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# Design of Gripper for Borewell Rescue Operations

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***Abstract: A borewell rescue robot which can rescue a child trapped inside bore well is presented in this work. Borewell accidents involving children falling into uncovered bore holes are unfortunately all too common and can have tragic consequences. In this work we designed a gripper which shall perform operations like holding child smoothly and lifting it up without causing any injuries to child. It comprises of 4 DOF which makes it more unique than other grippers. The gripper is designed by keeping various factors in mind like as holding capacity, flexibility. The bevel gear supporting gripper consists of 32 teeths, for more reliability and flexibility. The Micro Servos used has payload capacity of 1gm/cm. The robots could be equipped with cameras and sensors to detect the child's location and condition, as well as provide them with food, water, and other necessities to keep them alive until rescue teams arrive. The use of robots in borewell rescue operations could not only help to save lives but could also reduce the risk to human rescuers who often must undertake these operations in precarious conditions.***
***Keywords: Bore well rescue robot.***

## I. INTRODUCTION

Bore wells are frequently utilised to accommodate the rising need for water, but if a youngster were to unintentionally fall in, they would be in grave danger. Robotic borewell rescue operations have been offered as an alternative to more time- and safety-intensive conventional rescue techniques including digging parallel pits. Robots are programmable, intelligent devices that can carry out a variety of tasks. There are no set standards for borehole diameter or depth in India, and the average borehole size has greatly expanded over time. In extreme instances, the bore well's diameter might reach 20 inches, making it challenging for rescuers to securely extract trapped children. It could be possible to create a lightweight machine to solve this problem. The machine would be lowered down the bore well using a pulley system and would be equipped with a high-powered LED camera and an infrared sensor to locate the child position correctly. Once the child is located, the robot's arm would be used to temporarily hold the child's head for safety. A circular plate with a fibre cable would then be used to pass through the gap between the child and the bore well wall. An airbag would be inflated under the child, which would prevent them from falling or sliding further into the well. Comparing this novel strategy to conventional rescue techniques offers various benefits. Robotic rescue operations lessen the risk to human rescuers, who frequently have to operate in hazardous and unstable environments. The system's accuracy would guarantee that the youngster could be discovered swiftly and efficiently, and the lightweight device could be transferred with ease to the rescue location. In conclusion, using robots to perform borewell rescue operations has the potential to completely change how these rescues are done. This novel strategy could save lives and lower the risks involved with conventional rescue techniques by offering a secure, effective, and precise way to get hold of imprisoned kids.

## II. LITERATURE SURVEY

Water scarcity is a significant issue in today's society, and as a result, numerous bore wells have been dug, which have unfortunately caused many innocent lives to be lost. Uncovered bore wells that previously yielded water are now causing accidents. To prevent such tragedies, we suggest implementing a system that uses a brightly coloured, sturdy cap to cover the bore well's opening [1].

The primary focus of our system is to rescue the child safely and without causing any harm. The robot is operated via a PC and wireless camera and is designed to have a balloon that will lift the child out of the bore well. Our paper presents a proactive approach to prevent child fatalities caused by open, uncapped bore wells in India, which uses Infra-Red (IR) signals to communicate. The system places an IR signal two inches below the bore well's ground surface, and if any obstruction breaks the signal, a buzzer alerts and a stake below the bore well closes it to prevent any object from falling further into the well. This solution is cost-effective, scalable, and utilizes proven IR signalling technology [2].

The primary objective of our project is to rescue the trapped infant from the bore well. In the past, this has been a risky and challenging process that could take more than a day to complete. However, our proposed system, which relies on IR signals, can alert rescue teams when an obstruction is detected and automatically close the bore well to prevent the child from falling further. This system is particularly useful for agricultural bore wells, where such accidents are common.[3]

We propose an alternative solution that does not require the digging of a parallel pit, which can take a long time and may not yield any results. Instead, we suggest using a clipper that can pick up and place the child with the help of a remote controller. The clipper is attached to a rope that is manually lowered into the bore well. With this method, the child can be rescued quickly and without any significant difficulties.[4] Our bore well rescue robot is a fast, safe, and economical solution to this problem. It includes an ultrasonic sensor to calculate the distance to the child, a temperature sensor to measure temperature, and an APR module for communicating with the child. The robotic arm has a motor attached to it for picking and placing the child. This lightweight machine will go down into the bore well pipe and systematically save the child's life without causing any significant injuries.[5]

## III. EXISTING SYSTEM

The main objective of this project is to develop a safe and effective method to rescue children who have fallen into bore wells. Traditionally, the rescue process involved digging a large hole beside the bore well and creating a horizontal path to reach the trapped child. However, this method is time-consuming, risky, and requires a lot of resources, including manpower, machinery, and space.To address these challenges, this project proposes the use of a robot arm controlled by a person outside the bore well. This approach not only saves time and resources, but also eliminates the need for a large hole to be dug. The robot arm can be maneuverer to reach the trapped child, and can also supply oxygen. According to a National Crime Records Bureau data from 2011, there are an average of five fatalities per day in licenced bore wells in India as a result of inadequate tools and methods for rescuing victims of bore well accidents. This project aims to lower this number by offering a dependable and economical remedy to this issue.

## IV. PROPOSED SYSTEM

The development of a robotic system for use in borehole rescue operations and pipeline fault detection requires careful consideration and planning. The system must be designed to accurately measure temperature, provide visual surveillance, detect objects through ultrasonic sensors, emit light using LEDs, and operate robotic arms using servomotors. Furthermore, the system must be controlled by a microcontroller that can process information and send commands to each of the system's components.

### *A. Temperature Sensor*

One of the key components of the robotic system is the temperature sensor. The sensor must be capable of accurately measuring temperature within a wide range of operating conditions. The LM35 is a precision IC temperature sensor that is ideal for this application. The sensor provides a temperature output that is proportional to the temperature in Celsius, ensuring accurate temperature measurement. Additionally, the LM35 has low self-heating and does not cause more than 0.1°C temperature rise in still air.

### *B. Camera*

Another important component of the robotic system is the camera. The use of CCTV technology in industrial plants is common, and it can be used to observe parts of a process from a central control room. For borehole rescue operations and pipeline fault detection, a camera is necessary for visual surveillance of the area being inspected. CCTV cameras are available in a variety of configurations, and they can be easily integrated into the robotic system.

### *C. Ultrasonic Sensor*

Ultrasonic sensors are also necessary for the robotic system to detect objects within the pipeline. The HC-SR04 is a low-cost ultrasonic ranging module that provides non-contact measurement from 2cm to 400cm. The ranging accuracy of the module can reach 3mm, making it ideal for this application. The basic principle of operation involves using IO trigger for at least 10us high-level signal. The module then automatically sends eight 40 kHz signals and detects whether there is a pulse signal back. If the signal is received, the time of high output IO duration is the time from sending ultrasonic to returning, and the test distance can be calculated.

### *D. LED*

To emit light, the robotic system requires LEDs. When turned on, LEDs are tiny light bulbs that fit neatly into an electrical circuit and produce light.

Their long lifespan and low power consumption make them perfect for this application. LEDs are a more dependable option for borehole rescue operations because of their long lifespan, which is thousands of hours longer than an incandescent bulb's brief lifespan.

### *E. Servomotor*

Servomotors are used to operate the arms of the robot. The servo motor is an assembly of four components: a normal DC motor, a gear reduction unit, a position-sensing device (usually a potentiometer), and a control circuit. The function of the servo is to receive a control signal that represents a desired output position of the servo shaft and apply power to its DC motor until its shaft turns to that position. The servo uses the position-sensing device to determine the rotational position of the shaft, so it knows which way the motor must turn to move the shaft to the commanded position.

### *F. Microcontroller*

The robotic system also needs a microprocessor to process data and transmit instructions to all of the system's parts. An 8-bit, low-power CMOS microprocessor built on the AVR RISC architecture is called the ATmega328p. It can process complex instructions in a single clock cycle, with throughputs that are close to 1 MIPS per MHz. 23 programmable input/output (I/O) pins on the ATmega328p can be used to interface with the outside world. Additionally, it is possible to configure them as input or output by setting a particular register value through programming.

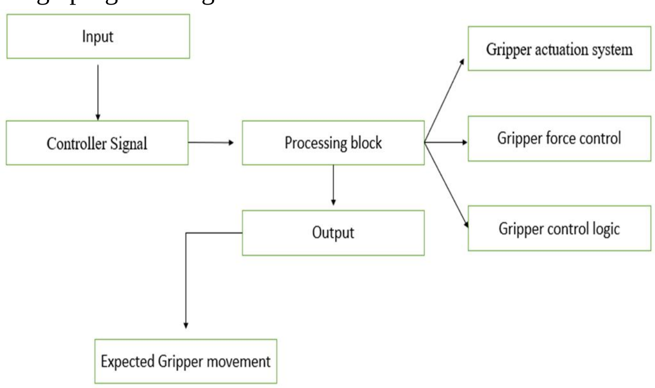


Fig.1 Workflow of System

## V. METHODOLOGY

The methodology employed in this system aims to rescue a child from a borewell, with the primary objective being the design of a system capable of lifting 30-35 kg of weight. To achieve this goal, various factors such as depth, obstacles, and desired level of performance were considered. This led to the selection of components such as LED, camera, and APR to capture sound, as well as servos that can work with high load resistance. The rescue robot device consists of various types of pneumatic, hydraulic, and sensor operated components, which are divided into five elements: fixing, rotating, translation, grasping, and supporting elements.

In terms of component selection, the HC-SR04 sensor was chosen for its higher accuracy and precision in measuring the distance of an object. A DC motor and motor driver, specifically the L293D with a voltage rating of 12V, were used for amplification of the signal. A different motor with a higher payload capacity would be used for the actual system instead of the micro servo, which had a capacity of 1gm/cm for the prototype. The degree of freedom (DOF) of the system dictates where the motor should be placed. Two servos are used to move the gripper left and right, and one servo is utilised to retain the object without damaging it. The gripper can rotate 360 degrees thanks to a second servo that is attached on the base.

In terms of fixing elements, two types of fixing were used: rope drive and fixing elements. Rope drive was used to control the positioning of the device, with the position depending on the child's location. However, this only provided 50% stability due to the device hanging from the ground surface and thus oscillating. To improve stability further, fixing elements were used. This involved using a cylinder and piston or bevel gear arrangement to fix the device in place, providing maximum stability.

Rotating elements were used to rotate the device to the correct position according to the child's position. A set of bevel gear or worm and worm wheel arrangements were used for this purpose.

Translation elements were used to move the robotic hand, which is positioned near the child, to access the child correctly. Grasping elements were classified into two categories: power grasp and pinch or precision grasp.

Power grasps are associated with high grasping forces. Precision grasps are typically identified by their tendency to require less force and involve contact that is primarily localized to the fingertips..

To create the system design, a methodical systematic approach was utilized, which involved dividing the design problem into a comprehensive function structure. In order to synthesize solutions from partial solutions, systematic design were employed to organize and consolidate features based on the required design functions. The features were listed in a manageable way to ensure that all functions were at a comparable level of detail. A table was then constructed to document the achieved functions, and one means from each row was chosen to combine into a design. However, not all combinations were practical and thus, only feasible options were considered.

In conclusion, the methodology employed in this system was based on a careful consideration of various factors such as depth, obstacles, and desired level of performance. The selection of components and the division of the robotic device into fixing, rotating, translation, grasping, and supporting elements were essential for achieving the primary objective of rescuing a child from a borewell. The use of a morphological approach to system design provided an effective means of organizing and synthesizing solutions from partial solutions, leading to the creation of a feasible and functional design.

Table 1. Component and Function

| Sr No | Component | Function |
|---|---|---|
| 1 | Digital Integrated Camera | To recognize and address the placement of the infant. |
| 2 | Digital oxygen supply system | To furnish the baby with oxygen derived from the surrounding environment. |
| 3 | Advanced small sized servo Motors | To operate the machinery responsible for governing the actions of the robot. |
| 4 | Advanced strain measuring pressure sensors | To gauge the pressure exerted on the robot's hands and detect any strain. |
| 5 | Digital infrared thermometer | To quantify the temperature of both the infant and the immediate environment in which they are situated. |
| 6 | International standardized rope and pulley | To transport and uphold the robot and its accompanying apparatus. |

### *A. Features*

1) Utilizes a visualization process to aid in conceptualizing the design space.
2) Makes the list of features based on required design functions.
3) Should be manageable size to prevent overwhelming complexity.
4) Features are presented at a consistent level of detail to facilitate comparison and selection.
5) Document the attained functions, a table is constructed that lists each function and its corresponding means.
6) Choose one means from each row to combine into a design taking into account the feasibility of the combination.
7) Not all are feasible, and careful consideration must be given to selecting practical options.

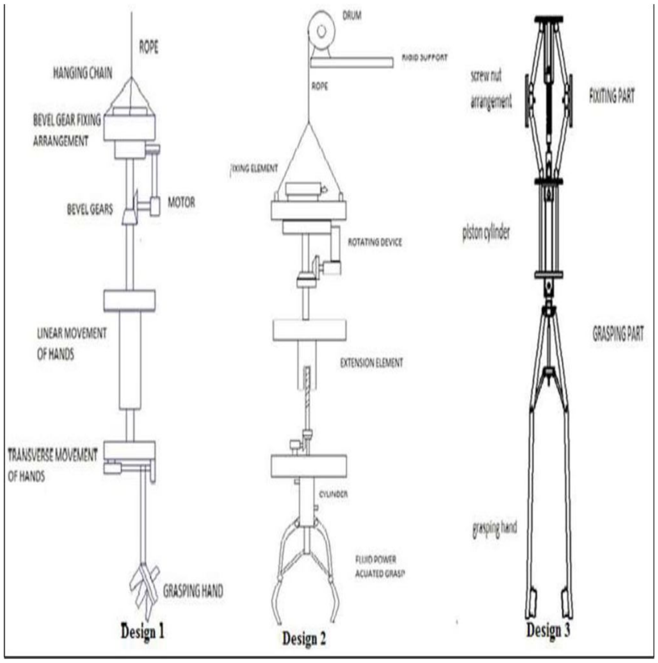


Fig.3 Components used

### *B. Design of System*

In rescue operations, time is of the essence and efficiency is key. The successful retrieval of a trapped individual from a bore well requires a well-planned operation, with specialized equipment and skilled personnel. One such operation involves the use of a rescuing device that is carefully lowered into the bore well until it reaches the child's location.

The rescue operation begins by setting up a stand and pulley in a suitable position that facilitates the easy lifting and lowering of the rescuing device. Once the equipment is connected to a rope through a hook joint, the movement of the rope is controlled by a motor that passes through the pulley. The power supply is given to a camera and light source that allow for the real-time display of the bore well on a screen at ground level. To ensure the safety of the trapped individual, the rescuing device is fitted with an oxygen concentrator that detects the level of oxygen around the child. If the oxygen levels are below 18%, the concentrator sends oxygen to the child from the surface, thereby preventing breathing problems. The device also contains a temperature sensor that measures the temperature.

Before being lowered into the bore well, the device's hands are expanded to make it easier to place the device in the correct position. Once the device is in the correct position, a fixing pad is expanded to secure the device to the bore well wall. The fixing pad is held in place by a pressure sensor that measures the pressure acting on the wall by the pad. The grasping process is a delicate operation that requires skill and precision to prevent harm to the child. To ensure that the child is not injured during the process, pressure sensors and a cushioning system are placed in the grasping pad. Once the child is safely secured, the fixing pad is retracted, and the device is lifted out of the bore well using the motor and pulley. In conclusion, the use of a rescuing device in bore well rescue operations can be highly effective in retrieving a trapped individual safely and efficiently. The device's temperature sensor and oxygen concentrator ensure that the youngster is not hurt while being rescued, and the grabbing pad's pressure sensors and cushioning mechanism shield the child from harm. The rescue operation may be carried out precisely and quickly, saving lives and providing consolation to families, with the right tools and trained personnel.

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## VI. APPLICATIONS

The gadget in question is a flexible robot with the ability to carry out a variety of tasks, including cleaning pipes, inspecting pipes, and executing rescue operations. Its main application is the rescue of kids who are trapped in bore wells, where its capacity to operate through constrained locations is quite valuable. In addition to this, the robot can be used in pipe cleaning applications. Its rotary brush attachment enables it to clean dirty pipes thoroughly, and its high-quality wheels provide excellent traction even on wet or slippery surfaces. This makes it an ideal tool for cleaning pipelines in various industries.

Additionally, the machine can be used for pipe inspection tasks, using specialised inspection tools like sensors and x-rays to find any flaws or damage in pipes. This is significant in sectors like the oil and gas industry where pipeline integrity is essential.

Aside from these applications, the robot can also be used in a variety of other contexts. For instance, it could be used in manufacturing industries to move materials or parts from one location to another, or in space programs to conduct research or perform repairs on spacecraft. It could also be used in radioactive or hazardous environments, where human workers would be at risk, or in underwater operations, where it could be used to explore and inspect underwater structures. Overall, the machine in question is a highly versatile robot with a wide range of potential applications. Its ability to navigate confined spaces, clean pipes, inspect pipelines, and perform various other tasks make it a valuable tool in a variety of industries and contexts.

## VII. TESTING

The Prototype performs the operation in 4 DOF. It moves Up, Down, Left and right. The Gripper is designed to hold child/object without causing harm to it. The servo we used are Micro Servo, with a payload capacity of 1gm/cm. X,Y,Z coordinate and orientation these four parameters fully describe the position and orientation of a gripper with 4 DOF. Table .1 gives a detail information about the configuration of the system.

Table .2 Configuration

| Sr No | Elongation | Angle | Position |
|---|---|---|---|
| 1 | 8 cm | 180 degree | The position of the gripper in the horizontal direction (left and right). |
| 2 | 6cm Up | 70 degree | The position of the gripper in the vertical direction (up). |
| 3 | 5cm Down | 40 degree | The position of the gripper in the vertical direction (up). |
| 4 | fixed | 0 degree | Base |
| 5 | 2cm – 4cm | Gripper Angle – 10 – 60 degree | Fixed |

Fig .5 Horizontal Direction

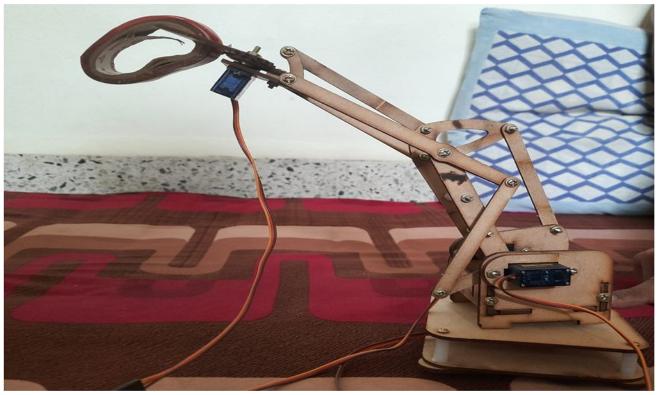

Fig.6 Vertical Direction

The above fig shows the object can be lifted up to 70 degree and has a payload capacity of 1gm/cm. The micro servo supports the motion and has a fixed base.

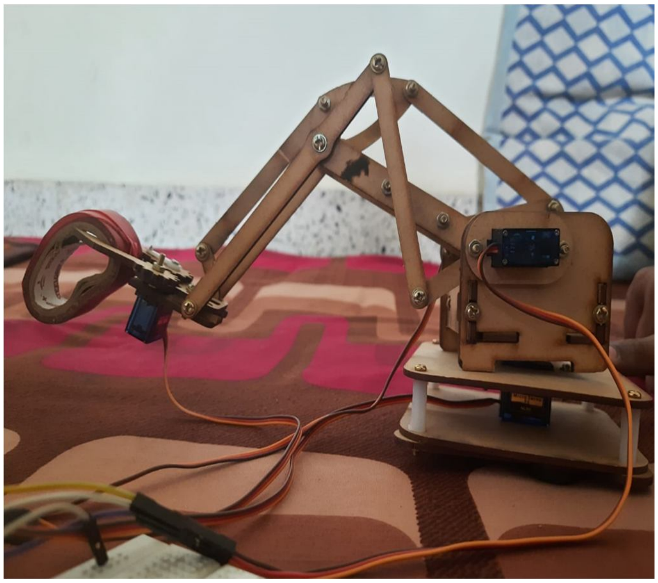

Fig.7 Vertical Down Direction

## VIII. RESULT AND DISCUSSION

We hereby propose a design model as bore well rescue robot which can rescue a child trapped inside bore well. It can measure temperature as well as the altitude. Its ability to quickly and accurately identify victims and provide real-time information to rescue teams makes it an invaluable asset in emergency situations. The proposed model design is supposed to look like the following.

## IX. ACTUAL MODEL

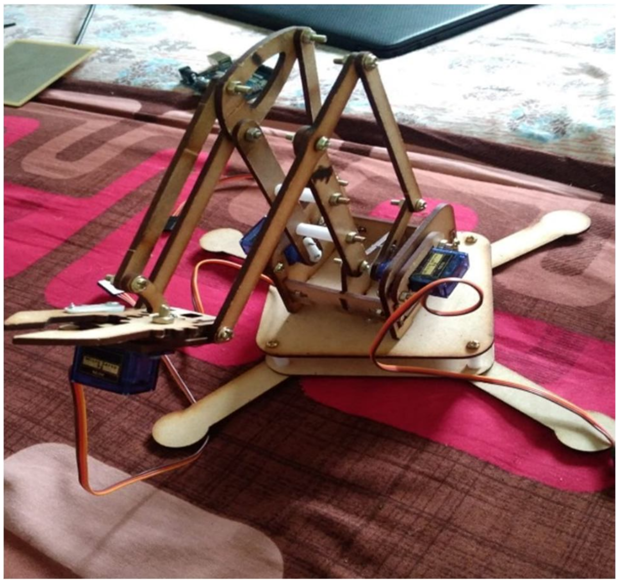

Fig.8 Model

## X. CONCLUSION

Due to the unfortunate incidents of people falling into borewells, particularly in rural areas, and the lack of timely assistance leading to fatalities, there is a pressing need for an efficient and quick rescue system. The current approach of digging a pit beside the borewell to rescue the victim is a cumbersome and time-consuming process, often resulting in delays and failures. To address these challenges, a lightweight and portable system has been proposed that can be easily transported and deployed to the location.

The system is designed to optimize the rescue process by minimizing human effort and time required for the operation. It has been developed with all possible hurdles in mind, and the rescue operation can be completed in a significantly shorter duration as compared to conventional methods. This system is expected to save lives and provide immediate assistance to victims who fall into borewells, mitigating the risks and challenges associated with the rescue process.

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