Designing Of A Borewell Rescue Machine

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***ABSTRACT*—This project focuses on the design and development of a borewell rescue system aimed at efficiently rescuing objects or trapped entities from borewell holes. The system is built using a sturdy tripod frame equipped with a top-side pulley, which allows for the smooth movement of the rescue mechanism. The primary lifting mechanism involves a wiper motor attached to a steel strip, which operates a specialized arm gripper designed to retrieve objects from deep inside the borewell. The system is controlled wirelessly via an Arduino microcontroller interfaced with an HC-05 Bluetooth module, enabling remote operation of the motors. Motor drivers are used to control the wiper motor and other necessary components for precision movement. Additionally, the setup includes an Arduino camera for real-time monitoring of the borewell interior, and an IR sensor for obstacle detection, ensuring safe and efficient operation. This innovative rescue system is portable, user friendly, and provides a cost-effective solution to the growing issue of borewell accidents, offering both enhanced safety and precision during the rescue process.**

Keywords— rescue machine, motor drivers, wiper motor, obstacle detection, borewell accidents

I. INTRODUCTION

As of day, by day the demand for water is increasing which eventually disturbing the climatic condition. This disturbance creating the imbalance in natures cycle which create drought like situation or flood in many regions which are unexpected. This imbalance is increasing day by day and creating more accidents with more upcoming unexpected accidents which can never be imagined by human nature. These accidents many includes drowning in flood or falling in tube wells/wells in dry region. The tubewell falling has been increasingly seen nowadays.

This accident happens with children in rural areas whereas with adult in urban area or in old dugged mine holes. Due to more decrease in ground water the formation of borewells is increasing which creating ratio for accidents too.

Borewell accidents, especially involving children, have become a critical issue in many parts of the world, particularly in rural areas where uncovered or abandoned borewell holes pose a significant hazard. Despite various government regulations, incidents continue to occur, necessitating the development of efficient rescue systems. Traditional methods for borewell rescue are often time-consuming, complex, and risky, involving manual operations with heavy machinery that can take hours or even days to rescue the trapped entity.

The borewell rescue system presented here is a smart, automated solution that uses a tripod frame with a pulley mechanism, a wiper motor-driven gripper arm, and wireless control to streamline the rescue process, making it faster, safer, and more efficient.

This system leverages modern technologies such as an Arduino-controlled motor system, Bluetooth wireless operation, and sensors for obstacle detection to address the shortcomings of manual rescue operations. The design aims to provide a reliable solution that can be quickly deployed in the event of a borewell accident.

II. OBJECTIVE

Here are the key objectives for the design and development of a borewell rescue system using a tripod frame, wiper motor, and various electronic components:

1. To design a system that can safely retrieve objects or individuals from borewell holes without endangering rescuers, using a motorized gripper arm suspended from a pulley system.
2. To utilize Arduino and the HC-05 Bluetooth module to enable remote wireless operation of the motors, reducing human intervention in hazardous conditions.
3. Install an Arduino camera to provide live video feedback of the borewell interior, aiding in accurate identification and monitoring of obstacles or the individual trapped.
4. Use IR sensors to detect obstacles within the borewell hole, preventing accidental damage to the system or the object being rescued.
5. Ensure the system, including the tripod and pulley, is portable and easily deployable, especially in rural or remote areas where such incidents frequently occur.
6. To make a speedy action on the incident happened to ensure safety of victim.

III. LITERATURESURVEY

This whole survey for the design is based on different engineering design and analysis approach. While giving more importance to the design procedure, the analysis of different methods and procedures were undertaken to design a reliable model for reducing the time and to rescue the victim as soon as possible in less time. A number of research papers were referred to which formed the basis of our model. Some of these papers are as follows.S. Arthika and et. al presents Borewell Child Fall Safeguarding Robot which works with the help of microcontroller-based system which operates on the command and the sensor placed with it to measure te0mperature as well as gas in the bore hole. This system focuses on time saving and pulling the victim from the bore hole with the help of robotic arm as specified in diagram. [1]

A. Shenai and et. al introduces Development of In-Pipe Robot for Assisting Borewell Resue Operation. They use robot as a rescuing medium with controller and various sensors applied to it. These robot works in in-pipe system with advanced live stream and motion control to control which minimizes risk and advances the controlling medium of speed of motor. [2]

Nanditha Bala and et. al introduces Smart Borewell Child Rescue System Through Wireless Monitoring Using Artificial Intelligence. In this paper a hardware module is designed using a raspberry pi as a processing module and a camera module. The facial emotion from the child is recognized by using emotional VGG net algorithm to check if the child is in distress and a music is played to keep the child calm. They too had enabled Ai to work smartly and advance the process for the future development.[3]

Kavianand G. and et. al presented Smart Child Rescue System

from Borewell. This system consists of PIR sensor to sense human irrespective of external conditions. These sensors will place at top of borewell. Then the sensed signal will be sent to controller and a alert message will be sent to fire service with location information and a closing is provided for protection.[4]

Nish Mohith Kurukuti and et. al presents A Novel Design of Robotic System for Rescue in Bore well Accidents proposes a novel, adaptable rescue robot design that adjusts to varying borewell diameters, ensuring secure attachment and smooth traversal. Equipped with two artificial arms, a camera, and communication capabilities, the robot facilitates safe and efficient rescue operations, encompassing victim location, communication establishment, and retrieval.[5]

Siddharth Singh and et. al presented Implementation of a Child Rescue System from Borewell using Zig-bee for Long Range Application. This project is based on zig-bee model which receives data from sensor which are placed at different position to get the live visual and to make the process easier. The motor drive present are controlled by microcontroller for its positioning and speed. At the deepest point of rescuing a gripper is placed to grab the body and hold it until safely procured. It also consists of lcd display to get exact data of oxygen level and gas detection at the point.[6]

Akash B and et. al introduces Design and Development Of Robot For Rescue Operations For Bore-Well Victims. This project designs a robotic system with dual arm grippers, utilizing a gear mechanism and lead screw for safe and controlled movement. The system interfaced with Raspberry Pi enables live streaming and real-time sensor data monitoring of distance, temperature, and humidity. The entire system is controlled and monitored through a webpage, facilitating the safe rescue of children trapped in borewells.[7]

S. Gopinath and et. al presents Rescue Child from Bore well using Embedded System This project develops a robotic system for rescuing children fallen into borewells, utilizing an ARM8 process or enabling seamless data processing and analysis. Furthermore, a vacuum cup is utilized to adjust the child's position, ensuring precise alignment and stability. The robotic arm's movements are precisely controlled by a stepper motor, BLDC motor to locate, position, and lift the child to safety, with ZigBee enabling real-time data transfer between the borewell and the recovery team, thereby ensuring a coordinated and efficient rescue operation.[8]

Ms. P. Suji and et. al introduces Smart Borewell Rescuing robot. The system utilizes an Arduino Uno microcontroller to control an Ultrasonic sensor, measuring the victim's distance and displaying it on an LCD display. The Rescue unit features2 DC motors for horizontal/vertical and open/close movements, Web camera for real-time victim monitoring via PC, LED light for illumination and Motor driver (L293D) for DC motor control enabling efficient and informed rescue operations.[9]

Rajarathnam D.R.P and et. al presented Borewell Rescue Robot. The proposed model incorporates a dual-layer safety mechanism, comprising robotic holding apparatus at the superior aspect and a safety airbag at the inferior aspect. This strategic arrangement ensures the child's stability and prevents further descent during the rescue operation. The robotic system is manually operated by a human controller, monitors its movements and performance in real- time via a computer interface, the rescue operation using a CCTV camera.[10]

S. Bharthi and et. al introduces AI based Smart Borewell Child Rescue System. This project creates a portable, real-time system that uses Artificial Intelligence to help rescue children trapped in small spaces, like bore wells. Innovative borewell rescue system utilizes Raspberry Pi as camera and handling module. By harnessing the capabilities of VGGNET calculations, the system analyzes a child's facial expressions to ascertain whether they are in a state of distress. To ensure the child's calmness, soothing music is played, web application developed using React JS-based app displays child's emotional state. Additionally, the equipment is equipped with sensors to measure the oxygen percentage within the borewell, providing critical data to inform rescue efforts. Provides effective, innovative solution for safeguarding trapped children.[11]

Krishna Bachlaand et. al introduces Rescue system For Manhole and Well introduces a system with camera servo motor to hold and pull the body upward to rescue from the incident. They use pneumatic gripper to hold the body. This gripper attached to motor to hold and pull the body outside.[12]

Nitin Agarwal and et. al presents Child Rescue System from Open Borewells. They present a pipe-based rescue system which is attached with camera and other sensor to communicate outside. They use body belt to be grabbed by the victim and thus the body can be pulled upward without any outer body harm. They show pipe as a protecting medium for the body. [13]

R. Gayathiri and et. al presents Hand Gesture base borewell rescue robot. This robot will operate using hand gesture with the cameras mounted to live stream the position and location of target. The robot them grabs the target by its arm and bring it out of bore hole.[14]

Y Sai Teja and et. al introduces Manhole Monitoring System. The proposed IoT-based manhole detection and monitoring

system consists of several components. To implement the system, the sensors are first installed inside the manhole and connected to the microcontroller. The microcontroller is programmed to process the data from the sensors and communicate with the wireless module. The wireless module can be either WiFi or cellular. Once the data is transmitted to the central server, it is processed and analyzed using machine learning algorithms to detect any anomalies or issues with the manhole cover.[15]

P. Srinivasa Rao and et. al introduces Borewell Rescue Robot This robotic rescue system is specifically designed to expedite the safe and efficient retrieval of children trapped in borewells. This innovative solution is quick, cost-effective, and prioritizes safety. It's equipped with features that allow it to monitor the child's condition, provide oxygen, and offer a stable platform for lifting. The robot uses its robotic arms to gently attach a harness to the child, ensuring a secure pickup. With its lightweight design, the robot can easily descend into the borewell pipe and execute a precise rescue operation. Infrared cameras and a high-resolution monitor enable real-time visualization of the child, making the rescue process even more efficient.[16]

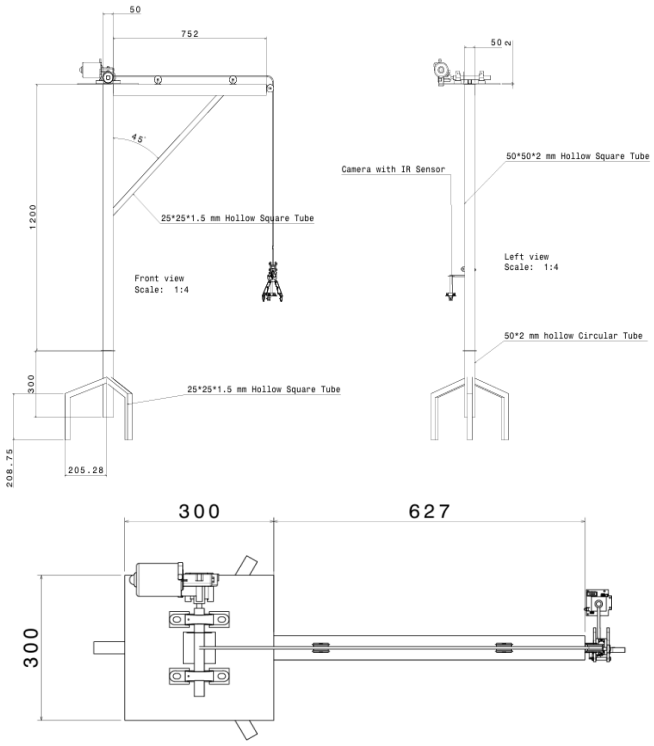

Fig No. 1 Design Of Borewell Rescue System

IV. METHODOLOGY

Rescue system involving in any accidental condition is the only option for the victim for his/her survival performed in less time with better percentage of result. Such cases have high chances of failure because of their low improvement in ideas with less help of innovation. The rescue system used by government bodies and the rescue team are way older and has less chances of saving victims' life especially in areas where the equipment's used by them cannot be used properly or in any remote or overcrowded areas. Many times, the accident happens with small children's or animals with small body structure. As the bore hole has less diameter causing human with small body or small animals are found in this accidental conditions.

In many of bore well accidents the victim has lost life because of less equipment to take accidents and the time-consuming methods causing loss of life. Since many of institutes and government bodies has done research and show cases many other methods which has innovative aspect in them, still many of them has failed or given bad performance due the environmental condition. As analyzing this report there seem to be a need of more reliable and efficient system to tackle this situation. The system needs to be simple with number of parts and the main objective to be the fast working to act on the situation. The accuracy of the system should be higher than the existing so as to work on its development in future.

V. BOREWELL RESCUE SYSTEM

The proposed design is based on the prototype model built to show case the performance of model built to rescue the victim of borewell fall accidents. This whole structure is made up of metal pipes for easy handling and balance weight for easy movement and deployment at the particular accidental place. The block diagram of proposed system is as shown in figure no. 1.

This section presents the design and development of a borewell rescue system using a tripod frame, pulley, wiper motor, steel strip, gripper arm, and various electronic components. Firstly, a problem is been identified and a need of automated borewell rescue system is needed to retrieve individual or object from narrow borewell holes. Here the key function requirements are the portability, wireless operation, real time monitoring and obstacle detection. A tripod metallic stand is been made to suspend over borewell hole which will support the pulley system and the gripper arm. A top side pulley machine is used to control vertical movement of the gripper arm and wiper motor to drive the steel strip which will operate the gripper arm for retrieval operation. The main control unit for managing the rescue operation is Arduino with FC-5 Bluetooth module for wireless control of system. A motor drives are used to regulate wiper's motor speed and torque for smooth operation. An integrated camera and IR sensor for obstacle detection and live visual in borewell. When the gripper arm is set to enter the bore hole a live visual is set by the Arduino camera which records the live data and send it to microcontroller through Bluetooth module which is then processed and is shown at screen at live.

The whole section of clamp is connected to motor drive which is by microcontroller and connected through Bluetooth module which is handled by the operator. As the signal goes motor drive moves downwards. An IR sensor is also placed to ensure safe route and alert when any of obstacle detected in its route. The sensor senses the obstacle send signal and after 5 second it the clamp to move downward. After spotting the human the operator can examine the situation with the help of camera and furtherly they can grab the human in the clamp placed with rubber at the arms to ensure less harm to body. In this whole operation the camera, clamp and the controller play important in driving the whole operation with speedy task handling and executing the operation. This whole operation is controlled through application which is installed in smartphone

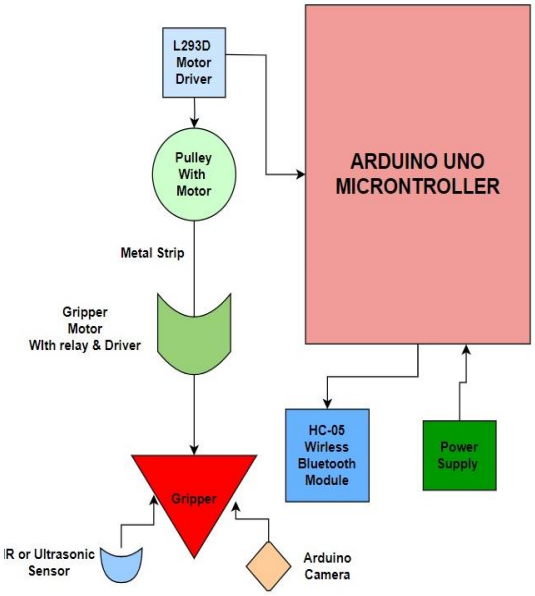

Fig No. 2 Block Diagram of Borewell rescue System

A. ARDUINO UNO R3 (ATMEGA328) MICROCONTROLLER

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. Instead, it features the Atmega16U2 (Atmega8U2) programmed as a USB-to-serial converter. The operating voltage

is 5V.

Fig No. 3 Arduino Microcontroller

B. DC MOTOR

This motor is PMDC worm gearbox motor. The standard voltage requirement for the wiper motor is 12 volts DC. The minimum required current for the motor is 1.6 amps at 70 rpm, 0.9 amps at 41 rpm. The worm gear reduction can multiply the torque of the motor by about 50 times, while slowing the output speed of the electric motor by 50 times as well. The output of the gear reduction operates a linkage that moves the wipers back and forth. This motor is 15 watts and 18 rpm at 12V.

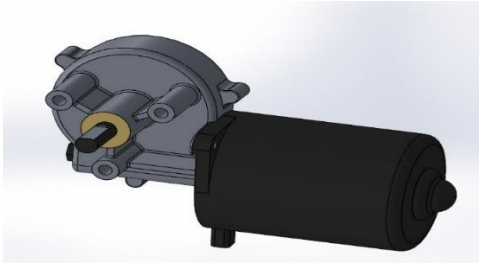

Fig No. 4 DC Motor

C. ARM GRIPPER

Attached to the steel strip, it is designed to grasp objects securely for safe retrieval. The arm gripper is a vital component of the manhole rescue system, designed to securely grasp and retrieve objects or individuals trapped within confined spaces. Attached to a metal strip at one end and connected to a pulley system operated by a DC motor on the other, the arm gripper provides precise control and movement during rescue operations. This flexibility arm is crucial in emergency situations, as it allows responders to adapt to different circumstances and safely retrieve victims or equipment from deep or hazardous environments. The integration of the pulley system with the DC motor ensures smooth and controlled motion, facilitating accurate positioning of the gripper.

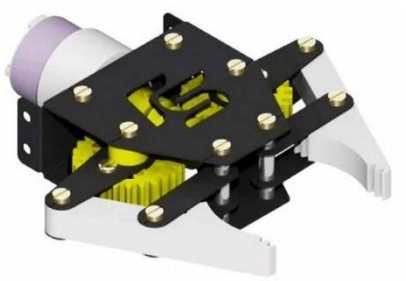

Fig No. 5 Arm Gripper

D. HC-05 WIRELESS BLUETOOTH MOULE

The HC-05 Bluetooth Module can be used in two modes of operation: Command Mode and Data Mode.
In Command Mode, you can communicate with the Bluetooth module through AT Commands for configuring various settings and parameters of the Module like get the firmware information, changing Baud Rate, changing module name, it can be used to set it as master or slave. A point about HC-05 Module is that it can be configured as Master or Slave in a communication pair. In order to select either of the modes, you need to activate the Command Mode and sent appropriate AT Commands.

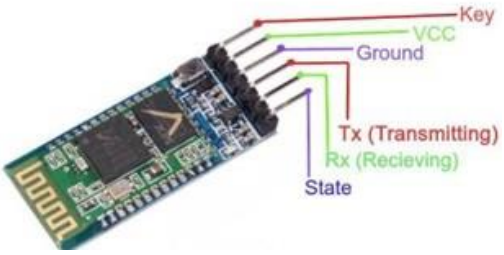

Fig No. 6 HC-05 Bluetooth Module

E. ULTRASONIC SENSOR

Detects obstacles within the borewell, providing feedback to prevent collisions and guide the operation. HC-SR04 distance sensor is commonly used in distance measurement. The current consumed by the sensor is less than 15mA and hence can be directly powered by the on board 5V pins (If available). The Trigger and the Echo pins are both I/O pins and hence they can be connected to I/O pins of the microcontroller. To start the measurement, the trigger pin has to be made high for 10uS and then turned off. This action will trigger an ultrasonic wave at frequency of 40Hz from the transmitter and the receiver will wait for the wave to return. Once the wave is returned after it getting reflected by any object the Echo pin goes high for a particular amount of time which will be equal to the time taken for the wave to return back to the sensor.

Sensor Features:

- Operating voltage: +5V

- Theoretical Measuring Distance: 2cm to 450cm
- Practical Measuring Distance: 2cm to 80cm
- Accuracy: 3mm
- Measuring angle covered: <15°
- Operating Current: <15mA
- Operating Frequency: 40Hz

Fig No. 7 Ultrasonic sensor

F. NIGHT VISION CAMERA

Provides a visual feed of the borewell's interior, allowing for better decision-making during the rescue. In the design and development of the borewell rescue system, the camera plays a crucial role in enhancing situational awareness and operational effectiveness during rescue missions. Positioned strategically on the arm gripper or the tripod frame, the camera provides real-time video feedback, allowing operators to visualize the conditions inside the borewell. This visual input is invaluable for assessing the location and state of trapped objects or individuals, facilitating informed decision-making during rescue operation. By integrating the camera with the system operations users can monitor the gripper's interactions with obstacles and adjust movements accordingly, improving the precision of retrieval actions.

Fig No. 8 Night vision camera

G. BATTERY

The power supply used for the system is attached with it. It is a Li-ion battery with the supply voltage of 12V and 4.5Ah.

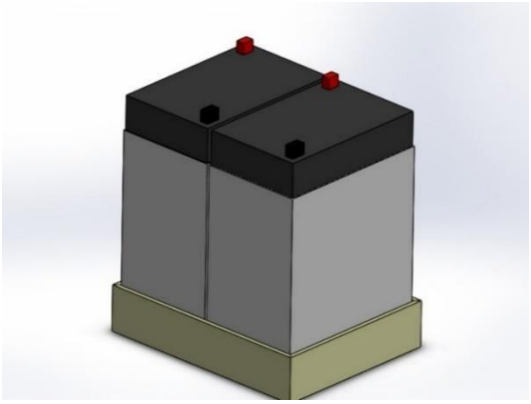

Fig No. 9 Battery

CONCLUSION:

This proposed prototype model for borewell rescue can be used and finds a better way in any condition whether it may be abandoned place or overcrowded one. This can be used for rescuing and the best part it its time efficiency which will increase the proportionality of saving victims' life. This machine is also light in weight and easily handled which gives benefits to various organization to handle at different places with less knowledge. The overall structure with new design shows a simplified way to rescue in less time.

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