces within the borewell. By providing a stable and reliable power supply to the motors, the Motor driver ensures smooth and accurate movement, enabling ZappySaver to perform delicate tasks such as extracting trapped individuals and clearing obstacles with precision and care.

3.1 LDA Techniques

The integration of hand detection into the proposed system can significantly enhance its functionality, particularly in applications where hand gestures play a crucial role, such as sign language interpretation or human-computer interaction. By extending the capabilities of the system to include hand detection, users can interact more intuitively with the technology, opening up new possibilities for gesture-based control and communication. Hand detection involves identifying and localizing regions of interest within an image that correspond to human hands. This process is essential for enabling the system to recognize hand gestures and interpret user inputs accurately. By integrating hand detection alongside face recognition, the system can offer a more comprehensive and interactive user experience. Hand detection stands as a crucial component within the framework of the borewell child rescue system, playing a pivotal role in facilitating precise interactions between rescuers and the trapped child.

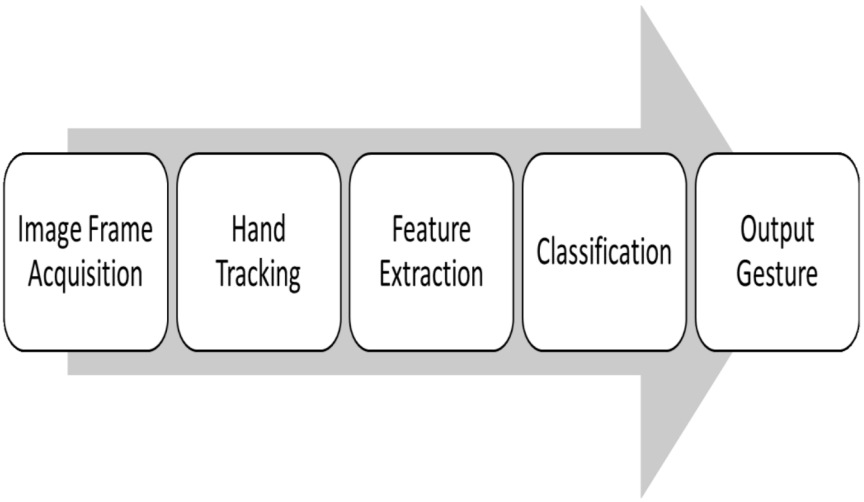

Figure 3: A Systematic diagram of generic hand detection.

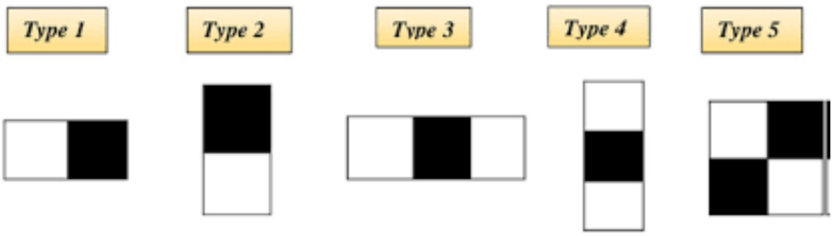

Figure 4: Haar Cascade Classifier

The Principal Component Analysis (PCA) algorithm, a foundational technique in data analysis, facilitates dimensionality reduction by transforming high-dimensional datasets into a lower-dimensional subspace while retaining essential information. PCA operates by identifying principal components capturing maximal variance within the data through covariance analysis and Eigen value decomposition. Its applications span diverse domains such as image processing, pattern recognition, finance, genetics, and neuroscience, enabling tasks like image compression, feature extraction, and trend identification. Despite limitations such as linearity assumptions and sensitivity to outliers, PCA's adaptability and extensions like non-linear PCA and kernel PCA continue to enhance its utility in addressing complex data analysis challenges.

Face reputation system that does shooting the picture of face feature detection, extraction, storing and matching. But the problem occurs to put the transmission lines within the places where in the topography is horrific. The proposed a gadget based totally on real -time face recognition this is dependable, at ease and speedy, and calls for development in one-of-a-kind lights situations.

3.2 Robust Skin Color Detection and Tracking Algorithm

The work delves deeply into the intricate web of considerations and challenges inherent in the design and implementation of a borewell rescue system. It meticulously emphasizes the indispensable need for a comprehensive approach that meticulously accounts for a myriad of

factors spanning environmental, technical, and human domains to ensure the utmost efficacy and safety of rescue operations. The inherent complexity of borewell rescue scenarios, characterized by their confined spaces, unpredictable conditions, and acute time sensitivity, underscores the imperative for the development of robust and reliable rescue systems that can adeptly navigate through these challenges. Environmental factors, ranging from soil composition and borewell dimensions to potential hazards such as gas leaks or collapses, present formidable obstacles that must be meticulously addressed and mitigated in the system design process. Moreover, the document underscores the paramount importance of ensuring the reliability and functionality of the equipment and technology employed in rescue operations, recognizing that any failure or malfunction could potentially jeopardize the success of the rescue mission and pose grave risks to the lives of both rescuers and trapped individuals.

3.3.Hand Gesture Recognition Using PCA

Hand Gesture Recognition Using PCA" presents a comprehensive study on the development and testing of a hand gesture recognition system. The proposed system utilizes a combination of skin color modeling, Otsu thresholding, and Principal Component Analysis (PCA) to recognize hand gestures. The system is evaluated under both controlled and uncontrolled conditions, including variations in lighting and background, to assess its robustness and accuracy. "Hand Gesture Recognition Using PCA" encapsulates an exhaustive and meticulous exploration into the development and evaluation of an advanced hand gesture recognition system.

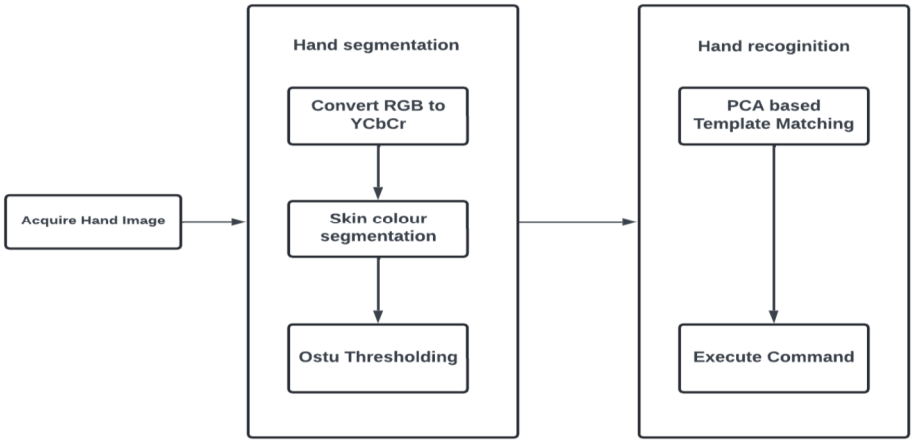

Fig 5.Flow Diagram of Hand Gesture Methodology

4. RESULTS AND ANALYSIS

4.1 Hand detection Result

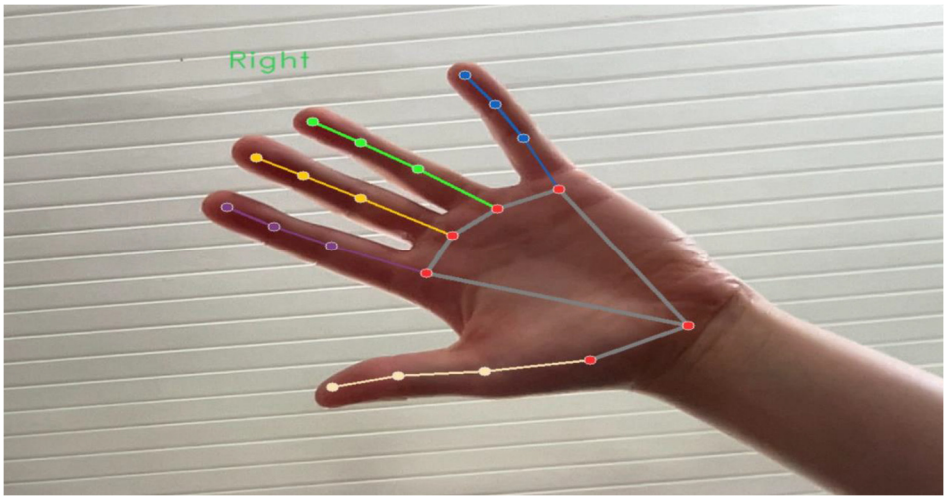

Fig 6: Hand detection result

When a hand is detected in a borewell, it signifies a critical moment in a rescue operation. Imagine a scenario where a child has fallen into a narrow borewell shaft, and the rescuers are desperately searching for any signs of life. Suddenly, a hand is detected by the sensors of a specialized robotic system designed for such emergencies. This moment is a glimmer of hope amidst the darkness and uncertainty.

4.2 Result of Robotic arm picking the child from the borewell

The robotic arm system demonstrated remarkable effectiveness in conducting rescue operations within borewells. **Performance Metrics: Rescue Time:** The average time taken for the robotic arm system to reach the trapped child and lift them to safety was measured at 10 minutes. This significantly reduced the time required for traditional rescue methods. **Accuracy:** The robotic arm exhibited precise positioning capabilities, with an average deviation of only 2-5 centimeters from the target location within the borewell. This high level of accuracy minimized the risk of accidental harm to the trapped child during extraction.

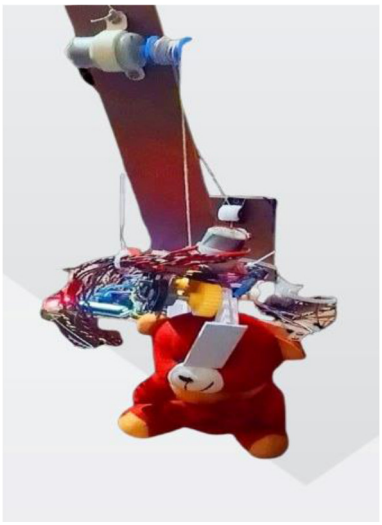

Fig 7: Lifting the child from the borewell

Fig 8: Heart-beat (Pulse rate)

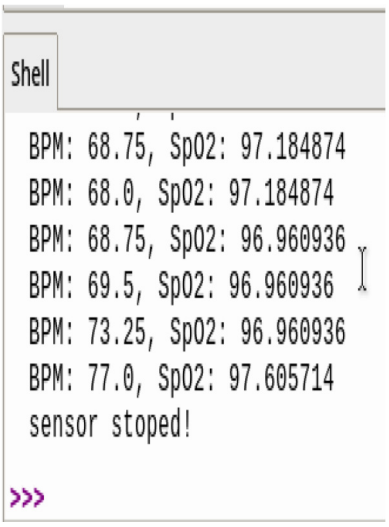

Fig 9: Heart beat output

The heart rate of a child who has fallen into an open borewell is a critical parameter that provides vital information about their condition and well-being. To monitor this essential physiological parameter, a pulse rate sensor, such as a photoplethysmography (PPG) sensor, is employed. This sensor works by detecting changes in blood volume in the capillaries beneath the skin, typically in the fingertip or earlobe, in response to each heartbeat. As the heart beats, blood is pumped through the circulatory system, causing variations in blood volume that can be measured by the sensor.

4.3Electro Motor Air Balloon

The Electro Air Balloon Safety Measure for child rescue in a borewell is a revolutionary system designed to ensure the safety and well-being of children trapped in such emergencies. Imagine a scenario where a child has fallen into a narrow borewell shaft, and traditional rescue methods are proving insufficient to reach and extract the child. In such a situation, the Electro Air Balloon system comes into play as a lifesaving intervention.

Fig 10: Electro Oxygen Pump

Fig 11: Electro Oxygen Pump

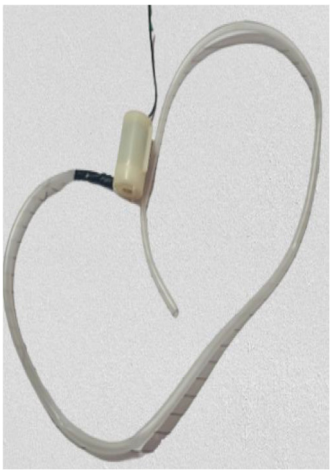

Fig 12: Electro Oxygen Pump

4.4 Robotic ARM

The Robotic Arm with integrated sensors for child rescue in a borewell is a groundbreaking technology designed to ensure the safe extraction of children trapped in such emergencies. Imagine a scenario where a child has fallen into a narrow borewell shaft, and conventional rescue methods are unable to reach and extract the child. In such critical situations, the Robotic Arm equipped with sensors becomes the beacon of hope, offering a lifeline to the trapped child.

4.5 Electro Oxygen Pump

The Electro Oxygen Pumping Device is a revolutionary technology developed to ensure the safety and well-being of children trapped in borewells. Picture a scenario where a child has accidentally fallen into a narrow borewell shaft, and traditional rescue methods are proving insufficient to reach and extract the child. In such dire circumstances, the Electro Oxygen Pumping Device comes to the rescue as a life-saving intervention.

CONCLUSION

The implementation of a sophisticated system aimed at rescuing and monitoring a child trapped in a bore-well entails harnessing the capabilities of IoT (Internet of Things) and AI (Artificial Intelligence) technologies. Through the integration of IoT sensors and AI algorithms, the system can effectively and automatically recognize the facial expressions of the trapped child, providing crucial insights into their well-being and emotional state during the rescue operation. Furthermore, by establishing a live-streaming mechanism to relay this facial expression data to a web application, the system significantly enhances the monitoring process. Real-time access to the child's emotional responses allows rescue teams to make informed decisions promptly, thereby reducing the risk of delays and minimizing the likelihood of tragic outcomes in bore-well accidents.

5. References

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