WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A Multi-Functional Rescue Robot for Disaster Response

Vigneshwaran V[1]*, Dhanush Adithya S[1], Mohamed Fazid S[1]

[1]Mohamed Sathak AJ College of Engineering
Vigneshwaranv1312@gmail.com

ABSTRACT:

There have been multiple incidents in India in the last few years with kids slipping into abandoned bore wells. Some abandoned bore wells have become child death traps. The issue affects India as a whole. Rescue crews try in vain to save these small children for hours, sometimes even days. These expeditions also cost a significant amount of money. They are typically unable to save the children. These kinds of incidents have occurred numerous times in the past, and each time the blame has fallen on the bureaucracy or the government. These days, the procedure to save the youngster from the bore well is drawn out and difficult. It takes the rescue team 20 to 60 hours to try to reach the victim from a parallel well. Seventy percent of rescue efforts end in failure due to this intricate process. The handling system's design ensures that the victim or baby never suffers harm, and the robot administers some pretreatment to prolong the baby's survival until the operation's conclusion. Our robot conducts the safest rescue operation and has the greatest ergonomic design.

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

1. INTRODUCTION

Boundary wells are dug to provide the ever-increasing need for water. However, since these are typically kept uncovered, kids frequently trip and fall. In order to reach the youngster, a parallel pit is typically dug, with neighboring holes made in the bore well walls. These, however, take a lot of time and could be fatal. A robot is an intelligent, multipurpose manipulator that can be programmed to carry out certain tasks. It is feasible to quickly rescue a youngster by using a robotic construction.

2. OVERVIEW

Robotic bore well rescue provides a way out of this predicament. It is quick, affordable, and secure. It is a place to keep an eye on stranded children, distribute oxygen and offer a helping hand to get them up. This technology uses robotic arms to pick up objects and fasten a harness to a youngster. An ultrasonic sensor is incorporated to determine the child's distance. Temperature is measured with a temperature sensor.

The infant can be quickly and easily rescued by the suggested system without suffering any serious injuries. High-resolution TV display and infrared waterproof cameras allow you to see the child. This little, lightweight device will descend into the bore well pipe and, by carrying out the necessary action, gradually save the child's life.

3. WORKING PRINCIPLE AND RESCUE ROBOT DETAILS

The rescue robot primarily uses a microcontroller for operation. In this case, the rescue procedure uses the microcontroller as a miniature computer. All mechanical and electrical components are operated under the direction of the microprocessor. Depending on the needs, commands will be issued to turn on the components. Two plates make up the child rescue device seen in Fig. 1 that is used to extract a child from the manhole. The holding plate is the initial plate. To take up the youngster, one must carry the rod's arm. This revolving rod supports the entire apparatus. Next, the holding plate—, which is attached to the rope directly—passes through the pulley, which is controlled by a handle to allow for lifting and lowering. A camera is fixed to observe it. The child inside the manhole is located using the webcam. With the aid of a fixed clamp, the arm that is attached to the holding clamp is moved when the motor runs, allowing the arm to grasp the child's waist. Through a shaft that houses a worm gear that is attached to the motor, the rotating plate is connected to the holding plate. The worm gear is utilised to slow down the lead screw's speed, allowing for a calm and steady operation that makes it easy to adjust the arms to the child's posture. The microcontroller-controlled lead screw can be used to open and close the arms. Additionally, the supporting plate may be managed by the Microcontroller to provide ascending and descending motion to the arms.

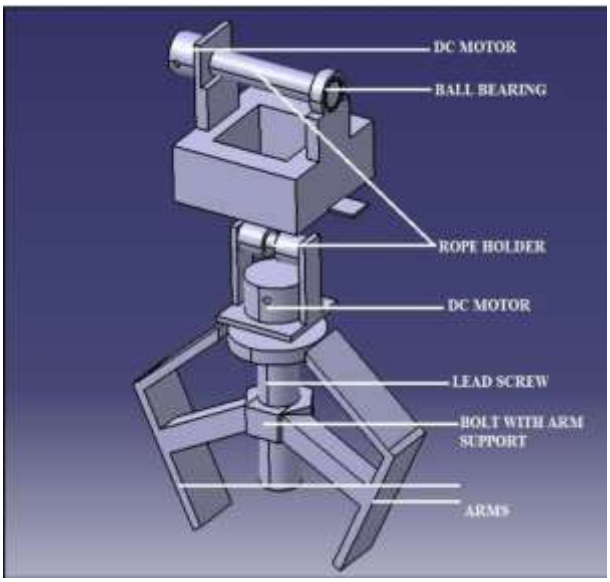

Fig. 1 Model of rescue system

The block diagram for the child rescue system is displayed in Fig. 2. In this case, all operations are controlled by serial transmission using the microcontroller. The DC motor is controlled by the relays, which function as switches. To ensure that it is unaffected, this relay gives the DC motors the necessary voltage. The gas sensor detects the gas concentrations in the hole; if any toxic gases are present, the level will be shown on the LED display. The gas sensor receives signals in analogue form, which is amplified and sent to the ADC (Analogue to Digital Converter) for conversion into a digital signal.

The child's location is recorded using the wireless camera, which is also utilised to monitor the rescue effort. The transmitter is attached to the camera so that the receiver at the top of the hole can receive signals. A 9-volt battery powers the wireless camera. The TV tuner card is used to link the receiver to the computer system, enabling the LCD display to display the visual display. The microcontroller is equipped with a display that can show two by sixteen characters. All of the commands that the microcontroller issues will be shown on the LED display as previously indicated. The voltage levels applied to the electrical components are stepped down by the transformers. Here, the voltage is stepped down using two transformers: a 9-volt transformer for certain components, and a 12-volt transformer to supply the necessary power to the DC motors.

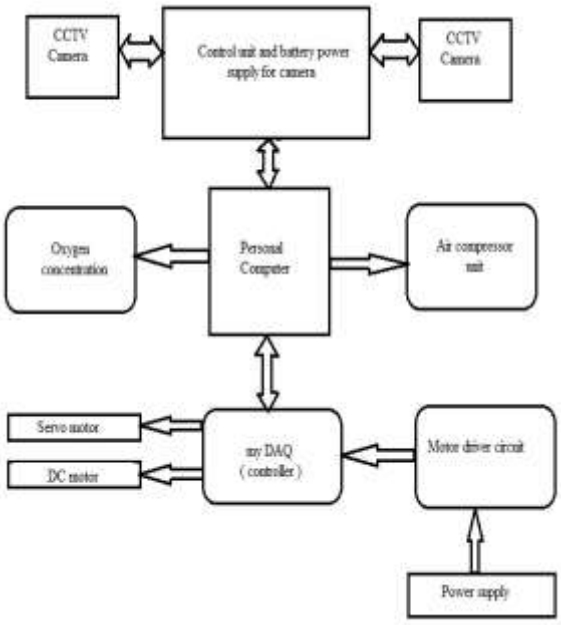

Fig. 2 Block diagram of child rescue system

4. Components used in rescue system

The components that are being used in rescue system are

- DC motor
- Wireless camera
- Lead screw
- Worm gear
- Gas sensor
- Microcontroller
- LCD display
- Crystalonic display

4.1 DC motor

Simple electromagnetism underpins the operation of every electric motor. When a current-carrying conductor exposed to an external magnetic field, it produces a magnetic field that is proportional to both the strength of the external magnetic field and the current in the conductor. As if polarities (South and South, North and North) repel one another, as you are well aware of from your childhood experiences with magnets. Opposite polarities (North and South), attract. A DC motor's internal structure intended to use the magnetic interaction between an external magnetic field and a current-carrying conductor to produce rotational motion.

4.1.1 DC motor calculation

Specification of a DC motor

Speed = N = 30 RPM

Voltage = V = 12 Volt

Loading Current = I = 300MA

No Load Current = I = 60MA

Power: P = VxI=12x0.3 = 3.6WATT

P = 0.0048HP (1Watt = 0.00134102HP)

Motor Efficiency = E =36%

Motor Shaft diameter = D = 6mm

A good scientific project goes beyond just creating a motor. It is crucial that you measure the various electrical and mechanical characteristics of your motor and use the useful formulas below to compute any unknown values. This formula has numerous applications. Your motor's resistance can be computed by monitoring the applied voltage and consumed current. With any given resistance—basically, the resistance of the coil in motors—this formula illustrates how applied voltage can regulate the current.

Where,
I – Current in Amperes (A)

V – applied voltage, measured in volts (V)

Motors are meant to be used for work, and their power is determined by two key factors. It is the motor's torque, or turning force, and speed. The motor's output mechanical power could be computed using the formula below.

Output power: Pout = T x ω

τ – Torque, measured in Newton/m

ω – Angular speed, measured in radians per second (rad/s).

Calculation of angular speed if we know rotational speed of the motor in rpm Angular speed:ω= N x 2π/60

Where,
π – Mathematical constant pi (3.14).

60 – Number of seconds in a minute. Meters

The motor's efficiency is determined by dividing its mechanical output power by its electrical input power.

Efficiency: E = Pout/Pin

Therefore, Pout = Pin x E

After substituting equation no 1 & 2 in equation no 4, we get

Txω = IxVxE (5)

TxNx2π/60 = IxVxE

Attach the load to the motor. The ideal method is to use the generator kit's motor. Why is it necessary to attach the motor to the load? Indeed, there cannot be torque without a load. Take rpm, voltage, and current readings. Now that you know the motor's efficiency, you can compute the torque for this load at this speed.

The torque of a motor varies with speed. You have maximum speed and zero torque when there is no load. Mechanical resistance added by load. In order to overcome this resistance, the motor starts to draw more current, which causes the speed to drop. The motor will eventually stop if the load is increased; this is known as stalling.

4.1.2 Torque of the Motor

The formula for calculating torque will be Torque = (IxVxEx60) / (N x 2π)

Speed: N =30RPM

Voltage: V = 12 Volt

Loading Current: I = 300 mA

Torque: T =(0.3x12x0.36x60)/30x2π

T = 0.412 Nm Torque: T = 4.2 Kgcm

4.2 Wireless camera

A camera is an apparatus that records images as still pictures or as a series of moving pictures (movies or videos). The phrase "dark chamber" refers to an early image-projecting device known as a camera obscura, which used an entire room as a real-time imaging system. The contemporary camera developed from the camera obscura. Cameras can use both the visible spectrum and other electromagnetic spectrum components. A camera typically consists of an enclosed hollow with a viewing or recording surface at one end for collecting light and an opening (aperture) at the other allowing light to enter. In order to collect incoming light and concentrate all or part of the image on the recording surface, the majority of cameras include a lens placed in front of the camera opening. An aperture's diameter is frequently adjusted by a diaphragm mechanism.

4.3 Lead screw

A leadscrew, sometimes referred to as a lead screw, is a screw used to convert turning motion into linear motion. It is also called a power screw or translating screw. Presses, jacks, vices, machine slides, and linear actuators are among the frequently used equipment. Leadscrews are produced in an identical manner to other types of thread. You can use a split nut in combination with a lead screw. Compared to mechanical parts that mate with rolling surfaces and bearings, a leadscrew nut and screw have a comparatively high friction and station because they mate with rubbing surfaces. The average range of lead screw efficiency is 25 to 70%, with greater pitch screws generally having higher efficiency. The ball screw is a more expensive but better-performing substitute.

4.3.1 Advantages of Lead Screw

The benefits of a leadscrew are as follows:

Large mechanical advantage; large load carrying capacity; compact and easy to design; easy to build without the need for specialised machinery Accurate and precise linear motion Quiet, easy to maintain, and minimal parts count The majority are self-locking

4.4 Worm gear

4.4.1 Advantages of worm gear

The benefits of worm gear one kind of mechanical gear is a worm gear. When significant gear reductions are required, worm gears are employed. Worm gears frequently have reductions of 20:1, and in some cases, even 300:1 or more. A unique feature of many worm gears is that while the gear can readily turn the worm, the worm cannot turn the gear. This is due to the worm's extremely shallow angle, which prevents the worm from spinning when the gear

tries to spin it. Instead, friction between the gear and the worm keeps the worm in place. Worm gears are used in an extremely intriguing way in the Torsion differential seen in certain very fast automobiles and trucks. a gear made up of a wheel with marginal teeth that meshes into a shaft with a spiral thread. This gear's toothed wheel is referred to as a worm wheel. Minimal construction conserves mounting area.

- Highly accurate.
- Runs forward and backward.
- High overload capacity and stable transmission with reduced vibration and noise.

4.5 Gas Sensor

In the modern technological environment, it is crucial to monitor the gases generated. Gas monitoring is essential for everything from electric chimneys and safety systems in companies to air conditioners in homes. Gas sensors are a crucial component of these kinds of systems. Gas sensors are tiny, similar to a nose, and they respond spontaneously to the gas in the environment, informing the system of any changes in the concentration of molecules in the gaseous state.

4.6 Microcontroller

The modern industry is moving more and more towards automation. Programmable controllers and robots are the two main parts of today's industrial automations. These days, there is a widespread trend towards the development of intelligent operations to help with laborious tasks and benefit humanity.

The "PC based child rescue system from bore well" is a proposed system that is made to do many functions in a harsh industrial setting. The GSM modem and Pic microcontroller are used intelligently. This project is unique in terms of technological development. This prototype system can be developed to meet the needs of commercial, industrial, and research applications while still operating successfully and efficiently.

The microcontroller, which powers all of the associated sub devices, is the central component of the apparatus. As a microcontroller, we have utilised. It has reprogrammable memory of the flash type. It can play this project and perform with a few auxiliary devices. Additionally, it supplies enough power to built-in peripheral devices. We do not have to provide each device something different.

4.6.1 Advantages of microcontroller:

The benefits of microcontrollers include

• Because microcontrollers are compact and inexpensive, they can be integrated into any kind of device.

• Microcontroller programming is easy to learn. It's not too difficult.

• We can view the real-world outcomes of our programme on computers by using simulators. Therefore, we don't even need to purchase the necessary chips and components in order to work on an embedded project. As a result, we are able to observe our project or programme in virtual reality.

4.7 LCD

Materials used in liquid crystal displays (LCDs) combine the characteristics of crystals and fluid. Instead of having a melting point, they have a range of temperatures where the molecules are nearly as mobile as they would be in a liquid yet are arranged in a crystal-like structure. An LCD is made up of two glass panels separated by a liquid crystal substance called sand. Transparent electrodes are applied to the inside surface of the glass plates to specify the character, symbols, or patterns that will be shown. Between the electrodes and the liquid crystal are polymeric layers that allow the molecules to maintain a specific orientation angle.

4.8 Crystalonic Display

There are two types of crystalonic dot matrix (alphanumeric) liquid crystal displays: TN and STN. They can be purchased with or without a backlight. Little power is used when C-MOS LCD controller and driver ICs are used. These modules can communicate with microcontrollers or 4- or 8-bit microprocessors.

5. Applications

As a bore well child saver: The machine's primary use is in the child's extraction from the bore well.

As a pipe-cleaning machine: This apparatus is suitable for cleaning pipes. It has the ability to manoeuvre through lengthy pipes and can effectively clean unclean pipes thanks to a rotating brush installed as an end effecter up front. The premium wheels can hold on the damp surface even though the inside of the pipes may be damp and slick.

As a pipe inspection machine: In the pipe manufacturing industry, the finished product must go through an inspection process to ensure quality control and prevent leaks in pipes. Additionally, oil and gas pipelines must be free of damage and leaks of all kinds because any kind of accident could cause enormous destruction. This inspection machine, which is equipped with specialised inspection tools including sensors and x-rays, can examine pipelines and find any kind of flaw that might be the cause of a major accident.

5. RESULTS & CONCLUSION

By including more components in the project, we will be able to use it for several applications in the future. By attaching a temperature sensor to the robot, we can obtain the temperature of hazardous areas directly from the personal computer. This eliminates the need to send people there and deal with issues on the ground. Instead, we can send robots there, and the sensor will measure the temperature. It will then provide the information to a microcontroller, which will then relay it to a transceiver, allowing us to obtain the data from the PC.

We can obtain information on the quantity of gases or smoke in specific fields, such as coal mines or dangerous zones, by attaching a smoke sensor to the robot. Information is sensed by the sensor, sent to the microcontroller, which then sends the information to the receiver, which allows us to access the data on our personal computer.

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