Multi-Purpose Prosthetic Bore Well Rescue Robot System

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Abstract: The aim of this research is to give an innovative concept to handle the bore well rescue operations. It is difficult and also risky to rescue the trapped children to aid in such rescue we proposed a system of designing robots to the rescue of a child in a borehole. A safety balloon is introduced in order to provide extra safety. The Physically Based Rendering System (PBRS) is provided with the newly developed revolving and stabilizing mechanisms for safe holding of child. The different proximity non-vision sensors are used for detecting human condition, depth from ground, surrounding temperature, pressure and existence of any smoke gas. The present proposed design is capable of handling scenarios when child is stuck up at bottom and middle. The PBRS is proposed to reduce the risk involved during the child rescue operation by analysing the situation and also to provide an option in crack detection inside the composite rocket casings, pipelines and boilers.

Keywords: Robot design, Safety balloon, Bore well deaths, Conventional method, Prosthetic.

I. INTRODUCTION

Today’s major problem faced by human society is water scarcity, which leads to a large number of bore wells being sunk. These bore wells in turn have started to take many innocent lives. Bores which yielded water and subsequently got depleted are left uncovered. Small children without noticing the hole dug for the bore will slip in and get trapped. There is no proper technique to rescue victims of such accidents. When the make shift local arrangements do not work. In most cases reported so far, a parallel hole is dug and then horizontal path is made to reach to the subject’s body. It is not only a time taking process, but also risky in various ways.

Besides it involves a lot of energy and dear resources which are not with no trouble available ubiquitously and in this process, we always need big space around the spellbound bore that we can dig a parallel bore. These ad-hoc approaches involve heavy risks, including the prospect of injuries to the body of the subject during the rescue operation. Also, the body may trap further in the debris and the crisis deepens even more means death. In most cases, we rely on some make shift arrangements. This does not assure us of any long term solution. In such methods some kind of hooks are employed to hold the sufferers clothes and body. This may cause wounds on the body of the subject. After studying all the cases we found a serious issue to do, to make a such robotic machine which can go through the trapped bore well without any support and grasp the trapped body at least minimum time with providing facilities of oxygen cylinder, safety balloon. By way of this machine, there is no chance of harmful human body and other minor compensation, and we called that machine as “Bore Well Child Saver Machine”.

As per the Indian government report, Newspaper articles and Google search of bore well accidents in the last 10 years resulted in a total of 39 bore well incidents since 2006. The actual number of incidents may be more since many incidents go unreported. Out of 41 reported cases, maximum number of accidents has occurred in the years 2007 and 2014.
The age of children trapped in the bore wells ranged from 2 years to 9 years. Analysis of a state-wise Pie chart, as in indicates that Haryana, Gujarat, Tamil Nadu top the list of the bore well accident states. These three states alone account for more than 50% of the bore well accidents since January 2006 until November 2015. This deaths are happening not only in India, but also in neighbour counties like China, Bangladesh etc…

![Fig. 1 Pie chart showing bore well deaths in Indian States](image1.png)

Investigating into reason behind these deaths, while rigging bore or after the exhaust of source people leave these holes not by covering or closing. Sometimes they close with gunny bags or with dry leaves and sticks. Children may play in that area and suddenly fall into the bore well and troubled for long time and die lack of oxygen at depth, water and food. As the depth increases temperature also increases and makes child not to tolerate at that condition. With increase in the temperature, pressure also increases. These violent conditions make the children prone to cause in hyperthermia.

![Fig. 2 Symptoms of hyperthermia condition](image2.png)

Heart rate and respiration rate will increase as blood pressure drops and the heart attempts to maintain adequate circulation. The decrease in blood pressure can then cause blood vessels to contract reflex, resulting in a pale or bluish skin color in advanced cases. Young children, in particular may have organ, unconsciousness and death will result
II. LITERATURE SURVEY

The primary use of robots includes searching for survivors, where unusual viewpoints can be perceived with better human-robot interaction. Usual method followed by the rescue team is first to find the depth of the child in the bore well by using rope. After finding the depth, a parallel pit is dug using Earthmoving vehicles. This method of rescuing has following difficulties, it takes up to 30 hours to dig the parallel pit, by that time the child would have died. Lack of oxygen inside the bore well. Lack of apparition causes the key intricacy in the rescue operation. There is no such special equipment for rescuing the child intent within the bore well.

Fig. 3 Army members working for the borehole rescue

Forty five deaths of children have been reported in the country since September 2009, from that we have only nineteen with the proof of a newspaper. In the year of 2012 Six year old boy was rescued from the bore well, but later died in the hospital due to injuries during the rescue operation and lack of medical aid. Their deaths are caused owed to bare arid bore wells.

Fig. 4 Depth of a Borehole

Safety Balloon

The safety disc is an air-filled disc that has a unique dome shaped top. The safety balloon disc is 12” in maximum diameter. It is initially in the deflated condition, fitted with the nozzle. It is inflated, when this safety balloon is in the right position under the baby. It is used to provide support for the baby.

Fig. 5 Safety balloon
Balloon Type Rescue System

The rope is connected to the top of the robot. As the robot is sent into the bore-well hole, electric wires for the motor from the control unit chip is attached along the rope. The oxygen tube is preset to the upper face of the robot. Depending on the robot progress, the tube length is adjusted from outside the bore-well. The gas tube from the compressor is connected to the gas box located on the lower plate through the hole in the upper face. The gas box act as an intermediate gas transmitter.

Using the motion detector and other special features of the camera, the baby position is seen through a computer. At the appropriate position, the fork will punch into the bore-well wall using the motor connected to the bevel gear setup on the upper face. If the baby is trapped in the middle of bore-well, using the motor connected at the lower end of the hollow tube, the lower plate is rotated in such a way the safety balloon gas tube is in the gap between bore-well and the baby. Initially the gas tube is above the end of robot hands.

It will circumvent attack of gas tube on the baby. Using the motor connected to the hold down, the rack is moved worse than the robot hands. Then the robot is moved down in such a way that the robot hands free to hold the baby head or middle of the body. Then the safety balloon is inflate by using the air compressor through gas box. The air pressure is measured in analog pressure estimate connected to the compressor. The digital display is placed below the upper camera. After the safety balloon reached the exact pressure, the compressor is cut off. Then the safety balloon is moved increasing using motor connected to the support and pinion setup till the safety balloon fully supports the baby.

Now the baby is completely in robot control. The baby movements see through the lower camera and other data readings see through upper camera. The two way audio communication will help us to know the stipulations of the baby. Then slowly, the baby is moved upward. By pulling the rope using the pulley control system. The medical team will be able to prepare for the treatment depending on the already seen temperature of the baby. At what time the robot is pulled away, the rope is cut off. The robot is occupied the motor control and the baby is occupied for handling.

![Fig. 6 Balloon type Rescue System](image)

New Prosthetic Rescue System

As a part of the bigger goal of engaging robotics technology for the welfare of mankind, there is a need to develop newco-operative networked intelligent rescue robots for natural disaster management. As per the United States of America and NASA in the future there should be more and more intelligent robots like in which can be used in any situations like rescue from fire, mining rescues, earthquakes, tsunamis, road accidents, aerial survey etc....
Over the last decade, rescue robots played an important role to reduce the damages caused by several natural and Terrorist disasters like Nepal earthquake [2015], Tohoku earthquake [2011], World Trade Centre [9/11, New York etc. The intelligent robots usually prosthesis robots. Generally, Prostheses means replacement of leg or arm to human body. But, in the robotic language Prostheses is one of the type in robot classification. It has a robotic arm or leg which is controlled by human brain. These prosthetics don’t have their own brains and are not truly programmable. They can make of either hydraulic or servomotor actuators, utilize servo control and work with a good mechanical linkage.

\textit{Physically Based Rendering (Pbr)}

\textit{Structure And Principle Of Prosthetic Bore Well Rescue System}

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

- Manipulator
- Sensory Devices
- Controllers
- Power conversion unit

\textbf{Manipulator}

Prosthetic manipulator is the collection of mechanical linkages connected by joints to form an open-loop kinematic chain. It includes the gears, coupled links, grippers, shafts, lead screws, forks and two round plates. It is capable revolving around $360^\circ$ and slide to side for holding the child. The head part in is having bevel gears and forks for Running stabilizing mechanism. It is inserted into hole through standardized rope and pulley from ground by tripod stand. After detecting the human, the manipulator stops and first stabilizes in the hole by fork stabilizing mechanism, inspired from three-jaw chuck operation in lathe machine. Later the second plate revolved as per child position, which can be seen in visual images by camera. Motor gripper will hold and pull child out from bore well. These can be operated by servo motor and hydraulic actuator, which is perfect in holding.
**Sensory Devices**

Sensory devices inform the system controller about the status of the manipulator. These will continuously detect instantaneous position of manipulator, needed velocity and possible acceleration information about the individual links, which can be feed back to the control unit to produce the proper control of the mechanical system. Visual and Non-visual sensors are two types of sensors used in arm. For lighting in the hole a LED light is fixed at arm end. Wi-Fi Camera is also used, which is coupled to an appropriate android mobile app with image detection hard ware is the one and only visual sensor in the system for tracking the position of child in the hole.

The different proximity non-vision sensors are used for detecting human condition, depth from ground, surrounding temperature, pressure and existence of any smoke gas. Provides different sensors, which are used in the system and depicted.

![How Does an Oxygen Concentrator Work?](http://iaetsdjaras.org/)

**Fig. 9** [a] Oxygen Concentrator; [b] Temperature Sensor; [c] Human Detecting Sensor [HS-101]
Controller

Controller will carry out the needed tasks. These will perform the necessary arithmetic computations for determining the manipulator path, speed and position. These send signals to the joint actuating devices [via interfaces] and utilize the information provided by the proximity sensors. The microcomputer-based arm controller is the devised that can be used in the servo-controlled arm.

Power Conversion Unit

It provides the necessary energy to the manipulator’s actuators. It can take the form of power amplifier in the case of Servomotor-actuated systems. It can be a remote compressor when pneumatic or hydraulic devices are used. Possible implementation of a prosthetic arm controller includes a single microprocessor is used as both the sequencer and the computational element. The common bus is the link that connects the micro-processor, its memory, the vision system, the binary I/O interface and the servo loops. By partitioning the system as shown, only the servo loops have to interface to the sensory data from the joints and provide drive signals to the power amplifiers. Also in this implementation, the vision system is self-contained and incorporates all the necessary hardware and software to perform its function. By distributing the system, we have removed some of the burden from the sequencer.

![Diagram of a prosthetic arm controller](image)

Fig. 10 [a] Possible implementation of system; [b] Sub systems of PBRS components

Operating Steps Of System

Entire set up is supported by tripod stand on the ground with oxygen concentrator aside. After detecting the human body the arm will stop at some distance above the child and give the information of depth from ground, position of child, surrounding temperature, pressure, O₂ level and existence of any smoke gases. Then stabilize the system with stabilizing mechanism, at the top of first plate will release stabilizing fork mechanism using servo motor by running one big and three small bevel gears. The controlling operator will take the results from sensors and give the input supplies of water, O₂ gas and cool air for child through the pipes of Oxygen concentrator.
The position images of the child can be viewed in the mobile or PC, which is connected to the Wi-Fi camera running in LED light. Run the second servo motor to revolve the gripper hand as per the child position. The lead screw will turn the spur gear for linear to rotary motion. Run the servomotor of the gripper. This will make the links to open the gripper hand. Then it holds the child body at safe body part [hip or shoulder]. Back the forks to the initial position by running bevel gear. Slowly lift child with controls to top.

![Fig. 11 Rescue operation with PBR System](image)

Now, press the safety balloon at the bottom such that it supports the child if he slips from grippers so that no slipping takes place. Treatment will be given to victim after taking him out from hole. We can use PBRS in sending medicines, food, oxygen, telephone signals and voice of their family to the men, who are trapped in mining accidents.

### III CONCLUSION

The proposed system operation was better than conventional bore well rescue operations and has several components to do different works which will make the arm more invincible and easier in operation. Since providing few modifications in the proposed design is more advantages and surely used in many applications like crack detection in pipe holes, rocket motor casings, boilers, chimneys and mining rescues.

### REFERENCES


