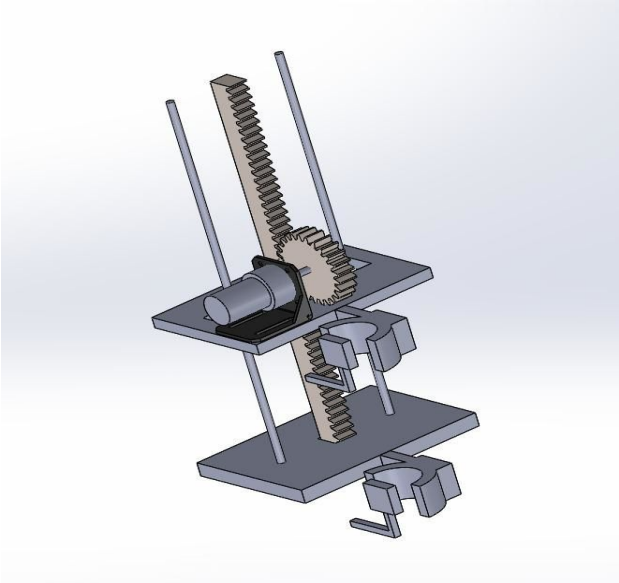
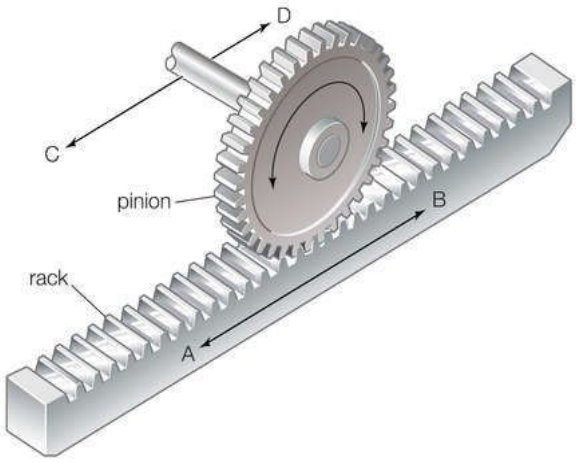
Models and Robotics Section(MaRS)
IIT Roorkee

# POLE CLIMBING ROBOT

# PROJECT REPORT






## A. Abstract

Pole climbing robot utilizes a rack and pinion system to perform vertical motion up and down a pole, with the caterpillar motion of the top plate and bottom plate. The robot can climb up the poles within a certain range of diameters. The robot is mounted on the pole, then the top plate clamp unclenches, the pinion is rotated up the rack and hence the top plate moves upwards while the lower plate remains fixed. Then the top plate clamp grips while the lower plate clamp is unclenched. Then the pinion is rotated such that the rack along with the lower plate moves up. Then the lower plate clamp holds the pole while the upper clamp unclenches, and the same motion is rotated again and again.

## B. Motivation

Electricians and workmen have to climb up an electric pole in case of a malfunction, this leads to several accidents. This can be avoided if a robot can be made to climb the pole and perform specialised functions. As a first step towards that, this robot has been designed to climb a pole. It can also be used for surveillance and fruit harvesting.

## C. Mechanical Aspect of the Design

The robot consists of a top plate connected to the pinion and a clamp whereas the bottom plate is connected to the rack and the lower clamp. The clamp is 3d printed and is specifically designed for this purpose. It is padded with a soft gripping rubbery material. It's grip is loosened or tightened using the motion of a lead screw. The two plate system is stabilised by two rods which pass through the top plate through linear bearings and are connected to the bottom plate.

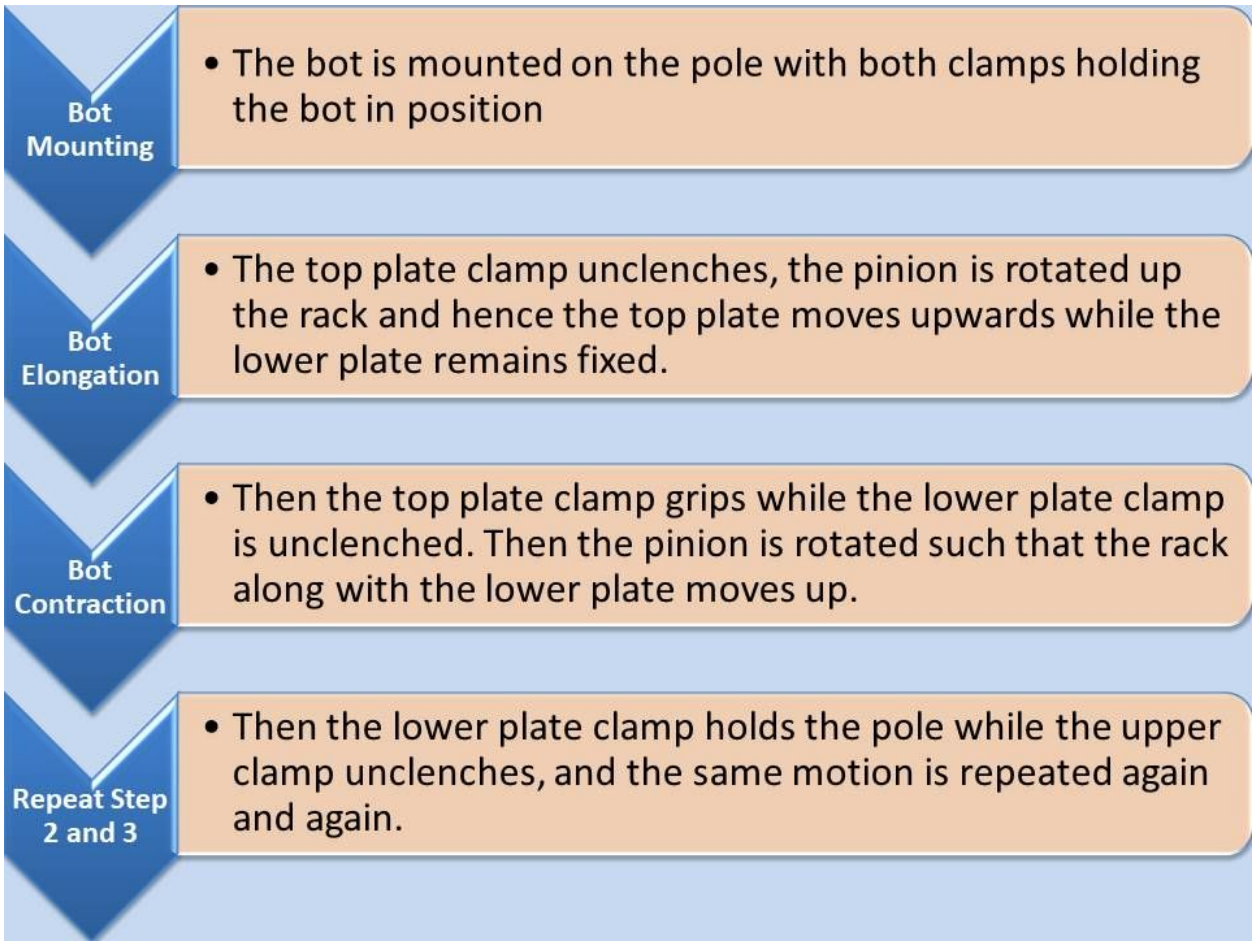
## D. Electronics Aspect of the Design

The microcontroller used is Arduino UNO and Cytron motor drivers. The pinion is rotated by a DC motor with an encoder. The lead screw of the clamp is rotated by a DC motor with an encoder.

## E. Cost Structure (In Rupees)

| Sr. No. | Equipment | Cost | Quantity | Subtotal |
|---|---|---|---|---|
| 1. | Arduino UNO | 500 | 1 | 500 |
| 2. | Encoder | 1500 | 3 | 4500 |
| 3. | DC Motor | 300 | 3 | 900 |
| 4. | Cytron MDD | 1700 | 2 | 3400 |
| 5. | Lead Screw | 450 | 1 | 450 |
| 6. | Brass Rod | 80 | 1 | 80 |
| 7. | Linear Bearing | 170 | 2 | 340 |
| 8. | Circular Bearing | 40 | 2 | 80 |
| 9. | 12 V Battery | 1500 | 1 | 1500 |
| 10. | Miscellaneous | 300 | - | 300 |
| | **Total** | | | 12,050 |

## F. Workflow


Bot Mounting
• The bot is mounted on the pole with both clamps holding the bot in position
Bot Elongation
• The top plate clamp unclenches, the pinion is rotated up the rack and hence the top plate moves upwards while the lower plate remains fixed.
Bot Contraction
• Then the top plate clamp grips while the lower plate clamp is unclenched. Then the pinion is rotated such that the rack along with the lower plate moves up.
Repeat Step 2 and 3
• Then the lower plate clamp holds the pole while the upper clamp unclenches, and the same motion is repeated again and again.

## G. Applications

1. Fruit harvesting: This bot can be used to climb us trees with slender stems, and can be mounted with a cutting device
2. Painting poles: With proper painting equipment, it could be used to paint poles
3. Cleaning lamp post: Several lamp posts become inefficient, after they become unclean and dusty,these robots can help clean them.
4. Accessing wind turbines or street light for inspection: Wind turbines are expensive and delicate, they can inspected using this bot, after mounting this robot with a camera
5. Surveillance: This robot can be used by defense services to climb up trees or poles to spy on enemy camps or for surveillance of our own camps.
6. Fix Telecom cables: Many accidents happen, while fixing telecom cables, they can be avoided by loading the requisite equipment on the robot.

## H. Limitations

1. The lead screw mechanism is slower than we'd desire.
2. The rack and pinion is slightly slower than the faster actuators like hydraulic and pneumatic.
3. The clamp design limits the width of the rod that can be climbed.
4. The bot's weight increases because of the several actuators and other parts.

## I. Future Improvement

1. Design a prototype at big size, which can be used for pole with different diameters and high payloads capability
2. Replace the grippers with a better gripping mechanism ( Ex: Soft robot gripper or more number of grippers to climb poles of any texture and diameter)
3. Remotely control the robot from a smart device.

## J. Team members

1. Akshara Singh
2. Nitika Gupta
3. Parag Garg
4. Sarthak Sharma

## K. Mentors

1. Aditya Raj
2. Rishika Chandra

## L. Proper References with link

1. Rack and Pinion mechanism: https://www.britannica.com/technology/rack-and-pinion

2. Lead screw clamps: https://in.misumi-ec.com/vona2/mech
3. Pole Climbing basics: http://engineering.nyu.edu/mechatronics/projects/ME7836/spring2017/Arduino/4mini1/report.pdf