Investigation and analysis on child rescue system from open bore well

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Abstract. In recent days, there are a lot of cases related to a child stuck in an open bore well. The actual methods involved in rescue are pulling the child using a rope with different knots or digging a parallel line beside the open bore using machines to the depth at which the child is stuck, the child is then pulled from the depth. But at deeper bore wells, these methods fail. This paper deals with a design to save a child who is stuck in manhole or open bore-well. Using this design the child can be easily rescued from the open bore wells, as this design includes hydraulic arm to hold the child with grips which won't slip due to sweat or wet condition of the bore well, the locking mechanism to hold the rescue system in one place inside the pit once it reaches the depth at which the child is stuck. A live streaming video surveillance for monitoring the child motion, oxygen supply channel for the child and a communication system to have contact.

1. Introduction

India is a country with a wide population and a diversified culture. Due to the ever increasing population and the demand for resources, a lot of villages and cities face issues. One of the major issues is regarding the water scarcity. The agriculture and household activities need water as a major source. There are a large number of households where the demand for water is huge. So humans adopted a method for extracting ground water, which is bore wells. We drill bore wells for extracting ground water and supply it to the crop fields, houses and use it for a lot more applications. These bore wells are drilled to a depth of at least 100ft and may extend up to 300ft or more in some cases. These bore wells in the remote areas are utilised efficiently till the water scarcity occurs. After the ground water level reduces or the work for which it is utilised is done, these are abandoned. These bore wells are left open. Usually the bore wells are bored about 6-inches to 8-inches in diameter with insulation provided. After abandoning of the wells, these insulations are removed and the diameter of the drilled bore well increases to 10-inches to 12-inches sometimes. This proves sufficient for a 2 to 5 year old child to get trapped inside it. These children fall into these holes and get trapped inside them, while playing or running around, as these bore wells are inobservant. These bore wells at depth lack oxygen, have a higher temperature as compared to the surface temperature and are really dark. These parameters suffocate the child who is trapped inside and push them to death.

There are a lot of cases related to these incidents, registered or unregistered, happening across the globe. Speaking of India, since 2009, more than 40 cases have been registered and only 30% of the cases have been successfully resulted. The rest 70% cases resulted in failure, where many innocent lives are lost. According to the statistics, in the last 15 years, 10 innocent lives are taken by these deadly bore wells, in Tamil Nadu. Few of the registered cases are, 6 year old who feel into a bore well of 400 feet depth, in Tiruvannamalai District of Tamil Nadu, in 2013. Satya, a 5 year old boy from Ramnagar Village of Madhya Pradesh, in the year 2017. Seema, 4 year old girl from Jodhpur, Rajasthan got stuck in the year 2019. The latest news of all, Sujith, a 3 year old boy from Trichy, Tamil Nadu lost his life after a rescue operation of 80hours. To save these lives, there aren’t a lot of equipments. This Project extends a hand towards saving the innocent lives which are taken by these bore wells. This Design is purely based on a smart system which helps in rescuing the children. This design is an integrated method, which consists of a Hydraulic system, Mechanical gripper arms with rubber grips attached to provide anti-slip properties, an Electronic device to operate video surveillance & communication system and telemtry system to engage these.
2. Literature Survey
Ashwani et al., in their work “Child Rescue System against Open Bore Well”, [1] have created a design which has a sensor to sense the child inside. The sensor actuates the lock which prevents the child from going beneath 3feet. The gear mechanism is initiated with the help of a motor which pushes the arranged block at 120deg from each other towards the side of the bore well. Other motor turns by 360deg thereby helping to locate the gap through which the lifting rod passes and the child is rescued.Palwinder Kaur et al., in their work, “Pipeline Inspection and Bore Well Rescue Robot”, [2] made an attempt by creating a leg mechanism with wheels to go inside the pipe. The legs are symmetrically spaced about 120degrees apart. Temperature Sensor and LCD are interfaced with a microcontroller to sense the temperature inside the bore well and to display it respectively.Bharathi B et al., in their project, “Design and Construction of Rescue Robot and Pipeline Inspection Using Zigbee”, [3] has described a way in which a child rescue is done through a command by PC. The mechanism involved is Zigbee technology. The robot has a high power LED to eliminate the darkness. It also contains a pick and place arm to hold the child while pulling it out from the open bore well, in which the child is stuck. It is constructed with low budget and is human controlled.

Nitin Agarwal et al., in their project work, “Child Rescue System from Open Bore wells”, [4] has stated that, their project is based on the rescue system which can penetrate in the same bore well and perform certain actions to save the child. The CCTV camera and a high power LED light source are used. Their project includes series of process development from hand drawn sketches and computer design. Modern equipment with light weight servo motors has been installed in their system. Their project is human controlled.Prakash S et al., in their project “Smart Bore Well Child Rescue System”, [5] have described the solution for rescuing a child fallen in the open bores through a system which operates with the help of a 12volts battery. This is a remotely controlled robot which will go down the bore well and perform the action. Their motto was to design a robot with the help of a balloon to lift the child. The robot is operated through PC using wireless Zigbee technology and using wireless camera.Sumit Pandey et al., in their work, “Child Rescue System against Open Bore Well”, [6] have described that using IR signal, it when placed two inches diametrically under the ground surface of bore well, breaks due to any obstruction object, a buzzer starts sounding as an alert in mobile phone. After a few feet lower in the bore well, closes the bore in order to prevent the child from falling beneath.

3. Objective and problem statement
The objective of this project is to design a rescue system to support the innocent life stuck inside the open bore well and to pull it out of the bore in a shorter span of time. This also includes providing all the life supporting parameters like oxygen, light and communication to keep the child away from fear in the dark environment and more importantly the child must be pulled out without slipping due to the sweat generated in its body because of the hot temperature inside the bore well.

The problems which we would come across while saving the Child from open Bore well are: There will be darkness deep inside the bore wells which might fear the kid. There will be no visibility due to which the child cannot be observed rescuers directly. Lack of communication between the stuck child and the rescue team will be a major problem. The suffocation faced by the child due to the lack of oxygen underground. The solutions to the above problems are solved by the designed system in the following ways. This system has a torch attached to it, to avoid the darkness. A video surveillance is attached to the system to view the child using a screen at the surface, which is integrated using an electronic system. The problem of communication is eliminated using a speaker and a microphone attached to the electronic system. This system is attached with an oxygen supply to prevent the child from suffocating.
4. **System Description**

![Diagram of system description flow chart.](image)

**Figure 1.** System description flow chart.

The working of the system for rescuing the child (Figure 1) is initiated by turning ON the torch as it would be dark inside the bore well. Then the transmitter is turned ON, that switches on the video surveillance. The receiver in the rescue system placed just above the cylinder is turned ON next and in turn it is bind to the transmitter and signal check is done. Checking for the working of the apparatus efficiently is to ensure the safety of the child while rescuing and other processes to be carried out without any interference. The apparatus is checked for any oil leak and are corrected respectively. Then the hydraulic arms are engaged and disengaged to ensure they are working properly. The safety check may take hardly 15 to 20 minutes if there are no problems reported. Then, the machine is placed near the bore well. The oxygen valve is then connected to the apparatus with the valves turned ON. The rescue system is put down inside the bore well using the pipes with screw thread at the end for having a good contact between the successive pipes inserted. This pipe connection system is used rather than the ropes because, it provides a hard structural support while holding it from the surface and is reliable with lesser chance of failure. This system is then slowly lowered down near the child. The child’s body is seen through the image projected in the screen by the help of video surveillance camera. After the child is spotted, the depth and position of child is known. The system is held stationary. As the child has chance of falling into the hole while playing or unknowingly walking around it, the orientation would most probably be like, the head at the top with the legs hanging inside. The hands may or may not be above the body. In either case, the wide arms of the mechanical gripper with the rubber grips attached to it will hold the arms or the child's head. This exhibits only a small pressure to the child. Since the system tends to be in equilibrium. The vertical forces are determined by the product of mass and acceleration using Newton’s second law and are summed up. The counteracting friction forces are generated at the contact surface between the gripper arms and the body of the child. These friction forces prevent the body from slipping in the direction of gravity. The grip force ‘F’ per arm being generated by the gripper, is the normal force acting perpendicularly to the friction force ‘F’. Using Coulomb’s law of friction the friction force and the grip force are equated (Eqn. 1), thus, we obtain,

\[ f = \mu F \]  

Since the gripping force should be greater than the friction force (Eqn. 2), the value is calculated as,
Here,

\[ F > [m (g + a)] * s / \mu \]  

Here,

\[ F = \text{gripping force} \]
\[ m = \text{mass of the load lifted} \]
\[ g = \text{acceleration due to gravity (9.81 ms}^{-2}\) \]
\[ a = \text{acceleration, if it is significant} \]
\[ s = \text{safety factor} \]
\[ \mu = \text{co-efficient of static friction between the contact surface of gripper arms and the body of the child inside the bore well.} \]

The safety factor should be enhanced according to low or high friction use and the gripping force should always be greater than the weight of the child in Newton. The child’s position may be critical. The rescue system is oriented according to the position of the child by rotating the whole screw pipe system from the surface. The child’s body is then grabbed by the Gripper arm by viewing it through the video surveillance. It is made sure that the child is grabbed correctly before lifting the system up. Then, the system along with the child is pulled out of the bore well slowly. The wide arms provide more grabbing force as it has large surface area of contact. Thus, increasing the friction in the body of the child stuck. The rubber grips also make sure that the child doesn’t slip in any cause due to the sweat. The young life is pulled out of the deadly pit without any causality and given first aid. The flow of action explained in Fig 2. The detailed model of the child rescue system shown in Fig 3 and Fig 4.

**Figure 2.** Action flow chart.

**Figure 3.** Three dimensional view of the mechanical gripper (assembled view).
The child rescue system has various advantages including:

- Surprisingly, it will be cheaper than the parallel pit method used.
- All external apparatus used to support the child trapped inside are cumulated in one system.
- High reliability.
- Lesser chance of slipping as it has rubber grips attached to the arms of the system.

This device can be further developed in small scale and used in furnace application and industries. Similar system with four arms can be used to lift a heavier load in Industries. This can be varied in various scales and constructed with which animals that are stuck in pit or other canals can be rescued. Can be used in other small scale manufacturing industries.

5. Result
All the objectives of the project are fulfilled. The design for a rescue system is complete with the entire separate life supporting instruments involving the video surveillance to monitor the child’s motion, torchlight to eliminate the darkness, a communication system to interact with the trapped child to know its situation, an oxygen supplying tube connected separately to the system are all integrated together with the hydraulic system and the mechanical grippers, thus, forming an entire Rescue system. This design dominates over the other old rescuing methods as, this has all the individual instruments used to monitor and support the child assembled together, with arms to hold and pull the child up to the surface.

6. Conclusion
Each and every life in this world counts. One life supports the other in some or other ways. It is a moral duty of the society to save the innocent lives at risk. As an Engineer, it is our responsibility to develop various systems and machines to help these struggling lives from danger. These young children are the future of our society. Instead of letting them suffer and lose their life, it is our duty to save them by some means. This approach provides a way in which a life can be saved, whether it may be of a human or an animal, from the open bore wells in a shorter span of time.

7. Reference
[1] H S Chadtrakumar, L Ashwani, M S Lakshmi and S Shilpa Mandal 2019 Child rescue system against open bore well International journal of scientific research and review 7 357-64
[2] Palwinder kaur, Ravider kaur and Gurpreet singh 2014 Pipeline Inspection and bore well rescue robot International journal of research in engineering and technology 3 726-729
[3] B bharathi and Suchithra Samuel B 2013 Design and Construction of Rescue Robot and Pipeline Inspection Using Zigbee International journal of scientific engineering and research 1 75-78
[4] Nitin Agarwal, Hitesh Singhal, Shobhit Yadav, Shubham Tyagi and Vishaldeep Pathak 2019 Child Rescue System from Open Bore wells *International journal of trend in scientific research and development* **3** 639-642

[5] S Prakash, K Narmadha Devi, J Naveetha, V Vasanth and V Vishnushree 2017 Smart bore Well child rescue system *International research journal of engineering and technology* **4** 358-362

[6] Sumit Pandey, Sanjay Kumar Shah, Shreekanth Shah, Chandan Kumar Mahto and A Sathyarayanaswamy 2019 Child Rescue System against Open Bore Well *International journal of science technology and management* **8** 12-17