PIPELINE INSPECTION AND BOREWELL RESCUE ROBOT

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Abstract

The aim of this paper is to give an innovative concept to handle the bore well rescue operations without human intervention and to inspect any type of leakage in the pipe. Normal operation of child rescue is done by using big machines with large manpower involvement. It takes more time to rescue a child from the bore well and to check any kind of irregularities in pipe. Wheeled leg mechanism is employed in this design to go inside the pipe. The legs are circumferentially and symmetrically spaced out 120^o apart. The robot is made adaptive so that it can adjust its legs according to the pipeline dimensions. This structural design makes it possible to have the adaptation to the diameter of pipe and to have adjustable attractive force towards the walls of pipe. In this project, the condition of trapped child is captured with USB Camera and monitored on PC. LM-35 Temperature Sensor and 16X2 LCD are interfaced with PIC 16F877A microcontroller to sense the temperature inside the bore well and to display it respectively. The microcontroller stores the sensed data and displays it on the LCD. The robot structure consists of power supply, switch pad and gear motors. Adding a claw or gripper was the initial hurdle for which additional power supply and DC gear motor were needed. The microcontroller is not sufficient to give the sufficient amount of current to the multiple gear motors, so in spite of using motor driver, direct supply is given to gear motors using switch pad as its control centre enables the robot to work smoothly. The project is intended to reduce the risk involved during the child rescue operation by analyzing the situation and also to provide an option detect any leakage inside the pipe.

Keywords: *Bore well rescue robot, Life savior robot, Child trapped inside borehole.*

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1. INTRODUCTION

To improve security and efficiency of piping networks in industrial units, continuous inspection, maintenance, cleaning and repairing of pipelines are strongly demanded because due to aging problems, a lot of troubles like corrosion, cracks and mechanical damages are possible in pipes [1]. These operations are quite expensive, so robots prove an efficient solution in this situation.

A robot is an intelligent, re-programmable and multifunctional manipulator designed to work in inaccessible environment to do variety of tasks which are laborious, threatened and risky. The robots with flexible structure are needed so that they can adapt themselves according to the pipeline parameters. The wheeled robots are simplest, energy saving and best suited for use on prepared surfaces [2]. These locomotion systems have main chasis connected to a set of wheels through links and joints.

Along with pipeline inspection, the concept of rescuing the trapped child from the borehole is also implemented in the robot design.

Since water level is decreasing day by day so more people put ever increasing demands on limited supplies. To fulfill the needs, bore wells are constructed, but these are usually left uncovered. Many innocent children without noticing the hole have trapped and lost their lives.

Fig 1 A Miraculous escape of small child in bore well

In normal rescue operation, a parallel pit is dug deep to achieve the child and adjacent holes are made to the walls of bore well. A common method used to find the depth of child is the use of rope [3].

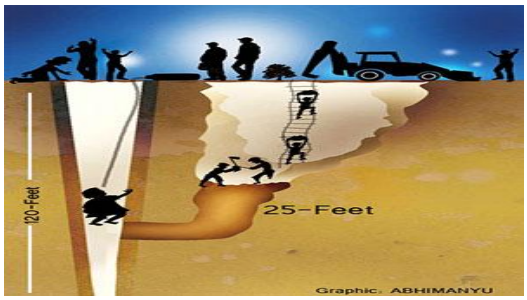

Fig 2 Image of a baby fell into borehole and Army members working for the borehole rescue

The injuries during and throughout the rescue operation also leads to the death of child [4]. The lack of oxygen inside the deep hole makes it impossible for the child to survive for long time .Hence this operation proves very difficult, risky and time consumptive.

The following Table no: 1 shows some cases of trapped children in borehole in India last five years.

Table 1 Incidents of trapping children in bore wells

S.No.	Name of child	Age	Place of incident	Alive or not	Source of information
1	R Madhumitha	3	Villupuram Distt., Tamilnadu	Recovered alive but died in hospital	The Times of India(5-4-2014)
2	Radheshyam	2.5	Churu Distt., Jaipur	Died in hospital	The Times of India(7-1-2014)
3	Chotu	9	Karauli Distt., Rajsthan	Not alive	IBN Live(10-8-2013)
4	Tanu	4	Palwal, Haryana	Alive	IBN Live(30-5-2013)
5	Muthulakshmi	7	Suryapalli Village, Tamilnadu	Died in hospital	IBN Live(28-4-2013)
6	K Ajith	5	Karimnagar, Andhrapradesh	Not alive	IBn Live(8-12-2012)
7	Mahi	5	Gurgaon	Not alive	Zee News(27-6-2012)
8	Tirumalesh	1	Mahabubnagar, Andhrapradesh	Not alive	Zee News(8-12-2011)
9	Ankit	4	Raimalpura Village, Kochi	Not alive	Zee News (4-11-2011)
10	Asmita	1	Rajkot, Gujrat	Not alive	Zee News(26-6-2011)
11	Om Santosh Devre	1.5	Nashik	Not alive	Zee News(20-3-2011)
12	Dilnaaj Kaur	3	Dheera Village,Gurdaspur, Pb.	Not alive	The Hindu (4-6-2010)
13	Ankitma Wada	2.5	Bhopal, MP	Not alive	NDTV (29-01-2010)
14	Pankal	4	Bhilwara, Rajsthan	Not alive	India Today(29-01-2010)
15	D.Dinesh	2	Hyderabad	Not alive	Hindustan Times(19-01-2010)
16	Darawath Prasad	1.5	Warangal AP	Not alive	NDTV Correspondent(18-01-2010)

In table 1, the ratio of dead and alive children is 15:1. This shows that frequency of those trapped children in bore well has increased who get died in the hole due to insufficient amount of oxygen or injuries throughout the whole process. The alternative solution to this problem is the use of robotic systems which can move down the pipe and bring the subjected body out of it properly and safely. This will take lesser time than the normal operation.

This work is aimed towards the construction and designing of a robotic system to work in borehole rescue operations and to detect faults inside the pipeline. The robot has the arm at its front to pick and place the objects. It has camera that is interfaced with MATLAB for the visual display. The motion of the robot is controlled through a remote (switch pad) and also the temperature inside the pipe sensed by the robot is monitored outside on the display device.

The project is intended to reduce the risk involved during the child rescue operation by analyzing the situation and also to provide an option detect any leakage inside the pipe.

1.1 Problem Description

As the project is being inspired by in-pipe inspection robot mechanism, some modifications are required that enable the robot to be used for child rescue operations from the borehole.

When claw or gripper is added to the robot, the controller is not able to provide the sufficient amount of current to the multiple gears which affects the operation. So motor driver section is removed from the robotic structure and direct supply is given to the gear motors using switch pad as its control centre enable the robot to work smoothly and effectively.

1.2 Objectives

Following are the aims and objectives of the proposed design:
1. To make an adaptive robotic design having three legs parallelogram structure so as to adjust it accordingly the pipeline parameters.
2. Add gripper or claw to it which can contract and expand according to necessity and can grasp the target inside the pipe.
3. To interface it with the controller unit, sensor unit and display unit and camera is mounted over it. Also PC is interfaced using MATLAB for visual display.
4. Software implementation.
5. To control the whole system with switch pad and to bring the target out of the pipe safely.

1.3 Block Diagram

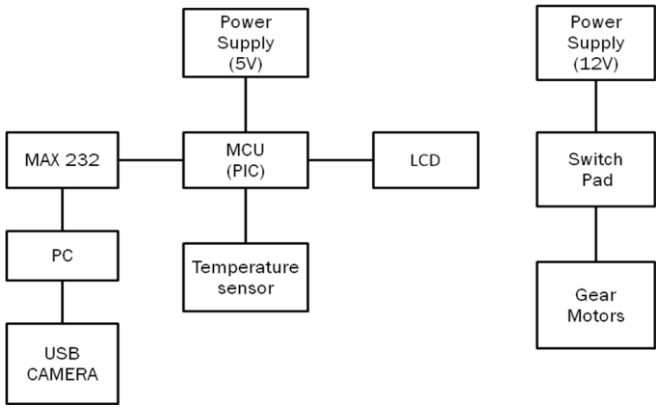

Fig 3 Block diagram for Pipeline inspection and bore well rescue robot

The whole system consists of the following parts:

1.3.1 Robotic Unit

This unit comprises of 12V power supply, switch pad and gear motors. The switch pad has three micro switches connected to the microcontroller I/O pins. One end of the switch is grounded and other is connected to the microcontroller port. When any switch is pressed that particular port is grounded. The microcontroller always monitors these switches in real time (i.e. in continuous mode).

Also five gear motors are used for performing the robotic action. Three motors are for moving the robot up and down, one for clock and one for the contracting/expanding of the gripper.

1.3.2 Controller Unit

This unit comprises of PIC 16F877A microcontroller. This is RISC (Reduced Instruction Set Computing) based microcontroller having analog input channels, analog comparators and additional timer circuits. The microcontroller stores the information captured by the robot and display it. The temperature sensed by the robot is firstly stored in microcontroller and then get displayed on the LCD. The video captured by the USB camera is displayed on PC using MATLAB. The serial communication between microcontroller and PC is done through MAX-232 interface. This is used to check the baud rate and changes the voltage level because microcontroller is TTL compatible whereas PC is CMOS compatible.

1.3.3 Sensing Unit

The unit consists of LM-35 temperature sensor for sensing the temperature inside the pipeline having range from -55^{o} C to $+150^{o}$ C. It is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature. It can be used over the voltage varying from 4V– 30V and current of 60 micro amperes.

It is suitable for remote applications. Ii has very low self-heating.

1.3.4 Display Unit

The temperature sensed by the robot is displayed on 16X2 LCD. This is an intelligent LCD used for alphanumeric characters & based on ASCII codes.

Also the video captured by the USB camera is monitored on the PC which gives the insight view of the borehole to perceive the location and position of the child and also able to detect any fault inside the pipeline.

2. METHODOLOGY

The robot will perform the following steps for performing the task:

1. The robot firstly goes down the pipe with by adjusting its legs according to the dimensions. It is controlled by the operator using switch pad.
2. The video camera mounted on it gives the insight view of the position and location of the target. This video will be monitored on PC.
3. The robot then grasps the target by contracting or expanding its gripper according to the requirement.
4. Temperature sensing is also done by the robot which is monitored on LCD display.
5. The robot holds the target tightly and brings it out of the pipe safely.

This whole method is lesser time consumptive and risky than the normal operation.

3. CONCLUSIONS

In last 10 years, a lot of lives have been lost due to falling in the bore well because it involves digging a pit beside a bore well which is very time consuming. The proposed system is to overcome all these difficulties. This project is used to reduce human efforts for rescuing operations from bore well. It performs rescue operations in very less time as compare to humans. It can do the pipeline inspection which is beyond of human reach.

4. RESULTS

The robot designed is able to give the conceptual scenario in the situation of rescuing child from borehole which can be made in use by the government. By using this concept, robots for this situation can be made on the large scale for saving the life of child. It is able to see the irregularities of pipe by giving the insight view.

The manipulator designed was tested over a pipe having 8-10 inches width and 2-3 foot height. The robot manipulator had adjusted according to these dimensions.
Small objects having weight 200-300 grams was put inside the pipe. The robot moved inside the vertical pipe and controlled by the operator using switch pad .Then it perceived the target which was viewed on PC. Then according to the instructions it brought that object with the help of gripper safely out of it.
Hence this concept is really applicable in pipe line inspection and borehole rescue operations and can save many innocent lives with safety and low risk.

5. FUTURE SCOPE

The project can further be improved by adding or modifying by following features:
1. An additional feature of air bag can be used to provide support underneath the child which prevents the child from falling further deep.
2. Oxygen sensor and oxygen supplier can be installed.
3. Smoke sensor can be added to sense the dangerous gases concentration inside the pipe.
4. It can also be made water proof.

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