

Design and fabrication of wheeled pole climbing robot with high payload capacity

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Abstract. Nowadays Climbing robots are widely used in various applications in industrial and hazardous environment for inspection of vertical and inclined poles wiring on high voltage power transmission tower. Pole climbing for fixing any issues related to power transmission lines, bridge repair and maintenance, climbing trees, climbing lamp posts etc. In this paper aims in designing of Pole Climbing Robot (PCR). These types of climbing robots can be used for inspection as well. In this robot pair the smart phone with Bluetooth module connected to embedded system. Then using the graphical interface in android application able to give instructions to move up or down or stop moving performance. These commands are received by Bluetooth module and give corresponding instructions to arduino of the embedded system board, which, depending on the code in it drives the motor driver accordingly. The benefits of this work are to save human lives as numbers of people are died from electrical injuries almost every year. In Pole Climbing Robot (PCR) previous researches on climbing robots all around the world focused mostly on Wall Climbing Robots (WCRs) and only a few research works were performed on Pole climbing Robot(PCR's).

1.Introduction

The motivation behind this venture is to plan and assemble a robot that have fit for climbing a pole and do certain work. This paper depicts the outline of wheeled pole climbing robot with high payload limit. This outline having points of interest to climb a pole with wheel. A climbing robot is that kind of robot that can help people to climb poles or potentially to convey an instrument or gear at development or hazardous place. Plan and movement of PCR's can be influenced by the execution of robot so in this manner, steadiness assumes a vital part to stable robot while moving to a pole. The most vital thing is steadiness that ought to be considered while working of robot. Climbing robot is exceptionally valuable when an errand is required to perform. Wheeled post climbing robot has different points of interest like it is a quick moving robot in light of the fact that set up of actuators we will utilize wheels for both the getting a handle on and climbing the shaft moreover. Climbing robot has different applications in modern and dangerous condition. The most well-known application which is generally utilized by Pole climbing robot that is repairs of energy transmission lines, scaffolds and support of lamppost and climbing tree. Cleaning of electric lights on lampposts in parkways is remarkable and new errands. There are so many Pole climbing robot which is purely based on mechanical which can take humans. The usual solution to camera surveillance is preinstalled cameras.



Haruhisa Kawasaki, [1] had mentioned about the climbing method, which will be driven by servomotors with worm wheel reduction mechanism. In this mechanism, they had used two wheels so rather than more, so that there will be possibility of slipping. More wheels contribute more stability. Xu Fengyu, [2] have shown rod climbing robot which was specially designed to detect the internal steel wire fractures in the suspension bridges. However, the moving wheel of cable climbing robot will be attached to the surface of the cable by vacuum suction. They consist of one driving trolley and two driven trolleys. Rajesh kannan, [3] represents android wireless pole climbing robot, we will pair a smart phone with Bluetooth module which will be connected to the embedded system because that is also a part of robot. In android application we can give the commands so that it will work accordingly such as move up, move down, move right, move left. These all the commands are received by Bluetooth module. Moloy das, [4] had proposed about pole climbing robots that have ability to climb on pipes. The specialty of this robot design is that, there is no use of DC motor for climbing on a pipes and pole. The use of DC motor will be risky in high altitudes, if power failure happens in between while climbing then, robot will fall on the surface. So in places of motors, we can use two pneumatic cylinders as linear actuator, which will work for grasping the pole. This type of robot can be teleoperated mode. This type of robot should have less expensive and light in weight. In this robot, every grippers will be actuated by the pneumatic cylinder. The main purpose of selecting pneumatic cylinder because of its light weight, less expensive and load carrying capacity. S. C. Lau [5], have mentioned about Slider crank based climbing robot, which was designed to move upward and downward of pole perimeter. In this climbing mechanism they have used two types of mechanism; first one is continuous and step by step climbing mechanism. M. I. Nor Faizal [6], speaks about post like tree climbing robot, however shaft climbing robot is like tree climbing, yet in this robot the moving movement is extraordinary, they utilized two grippers, those are upper gripper and lower gripper, when the climbing movement begins bring down grippers discharge and climbing module contract upwards and bring down gripper come back to grasp again and process continue continuation. This robot has played an essential and indispensable part in industrial areas. Rajesh kanna [7] mentioned about the design and development of rope climbing robot with the help of four bar mechanism which enables the robot to climb in an inclined rope way. The main aim of this robot to climb by using of identical pair of four bar mechanism with 180 degree phase shift. The study of rope climbing in motion reveals that the robot uses its legs to climb on the rope, those legs having gripper in it. There are some disadvantages of this robot, it's like the wheel rope climbing robots require smooth rope for locomotion. This is type of robot needs more power to climb on the rope. This robot contains two different methods of modeling, those are mechanical modeling and electrical modeling. Mechanical modeling deals with design of 4 bar mechanism and electrical modeling deals with selection of motors. Zaidi Muhammad Ripin [8], have portrayed about the plan of climbing robot which comprises of two grippers for getting a handle on and another two focal arms are for climbing. The climbing pace of this robot will be controlled by the rate of filling the pneumatic cylinder. Sara Mahdavi [9], his paper demonstrates the three sorts of development of nonholonomic wheel climbing robot. This robot will give better mobility. This sort of robot has capacity to hop on ferrous and non-ferrous pipes and in addition post, it doesn't rely upon attractive force. Pongsakorn Polchankajorn, [10] his paper speaks to the investigation of the factor that influence the shaft climbing effectiveness of robot on the tube shaped post with constant sweep. The getting a handle on drive is influenced by the helical span and helical pitch edge. In helical setup there are two parameters that essentially influence the climbing ability. The joint setup of the robot that can be found from the connection of helical pitch edge and helical range and connection length of the robot. Zhou Qing [11], has given the design of this climbing tower robot is mainly consist of two parts those are structure and control system, according to the tower environment, this robot had been designed for various purpose. The mechanical structure of this robot is composed of two under actuated grippers. The control system include a control box and the body communicate via wireless fidelity (WIFI). The design principle of the prototype is reasonable, and the structure of gripper is feasible however the control system is simple and it is easy to operate. Jae-Hee kim [12], have specified about an arrangement of robot that have 5 level of freedom (DOF) controller and two grippers which will move along the round and hollow channels and over the ribs. This robot is uniquely intended to move

up a splash channeling framework situated at control of atomic plants. For a robot before getting a handle on the pipe, robot should know the position and introduction of pipe as homogenous transformation. Zahra bakhtiar Khalid [13], had made an electrical post climbing robot which will decrease the danger of human life the individuals who are chipping away at circulation lines. They had made shaft climbing robot which was taking a shot at the standard of direct motor. Haifei Zhu [14], had represent for biped climbing robot, in view of two criteria to assess the grips considering the qualities of climbing movement of biped climbing robot. biped climbing robot comprise of arm like serial body and grippers at both the closures of a robot, The fundamental point of this robot and commitment of this paper is to display criteria to assess each getting a handle on point inside the graspable locale, subsequently to help choose ideal getting a handle on designs to create the toehold grouping for biped climbing robot. Jean-christophe Fauroux [15], the reason for this paper is to depicted about the outline of robot, which is equipped for jumping on funnel shaped shapes. This robot utilizes self-locking idea for holding of tapered shape poles. Yisheng guan [16], for biped climbing robots, it is required that the grippers needs to lined up with the objective questions previously they get a handle on for climbing. In this paper we build up detecting framework by incorporating different sensor including a camera, a laser examining range discover and two ultrasonic sensors to distinguish relative setup of grippers as for target get a handle on. As of late 3DCLIMBER specialists have been investigated to conquer this type of issue which biped climbing robot is facings.

2. Methodology

In this work, methodology is separated from different sections, which are mechanical design, embedded system and testing.

2.1 Mechanical design

In this mechanical design, it includes the conceptual design of the robot, fabrication and finally assembly process.

2.2 Robot model

Figure.1 is going to show the part of robot created by using PRO-E software. This robot Structure is made of aluminium. this robot consist of three DC motor that have less rpm but higher torque, which is enough for gripping the poles or pipes, figure. 2 is showing the actual design and figure 3. is showing the testing of the robot.

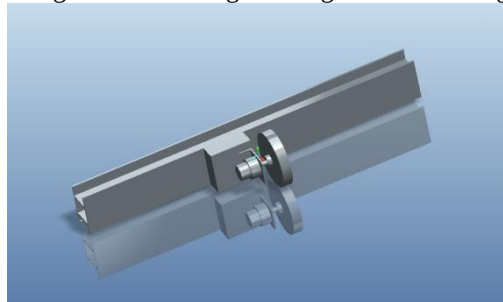


Figure 1. Part of robot

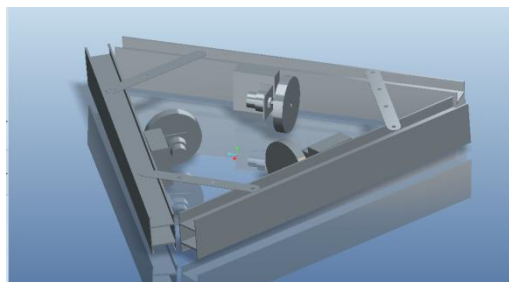


Figure 2. Actual design of robot

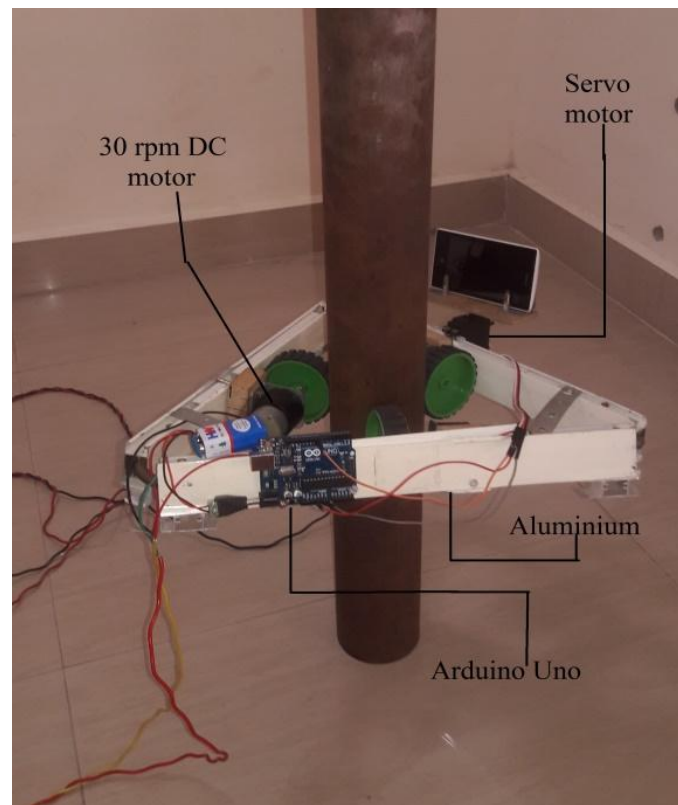


Figure 3. Testing of robot

2.3 Motor Selection

In this work, DC motor with high torque has been chosen as a climbing module and gripping module because it having higher torque and easy to control. Table 1. shows the specification of motor that has been used to control the movement of robot.

Table 1. Specification of motor

Motor	Specification
DC Motor	Speed - 30rpm Torque – 1.5kgcm Weight – 125gm No-Load Current - 60 Ma(Max) Load Current -300 Ma(Max)

3. Flow charts of methodology

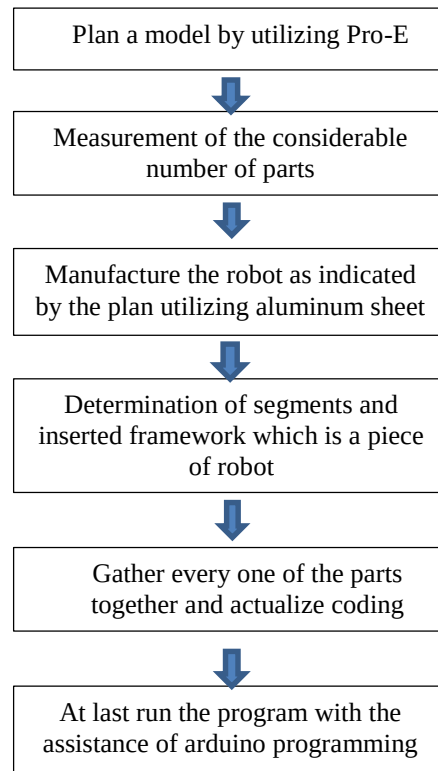


Figure 4. Flow chart of methodology

3.1 System Architecture

Figure 5 shows the system architecture of the robot. Arduino Uno is used as a processing unit to control three 30rpm DC motor. The electronic components used include 12V Lead Acid Rechargeable battery. The system has been designed in order to make the climbing robot run autonomously.

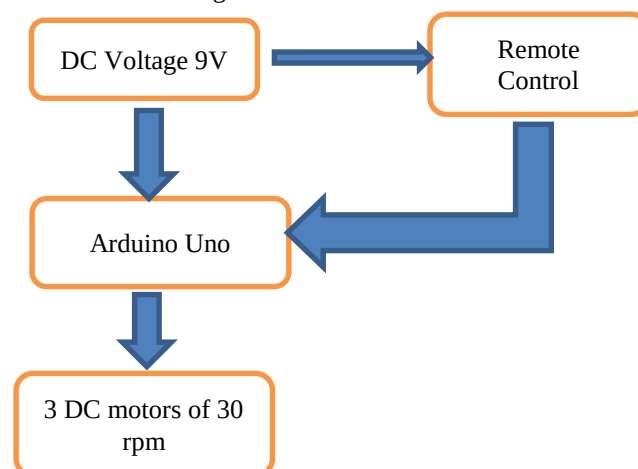


Figure 5. System Architecture

4. Experimental and Results

As we improved the design of robot and also increased the number of motors in connection with the help of controller it worked well. We have implemented smart phones on the robot as camera, we use IP Web cam android application, which works as a camera, with the help of this application we can do inspection and it is also used for security purpose.

5. Conclusion

Various designs have been made in earlier years for pole climbing robot. In this design we are going to use 30rpm Dc motors which have high torque for more gripping force. This will help to grasp the pole tightly so that the robot will be stable at the top of the height. Pole climbing robot which can lift a load up to 2 kg. The robot should be able to climb straight poles horizontally & vertically to fulfill all purposes.

6. Future Scope

The new approach and study of wheeled pole climbing robot, however the speed and payload capability are the main issues of climbing robot. Usual solution to camera surveillance is preinstalled cameras. Certain situations like sporting events, parades, festivals, riots and other gatherings of people require surveillance, but the preinstalled cameras are immobile. The solution to this problem is to make a robot that climbs a structure, like a lighting pole, and gets a high vantage point with a good overview of the crowd. To this unit a camera or other equipment can be installed. This project will research poles and other climbing options and with this research develop a pole climbing robot.

7. References

- [1] Ripin Zaidi M, Tan Beng S, Abdullah A B, Zahurin S 2000 Development of a Low-Cost Modular Pole Climbing Robot, *TENCON*. **1**, 196-200
- [2] C Balaguer, A Gimenez, J M Pastor, V M Padron and M Abderrahim 2000 A climbing autonomous robot for inspection applications in 3D complex environments, *Robotica*. **18**, 287-297
- [3] J Fauroux and J Morillon 2010 Design of a climbing robot for cylindro conic poles based on rolling self-locking, *Industrial Robot*. **37**, 287-292
- [4] A Sadeghi, H Moradi and M Ahmadabadi 2011 Analysis simulation and implementation of a human inspired pole climbing robot, *Robotica*. **30**, 279-287
- [5] G C Haynes, A Khripin G Lynch, and J Amory 2009 Rapid pole climbing with a quadrupedal robot *IEEE Int. Conf. on Robotics and Automation*. 2767–2772
- [6] A B Mehrabi, M Asce, C A Ligozio A T Ciolko and S T Wyatt 2010 Evaluation, Rehabilitation Planning, and Stay-Cable Replacement Design for the Hale Boggs Bridge *Journal of Bridge Engineering (Luling: Louisiana)*. **15**, 364-72
- [7] Y C Yu, K Yuan, W Zou 2008 Dynamic model of all-wheel-drive mobile robot climbing over obstacles and analysis on its influential factors (in Chinese), *Robot*. **30**, 1- 6
- [8] K H Cho, H M Kim, Y H Jin 2013 Inspection Robot for Hanger Cable of Suspension Bridge: Mechanism Design and Analysis, *IEEE-ASME Transactions on Mechatronics*. **18**, 1665-74
- [9] B Yazdani, M Nili Ahmadabadi, A Harati, H Moaveni, N Soltani 2004 Design and development of a pole climbing robot mechanism, *Proc. Conf. of Mechatronics and Robotics (Germany)*. 1285-1290
- [10] H Zhu, Y Guan, C Cai and L Jiang W 2010 climbot: A modular biped wall-climbing robot, *IEEE Int. Conf. on Mechatronics and Automation*. 1399–1404
- [11] Narayanan, S Vinoop, U Satish, M Yashwanth 2013 Autonomous tree climbing robot (Treebot), *Computational Intelligence and Computing Research (ICCIC) IEEE International Conference*. 26 - 28.
- [12] M Tavakoli, L Marques, A de Almeida 2011 *3DCLIMBER: Climbing and manipulation over 3D structures Mechatronics*. **21**, 48-62