International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 09 | Sep 2020 www.irjet.net p-ISSN: 2395-0072

Borewell Child Rescue System

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Abstract - Open bore wells are always a trap. And the accidents can't be avoided till now. Therefore, a practical, safe, and efficient rescue system becomes necessary. But still, the techniques are impractical. This project aims at designing a system that is capable of rescuing the child with ease, safe, and within less time. There are methods or techniques which can save the child from the borewell. But it may be impractical to do it with a single method. Therefore, this project consists of providing the provision for the inclusion of multiple rescue methods, which provides the possibility of choosing the best method to save. In our project, we plan to combine the various methods of rescuing, some of which do exist today. The design system is adaptable to the diameter of the bore well which varies from 8 inches to 12 inches. The system consists of a camera, lights, oxygen supplier, balloon technology, and umbrella technique. Using sensors and camera, the depth, position, and state of the child is monitored. The robot is then controlled to choose the appropriate rescue method. With the help of it, the child is prevented from falling into depth again. And the inflated balloon cushion is used to raise the child. The child is raised into a rescue bag to avoid further scratches. Then the whole robot assembly is raised with the child safely.

Key Words: Rescue bag, Rescue techniques, Balloon cushion, Borewell rescue, Child safety.

1. INTRODUCTION

A water well or Borewell is an excavation or structure created in the ground by digging, drilling, etc. to access groundwater in underground aquifers. Most bore wells that are constructed for pure water extraction are found in areas where there are human activities. These bore wells are often left open which has been known to be hazardous to human life. Children of very tender age tend to fall into these open bore wells and get trapped inside. Rescuing these trapped children is both difficult and risky for everybody involved in the operation.

A borehole generally is a confined shaft excavated into the ground. It is built for many uses including withdrawal of water, petroleum or natural gases, mineral extraction, temperature measurements, and other investigation and assessment purposes. They provide details about the soil and ground quality.

Over a period of time as the water level falls, borewells dry up causing them to be abandoned. These abandoned borewells are a major accident site since there are no measures taken to cover them up. Several cases have been reported of children accidentally falling into these borewells, ultimately leading to their death. This is mainly due to the absence of communication between the child and the rescue operators. This work addresses these problems so that the rescue process of the child becomes easier and faster.

1.1 Objectives of work

1. The design should be portable.
2. Less time of operation and an increased chance of survival.
3. It should include multiple rescue techniques and necessary life support system.
5. To avoid further fall of the child once the child is held by the system.

2. METHODOLOGY

2.1 Challenges involved

The primary characteristics of the bore well rescue system includes size, type of bore well and operating conditions. The challenges involved in the development of new system are:

1. How to detect the child in the hole alive or not?
2. How to detect position, depth?
3. How to supply Oxygen?
4. How to send the system into the hole?
5. How to stabilize it inside the hole?
6. How to hold the baby & take him out?
7. How to avoid further fall of baby after holding?
8. Cases like
    i. Child at bottom
    ii. Child stuck in middle
    iii. Child slipped to bottom
9. Mechanisms for smooth function

The proposed design is able to overcome all these hurdles.

2.2 Components

The design of the system involves the following main component sections for the required operations.

- Manipulator
- Sensory Devices
- Controllers
- Power conversion unit

a) Manipulator

A manipulator in general functions comparably like a robotic arm, that can hold or reach to the child's position. It includes several linkages, screws, nuts and bolts, and other mechanical parts to hold a part firmly. After setting up the ground, the system is slowly lowered through the borehole using rope and pulley and a tripod stand set up on the ground. After detecting the child's presence, the manipulator stabilizes in the hole by operating the independent 4 jaw-chuck mechanism. Observing through camera the second plate revolved as per child position. Next, the arm to hold the child is extended through the gap using a rack and pinion mechanism. The entire manipulator setup was modelled in AUTODESK FUSION 360 software package.

b) Sensory Devices

Sensory devices inform the system controller about the current status. These devices perpetually detect the varying positions of the manipulator and these o formations can be used to properly monitor and handle the system. Visual and Non-visual sensors are two types of sensors used in the system. For lighting in the hole, a LED light is used. A Wi-fi camera along with suitable software or apps is used to collect all the visual data so that the posture and other positioning details of the child and the system can be well-identified. A proximity sensor and the necessary connections are provided for analyzing and detecting the depth and position data of the child in the borewell.

The sensors detect the oxygen level at the rescue region and supply the required O2 to the child through a tube pipe. The manipulator to be sent into the hole with the help of a newly designed tripod stands for supporting rope, pulley, and entire manipulator setup. The child will hold and pulled out from the borewell through a holding mechanism, which is operated by a servo motor actuator. These are to be made of steel material and lubricated for smooth running. For the running of Gears and motion in the entire setup. Four ½ HP, ½ HP, and 1HP servomotors are used in various places for better functioning. Table [1] and Table [3] provides the locations, functions of gears and servomotors respectively.

Table -1: Servo motors and their location

Function	Location
For running bevel gear	At bevel gear mechanism
For rotary motion of second plate	At the lead screw
For extension of lifting arm	At rack and pinon mechanism
For radial motion of arm	Below top plate

Table -2: Components and its functions

Sl. No	Components	Functions
1	Digital Wi-Fi Camera [Interfaced with mobile phone]	Position and condition of the child in the hole
2	LED Light	Provide lighting to child and camera
3	Oxygen pipe	For free respiration of child
4	Rope and pulley	To hold the system from ground
5	Tripod stand	Support the rope, pulley and entire equipment
6	Gears	For running mechanism
7	Servo motors	For running gears and mechanisms
8	Computer, mobile, remote control	Entire setup will be controlled by these
9	Safety balloon	To provide support to child at bottom

Table -3: Gears and their location

Gear type	Function	Location
Bevel gear	For stability of the system	Top plate
Rack and pinion gear	Rotary to linear	At extending arm
Spur gear	For positioning the lifting rod with gap	Top plate
Screw Gear	For radial positioning of lifting rod	Below top plate

2.3 Materials used

For fabricating the working model, we have used Stainless steel, but for real life rescue operation it is better to use a system made with material like carbon fiber. Since it is rare and lifesaving requirement irrespective of cost we can manufacture with carbon fiber because of the following:

a) light weight
b) excellent fatigue behaviour
c) high tensile and compressive strength

3. DESIGN PARAMETRS

The design parameters are calculated by considering the following:

Bore well diameter ranges from about 15 cm to 30 cm

90% of victims are below 10-year-old, from this:

a) Shoulder width <28 cm
b) Height of child <140 cm
c) Weight of child <30 kg (All these details are according to BMI)

From these the design parameters are:

a) height of system when it is in packed condition i.e. before operation: 100 cm
b) diameter of the whole system: 25 cm (for easy lowering and operation of the system inside bore well)
c) lowering arm (with technique) length: 80 cm
d) protective casing length: 80 cm
e) swing arm diameter: 25 cm

Since the child is contained in the protective casing, instead of replacing the whole system, by using different protective casing with different heights and diameter according to the situation, we can use the same system.

In the design procedure we don't need to use or focus on complicated calculations and equations because of the following reasons:

a) Motors and gears are used only to rotate, extend and position the corresponding components.
b) And they are not subjected to operate with any heavy loads.
c) Hence avoiding calculations based on motor power and torque, and we can use motors used in existing methods.
d) Once the components reach their final state of operation, they can be considered like a rigid body, with no other movement.
e) The system is self-balanced hence there is no need of design to balance the system.

4. MODELLING AND WORKING

4.1 Mechanisms used

Rack and pinion mechanism are used to lower the technique beneath the child. It is used because of the following reasons,

a) It consumes less space and compactness is an important factor in the design.
b) The only purpose is to lower the technique and no additional load acts on it, therefore we need motor with less power and space.
c) We can use racks of different length to lower the technique according to the situation and height of child, which is not easy in any other mechanism
d) While the technique reaches below the child it gets locked by the system automatically at the current position and motor power is not required to raise it.

Scissor mechanism is used to position the technique above the kid. And the technique moves inside the system. We used this mechanism due to its following functions:

a) We can simultaneously move the four techniques at a time.
b) The mechanism makes the system self-balanced.
c) By moving any of the technique, the remaining 3 techniques also gets adjusted, thus we need to use only single motor to move any of the link.
d) All over these features makes it cost effective, and simple.

To stabilize the system inside the borewell with forks, the working principle or mechanism of independent 4 jaw chuck is used. In this method by using a single motor we can extend all the forks at the same time, in the same way, thus making the system stabilized.

4.2 Principle of Working

The procedure to be carried in the operation of the bore well rescue system:

First of all, the manipulator parts are to be assembled in the correct way. Later fix the system with all necessary components and connect it to the rope, which runs inside a narrow hole through pulleys. The entire set up is supported by a tripod stand on the ground with an oxygen concentrator aside. Send the system slowly inside the borehole through controls by watching the virtual images in PC or Mobile. After detecting the human body, the system will stop just above the child and give the information of depth from the ground, the position of the child. Then stabilize the system with a stabilizing mechanism, at the top of the first plate will release the stabilizing fork mechanism as shown fig [1].

The position images of the child can be viewed in the mobile or PC, which is connected to the Wi-Fi camera. At the same time, the protective casing is extended to the borewell side walls (fig [2]). Then the fourth motor helps the lifting rod to screw its way through the gap towards the bottom of the child.

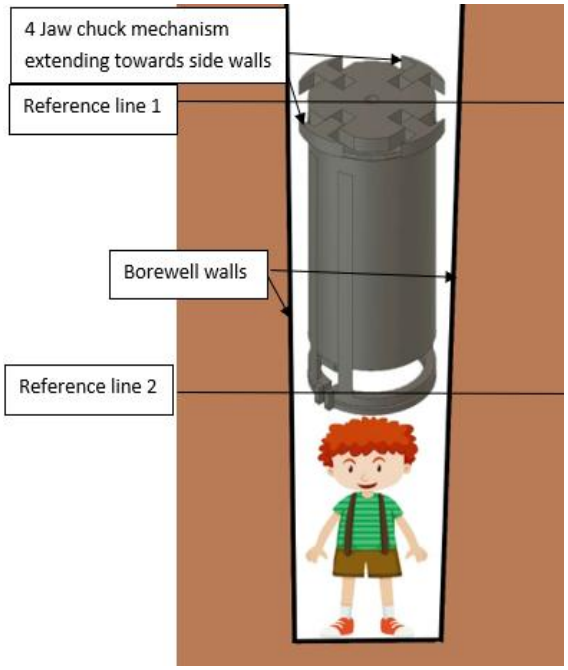

Fig -1: Stabilization of system.

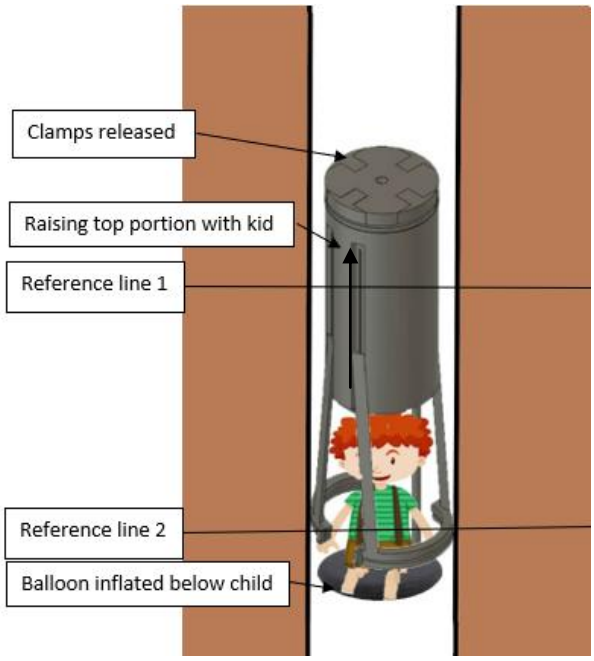

Fig -3: Holds and raises with proper rescue method (depicted balloon technique).

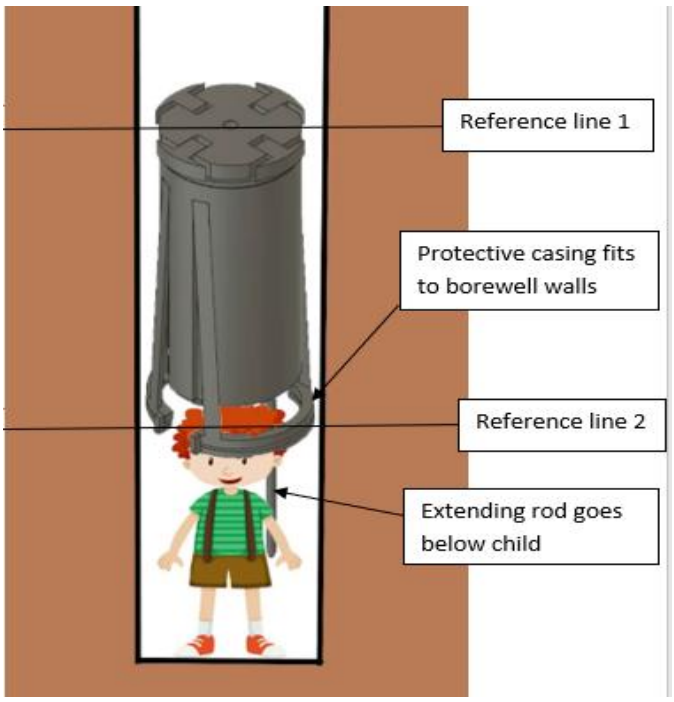

Fig -2: Rescue operation stage 2.

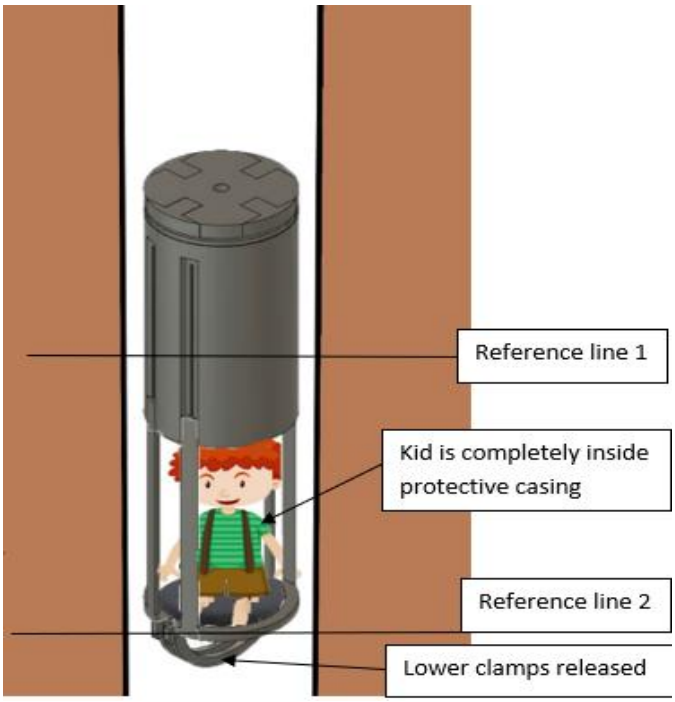

Fig -4: Rescue system raised with kid safely.

Once the lifting rod reaches a safe position under, an air compressor is operated to pump air to the balloon cushion attached to the end of the lifting rod through an air tube that runs downwards and kept inside the lifting rod (fig [3]). The bladder provides safe seating to the child. Then the first motor is then reversely operated so as to unclamp the system (fig [3]). Then the system is raised up to a certain level till the child reaches inside the protective.

After ensuring the child inside the protective casing, it is released from the borewell sidewalls, and the lower U claps also released as shown in fig [4]. Now the kid is completely inside our system and is safe from further falls, scratches, and any other harm. Slowly lift the child with controls to top. Treatment will be given to the victim after taking him out from the hole.

5. RESULTS

A prototype of our project was successfully designed and fabricated keeping in mind all the constraints and practical issues. The proposed system is tested and was found to perform satisfactorily within short time compared to traditional methods providing safety feature the biggest concern. Life supporting system including oxygen supply, assisting equipment like camera and lighting and other sensing elements were successfully installed and found to work smoothly. Overall our project was efficiently designed to perform with all the requirements and constraints based on our objectives.

6. CONCLUSIONS

The proposed system operation works better and can perform different works which will make the arm more secure and easier in operation. Since there is no need for a parallel hole for rescue purposes and the child is rescued through the existing hole itself, the rescuing time is reduced considerably. And there is no need of digging another parallel extraction pit that costs time.

As a development of the system in the future, we can provide additional comfort facilities like cooling. Also, the whole system can be fully automated. And it is better to replace the rope pulley arrangement, with any other suitable safe method.

ACKNOWLEDGEMENT

Hard work, presentation, and motivation have always played a key role in the success of any project. First of all, we would like to thank Almighty God, whose blessings have enabled us to successfully complete our project work. We express our sincere thanks to The Principal of GISAT and Head of the Department, Mechanical Engineering, for their support and guidance. We pay our deep sense of gratitude to the faculty of mechanical engineering, GISAT for their advice and support. Last but not least we would like to express our gratitude to our parents, classmates, and all the others who helped us to complete this project.

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