International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 4 Issue 06, June-2015

Design and Fabrication of a Robot to Rescue a Child in a Bore Hole

Ch. Tejaswitha
M.Tech Student,
Department of Mechanical Engineering
QIS College of Engineering and Technology
Ongole-523272, India

Dr. M. V. Mallikarjuna
Professor,
Department of Mechanical Engineering
QIS College of Engineering and Technology
Ongole-523272, India

***Abstract* - The project aims in designing a "Design and Fabrication of a Robot to Rescue a Child in a Borehole" which is capable of moving inside the pipe according to the user commands given from PC. The project also used for Picking and Placing of objects based on arm design. The robot is operated through PC using wireless Zigbee technology and using wireless camera you can view both audio and video on the TV. This robot has a high power LED which acts as a light source when light intensity inside the pipe is low.**

Keywords: Design and fabrication of 3-arm robot, ZigBee technology, Rescue child in bore well.

I. INTRODUCTION

To improve security and efficiency of piping networks in industrial units, continuous 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. 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. These locomotion systems have main chassis 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.

A. The objectives of the project include:

1. Design and Fabrication of Pipe Inspection Robot.
2. Wireless controlling of Robot through PC using Zigbee technology.
3. Implementation of pick and place concept to the robot.

II. DESIGN AND FABRICATION OF PIPE INSPECTION ROBOT:

An in-pipe inspection robot composed of body, fore leg system, rear leg system and springs. The robot mainly employs aluminum as structural material. Fore leg system and rear leg system are symmetric. Each leg system consists of a DC motor, worm gear driving system and three legs. DC motor is prime mover which is used to drive the robot. Three legs of each leg system are arranged at an angle of 120 degrees to each other to move inside various pipe diameters which is shown in figure. Worm gear system is constructed by using a worm and three wheels. Worm is mounted on motor shaft which drives three worm wheels. Each leg consists of a belt drive and two wheels. Belt drive is used to transfer a motion from worm wheel to robot wheel. A CCD camera is installed on front part of the fore leg system and wireless control system is mounted on a robot body.

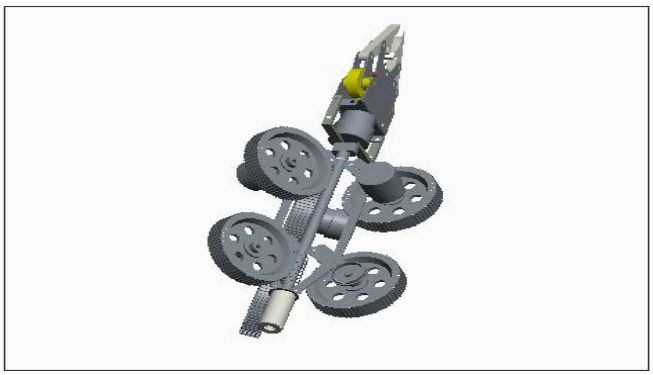

Fig 1 Model of the Robot

For inspection, robot is put into pipe. When electric supply starts, robot covers distance equal to perimeter of robot wheel and then it get stop. The ultrasonic sensor detects the cracks and damages in the pipe and it gives wireless data to computer. In this way we get size and location of crack from starting point on display screen of computer. During crack detection process, CCD camera does visual inspection of pipe and it gives an image of robot path in each crack detection cycle.

A. Analysis ofPipe Inspection Robot:

1. Selection of motor

Power required to robot to carry weight of W with v m/s speed is, ***P = W × v***. In worst case if only one motor is working then it has to give total power. Power required to two DC motors to drive the robot is, ***P required =2P***

2. Design of Motor Shaft

We can calculate the diameter of shaft following formula,

$$d^3 = \frac{16}{\pi \tau_{max}} \sqrt{(K_b M_b)^2 + (K_t M_t)^2}$$

Where, [Mt] = twisting moment, [Mb] = bending moment, Kt= torsional factor, Kb = bending stress factor
Now for shaft material, σut = yield stressτ = 0.5 σut,[τmax] = τ/fos
Checking for bending design shear stress is given by formulae,

$$[\sigma_d] = \frac{32\,[M_b]}{\pi d^3}$$

Where,
d = diameter of shaft (mm), Mb = bending moment (N-mm)

3. Design of Worm and worm wheel

System selection and Strength calculation to control abrasive wear and to provide continuous lubrication select close system.
Tooth profile: Involve profile for both
Pressure angle (α): 200, full depth system.
Quality of gear: To control seizure and pitting high quality precision gear is selected.

Checking for bending Bending stress (σb) is,

$$\sigma_b = \frac{1.9\,[m_t]}{m_x^3 \times q \times z \times Yv}$$

Check for Dynamic load (Fd), Static load (Fs)&Wear load (Fw)
Dynamic load (Fd):Fd = Ft × Cv
Where, Ft = tangential force (kgf), Cv = Barth velocity factor

$$\therefore C_v = \frac{6 + V_{mg}}{6}$$

$$V_{mg} = \frac{\pi d_2 N_2}{60}$$

$$d_2 = m_x z$$

Static load (Fs):Fs = [σb] × Yvww × b × mn
Wear load (Fw):Fw = Dg b Kw
Where, Dg = pitch diameter of gear (mm), Kw = wear factor (kgf/cm2)

4.Gear proportions

Worm: PCD of worm, d1 = q mx
Tip diameter (addendum), da1 = d1 + 2mx
Root diameter, df1 = d1 2fomx - 2c

Worm Wheel:
PCD of worm wheel, d2 = mxz

Calculation of spring stiffness (K): Spring stiffness = $\frac{\text{spring force}}{\text{maximum elongation of spring}}$

B. Design with PRO-E

The PRO-E Modeling application provides a solid modeling system to enable rapid conceptual design. Engineers can incorporate their requirements and design restrictions by defining mathematical relationships between different parts of the design.

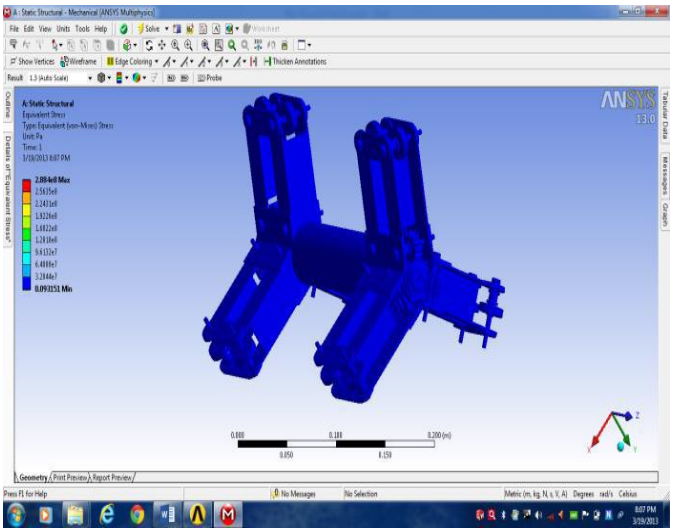

Fig 2 Model of Robot using PRO-E

C. Fabrication of ROBOT

Metal fabrication is the building of metal structures by cutting, bending, and assembling processes

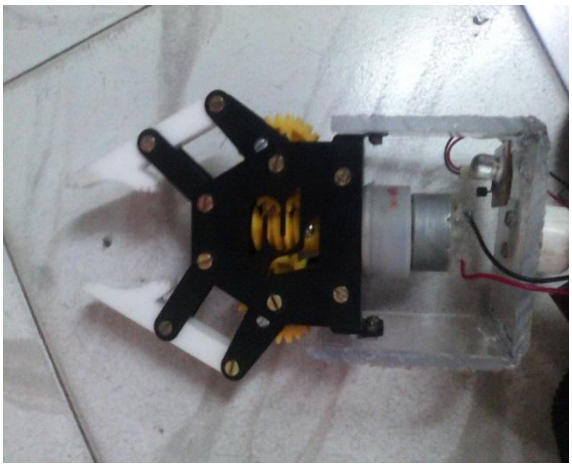

Fig 3 Robot gripper to pick and place objects

Fig 4 Complete Robot structure

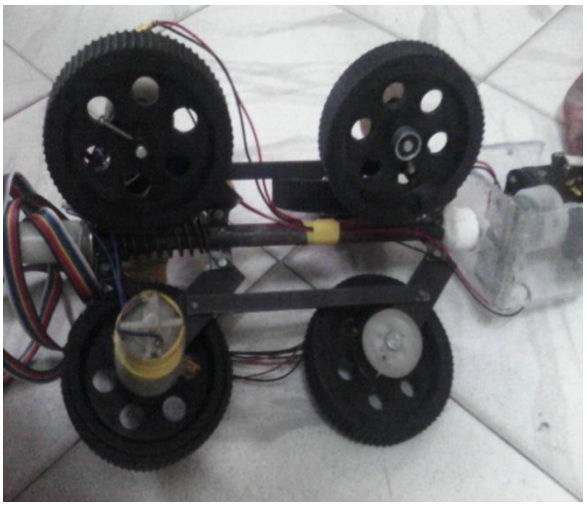

Fig 5 Wheel arms of the Robot

III. WIRELESS CONTROLLING OF ROBOT THROUGH PC USING ZIGBEE TECHNOLOGY

In this the block diagram of the project and design aspect of independent modules are considered. Block diagram is shown in fig:

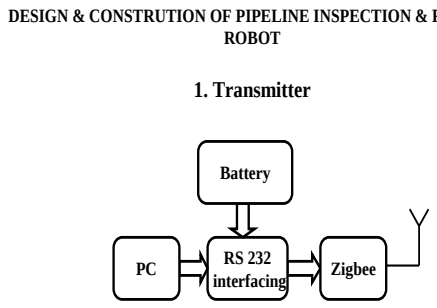

Fig 6 Block diagram of Transmitter

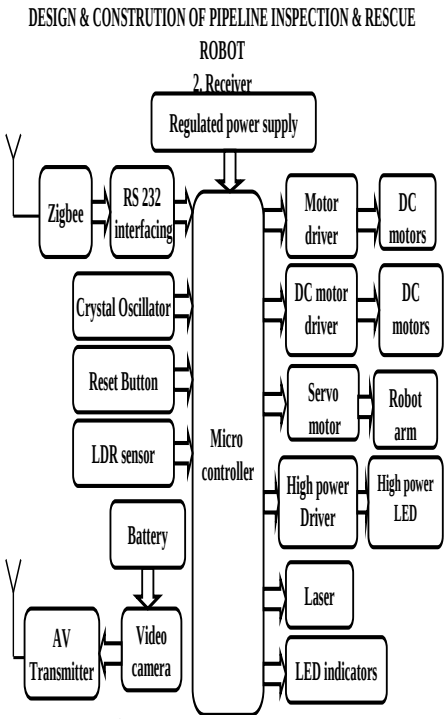

Fig 7 Block diagram of complete connections with the micro controller

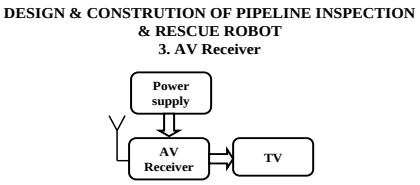

Fig 8 Block diagram of Receiver

A. The main blocks of this project are:

1. Micro controller (16F877A)
2. Reset button
3. Crystal oscillator
4. Regulated power supply (RPS)
5. High power LED
6. RS 232 cable
7. ZigBee module
8. DC Motors
9. DC motor driver
10. Wireless camera

B. MicroController

A Microcontroller is a programmable digital processor with necessary peripherals. Both microcontrollers and microprocessors are complex sequential digital circuits meant to carry out job according to the program / instructions. Sometimes analog input/output interface makes a part of microcontroller circuit of mixed mode (both analog and digital nature).

The microcontroller used in this project is PIC16F877A. The PIC families of microcontrollers are developed by Microchip Technology Inc. Currently they are some of the most popular microcontrollers, selling over 120 million devices each year. There are basically four families of PIC microcontrollers

1.PIC Microcontrollers:

PIC stands for Peripheral Interface Controller given by Microchip Technology to identify its single-chip microcontrollers. These devices have been very successful in 8-bit microcontrollers. The main reason is that Microchip Technology has continuously upgraded the device architecture and added needed peripherals to the microcontroller to suit customers' requirements.

*Low-end PIC Architectures:*12C5XX, 16C5X, 16C505

*Midrange PIC Architectures:*16C6X, 16C7X, 16F87X

C. Zigbee Technology

ZigBee is an established set of specifications for wireless personal area networking (WPAN), i.e., digital radio connections between computers and related devices. This kind of network eliminates use of physical data buses like USB and Ethernet cables. The devices could include telephones, hand-held digital assistants, sensors and controls located within a few meters of each other.

1.ZigBee Characteristics:

The focus of network applications under the IEEE 802.15.4 / ZigBee standard include the features of low power consumption, needed for only two major modes (Tx/Rx or Sleep), high density of nodes per network, low costs and simple implementation.

D. Regulated Power Supply & High Power LED'S

A battery is a type of linear power supply that offers benefits that traditional line-operated power supplies lack: mobility, portability and reliability. A battery consists of multiple electrochemical cells connected to provide the voltage desired. The process of converting a varying voltage to a constant regulated voltage is called as regulation. For the process of regulation we use voltage regulators. Regulated power supply is also connected to micro controller and LED's also connected to micro controller through resistors and motor driver connected to micro controller.

E. D.C MOTOR

A dc motor uses electrical energy to produce mechanical energy, very typically through the interaction of magnetic fields and current-carrying conductors. The reverse process, producing electrical energy from mechanical energy, is accomplished by an alternator, generator or dynamo. Many types of electric motors can be run as generators, and vice versa.The input of a DC motor is current/voltage and its output is torque (speed).

The DC motor has two basic parts: the rotating part that is called the armature and the stationary part that includes coils of wire called the field coils. The stationary part is also called the stator.

1.D.C Motor Driver

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

IV. RESULTS

The project "**Design and Fabrication of a Robot to Rescue a Child in a Borehole**" was designed to construct a Robot which is capable of climbing the pipeline. The robot was operated using computer wirelessly using ZigBee from a remote location and also such that Robot can move either Forward by pressing button 'f' or Backward by pressing button 'b', from the PC through the Hyper Terminal. This robot has a high power LED which acts as a light source inside the pipe.

Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC's with the help of growing technology, the project has been successfully implemented. Thus the project has been successfully designed and tested.

REFERENCES

[1] Hun-ok Lim and Taku Ohki, "Development Of Pipe Inspection Robot"ICROS-SICE International Joint Conference 2009,

[2] H.R. Choi and S.M Ryew , "Robotics system with active steering capability for internal inspection of urban gas pipelines", Mechatronics, vol.26, no.1,pp.105-112,2002.

[3] C. Kemp, A. Edsinger and E. Torres-jara. 2007, Challenges for Robot Manipulation in Human Environments.IEEE Robotics & Automation Magazine, 2007 pp 20-29.

[4] Chen, H., Chang,L., 2012, Design and Implementation of a ZigBee-Based Wireless Automatic Meter Reading System PrzeglądElektrotechniczny (Electrical Review),pp 64-68

[5] www.mobiusconsulting.com

[6] www.wikipedia.com

[7]www.microchip.com