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DESIGN AND SIMULATION OF BORE WELL RESCUE ROBOT - ADVANCED

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ABSTRACT

In the past few years, there have been several accidents of children falling into abandoned bore wells in India. Abandoned bore wells that have turned into death pits for children. The problem is all over India. Rescue teams spend hours and sometimes days in futile attempts to save these little kids. A lot of money is also spent in these missions. In most cases they are unable to save the kids. Such events have happened umpteen times in the past, and every time either the government or the bureaucracy is blamed. The rescue process to save the child from bore well is a long and complicated process now. The rescue team tries to approach the victim from a parallel well that take about 20-60 hours to dig. This complicated process makes 70% of the rescue operations fail. Very few of the victims have been saved in such accidents. Recently some autonomous robots came on to screen to take out the trapped body in a systematic way. But the question rises, why these bots are not in action in the real world. This brings out safety that how far the robot handles the child safely. The rescue operation mainly consists of three processes; Approaching the Child, Handling the body, Taking child out of the well. A regular autonomous robot could easily perform the first and third operations. These bots can make up these two steps within few minutes. But there is a great chance for injury of victim as they try hooking up body organs and cloths. Our Project deals with extreme Safe Handling of the victim. The design of handling system is made in such a way that the baby/victim never gets hurt and the robot itself provides some pretreatment to make the baby survive till the end of operation. Our Robot design constitutes a best Ergonomic Design and performs safest rescue operation.

Keywords: bore well, rescue, robot, design, simulation.

INTRODUCTION

Water well or Bore well is an excavation or structure created in the ground by digging, driving, boring, or drilling to access groundwater in underground aquifers. The well water is drawn by a pump, or using containers, such as buckets, that are raised mechanically or by hand. Now a days it's quite often we see unused bore wells left open after the use. Growing water scarcity is being recognized as an important problem facing India. Per capita availability of water in India has declined from over 3,000 cubic meters (CuM) per year from 1951 to 1, 820 CuM in 2001 [1]. In nine out of twenty river basins, per capita availability of water is below 1, 700 CuM per year, indicating that India is experiencing severe water stress. In particular, the status of groundwater resources of the country is a matter of serious concern. India is by far the biggest user of groundwater in the world, drawing an estimated 210 billion CuM of water per year; much higher than China's withdrawals of 105 billion cubic meters (BCM) and the U.S.'s 100 BCM. Groundwater irrigation has been expanding at a very rapid pace in India since the 1970s and now accounts for over 60 percent of the area irrigated in the country, as indicated in a recent report by the Indian Central Water Commission. The most dramatic change in the groundwater scenario in India is that the share of bore wells in total irrigated areas went up from a mere 1 percent during 1960-61 to 40 percent during 2006-07. The estimated number of wells and bore wells in India is now around twenty-seven million, with bore wells accounting for more than 50 percent. On average, there were twenty-seven bore wells per square kilometer of sown area in Punjab [2], twenty-two in Uttar Pradesh, and fourteen in Haryana. Interestingly, small and marginal farmers (with landholding sizes of less than two hectare) accounted for over two-thirds of the households that own bore wells.

Initially, open wells were dug and electrical centrifugal pumps were used to extract groundwater. Farmers started drilling bore wells from the early 1990s and shallow open wells gradually dried up due to falling groundwater levels. Over the last 15 years, the number of bore wells grew rapidly in these villages. Due to indiscriminate drilling of bore wells and unscientific groundwater exploration, many bore wells failed either at the time of drilling or after drilling. Furthermore, drilling bore wells as deep as 300 ft. resulted in drying of shallow, open dug wells and shallow bore wells [3]. These bore wells are left unclosed after identifying that ground water is not abundant at the place. Without a prior scientific testing, bore wells are started digging and later left abundant. This resulted in vast increase in number of bore wells. Drilled wells with electric pumps are used throughout the world, typically in rural or sparsely populated areas, though many urban areas are supplied partly by municipal wells. Most shallow well drilling machines are mounted on large trucks, trailers, or tracked vehicle carriages. Water wells typically range from 3 to 18 meters (9.8-59 ft.) deep, but in some areas can go deeper than 900 meters (3, 000 ft.).

SOCIAL ASPECTS OF CONCEPT

The government of Kerala has argued that it should be made mandatory to erect a three-foot wall around all such unused bore wells and tube wells [4-5]. It has also argued that it is time to frame stricter laws and

penalties to ensure accountability in the event of any accident.

The government of Tamilnadu also passed the Tamil Nadu Ground Water Development and Management Act in 2003. It made mandatory for people to get permission from the government before sinking bore wells, for the Water Supplies department to intimate the local authorities and for the local authorities to monitor the activity [4].

As many as 157 illegal bore-wells and tube-wells in various colonies in Gurgaon have been dismantled and sealed and First Information Reports have been registered against their owners during the past one year [6].

Various cases are being encountered where people especially children are accidentally falling and trapped in the bore wells. Taking them out safely is one of the difficult challenges which involve risk and lot of human effort and time. Sometimes the bore wells are so deeper that a human cannot enter leaving the victim helpless inside the bore well. Using smart robot technologies for rescuing is one of the good solutions eliminating the human effort and time. The paper discusses about smart robot which are designed by the authors for this purpose.

THE SOLUTION AND RESCUE ROBOTS

Available solutions

(i) So far there is no proper solution available for giving relief in such accidents. Generally, a hole parallel to the bore-well is dug up then a horizontal path is created to reach to the subject's body. But it takes too much time to save the life of the sufferer. Moreover, it involves a lot of energy, and expensive resources which are not easily available everywhere. It also involves possibilities of damaging the body of sufferer during the rescue operation loom large.

(ii) In some cases makeshift arrangements are made to pull out the body of sufferer. In such methods some kind of hooks are used and sufferers' clothes or body organs get caught hold of. This may cause wounds on the affected body.

Possible alternative solutions

Robots are replacing humans [7] in the activities of performing repetitive and dangerous tasks which humans prefer not to do due to size limitations, extreme environments, etc. Rescue robot technologies were already developed. They came into notice after world trade center disaster in U.S.A. In order to overcome this problem of rescue operations, an alternative (feasible) proposal of developing a robot machine is proposed that can take out the trapped body in systematic way. It will also perform various life-saving operations for the victims such as oxygen supply. A video camera to observe the actual situation closely and continuous interaction with the sufferer could also be possible.

DESIGN CONCEPT

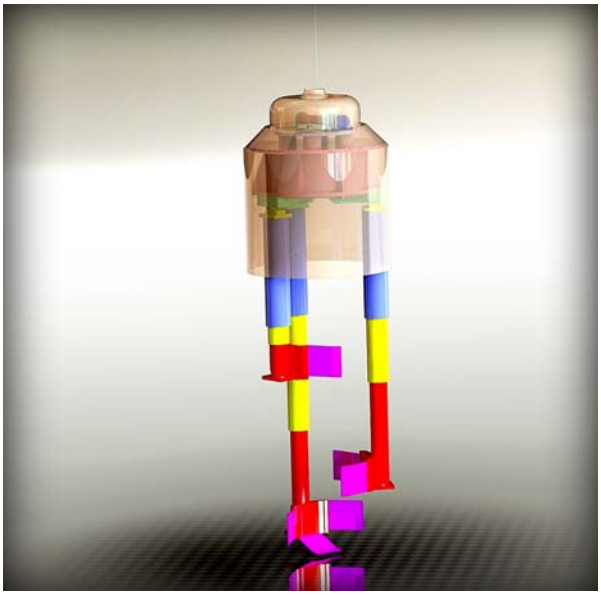

Figure-1.

Robot is designed in such a way that it will be a light weight machine that goes down into the bore well pipe and hold the trapped body systematically. This machine assembly will be supported by a cable wire and this will be controlled and supported by a gear assembly, a stand and all necessary accessories. In this alternative scenario, there will be no requirement of digging any hole parallel to the bore-well. The remotely controlled robot will go down the bore well and perform the action. A lot of other hassles will also be avoided by this technology.

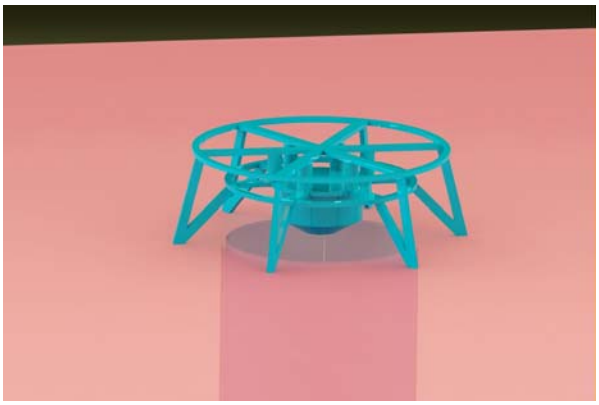

Figure-2.

METHODOLOGY

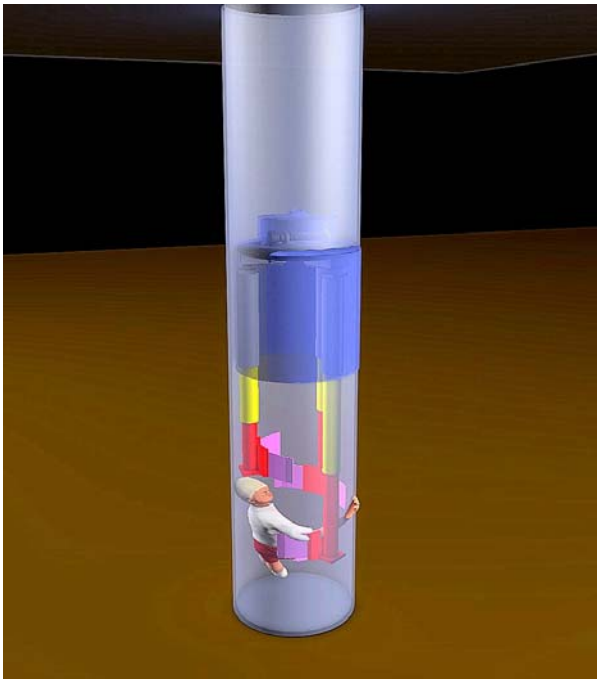

Figure-3.

The idea for this project was conceived from rapid bore well accidents prevailed in India during 2000 - 10 to prevent the children fell into unclosed bore wells reducing the technical and financial risks involved in rescue operation and to perform the rescue operation in extreme safe conditions. The basic concept of this project is to bring the victim to ground without any injuries in a very short span. This could be achieved by the advanced ergonomic design involved in the robot. It seeks to harmonize the functionality of tasks with the human requirements of those performing them. Ergonomic design focuses on the compatibility of objects and environments with the humans using them. For completion of present design to reach prototype stage, the following steps are followed as shown in the flow charts - Design needs, Problem Definition, Concept Design, Preliminary Design, Detail Design, Design Communication and Final Design. The aim of the first two steps is to make safe and sophisticated rescue robots. After making the concept ready, further design and modeling were carried out.

Design Criteria

To design rescue robots for saving people trapped in bore wells, following three criteria are considered:

a) Supplying oxygen to the victim trapped inside the bore well.
b) Picking him/her up safely to the outside without failing or slipping of robot in between.
c) Talking out the victim safely as fast as possible.

Considering the above criteria rescue robot was designed. The reason that these rescue robots are not into market or common use is that they fail to serve above one or more. Hence every aspect of design was taken care to make sure that our design satisfies above mentioned criteria to a good extent.

Mechanism

The robot is expected to be fabricated in such a way that the trained operator opens the stand and fixes over the bore well and give the input regarding depth and diameter of the bore well. The robot self-operating system starts with the given input into the well. The IR sensor place along with camera on the bottom will detect the distance of the victim from the ground. Then the rescue robot is going to fit in the bore well. Oxygen supply is provided through a special pipe arranged from the rescue robot. The rescue robot is going to sense the position of the person or child and it is going to send a long assisting pipe so that child can mount on them. The assembly of robot is such a way that it has three degrees of freedom and can adjust its position according to safety and comfort of child. Then with the help of motors, the child or person mounted on the three legs of rescue robot is pulled upward safely in fastest possible time.

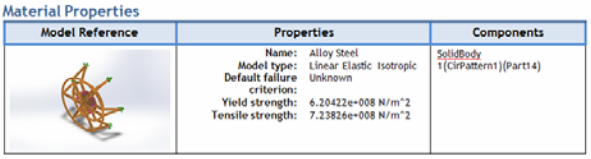

Figure-4.

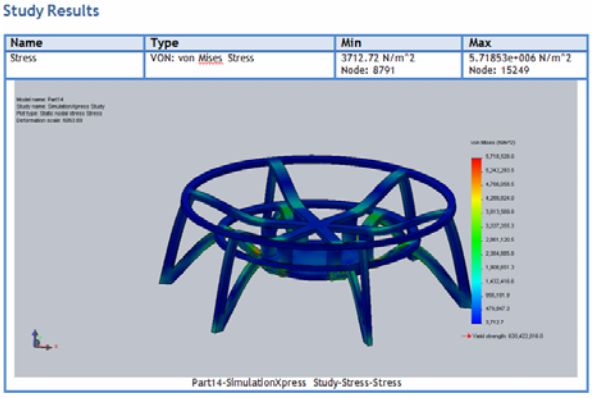

Figure-5.

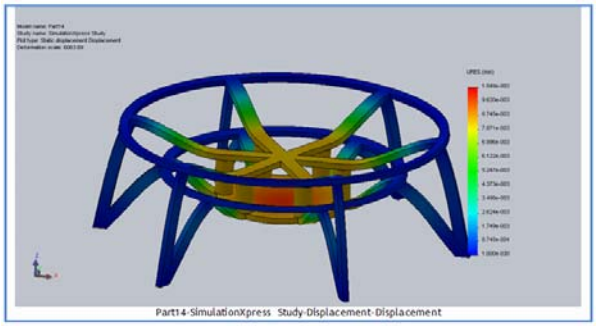

Figure-6.

CONCLUSIONS

It is concluded that the rescue robot can provide the safest and fastest way to save victims trapped in bore wells. If this could be implemented into prototype, it could save many people who are trapped in the bore wells every year. Our rescue robot can also be used in other applications where people are trapped in between structures like during earth quakes.

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