

DESIGN AND FABRICATION OF LADDER CLIMBING LOAD CARRYING ROBOT

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering degree in Mechanical Engineering
By

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**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with grade “A” by NAAC

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of M. Bhargav (Reg. No. 37150031) and D. Venkata Sai Siva Kumar (Reg. No. 37150051) who carried out the project entitled "**DESIGN AND FABRICATION OF LADDER CLIMBING LOAD CARRYING ROBOT**" under my supervision from August 2020 to March 2021.

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1.

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DATE: 30.03.2021

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ABSTRACT

A robot is usually an electro-mechanical machine that is guided by computer and electronic programming. Many robots have been built for manufacturing purpose and can be found in factories around the world. Designing of the latest inverted ROBOT which can be controlling using an APP for android mobile. And in which we use Bluetooth communication to interface Arduino UNO and android. Arduino can be interfaced to the Bluetooth module though UART protocol. According to commands received from android the robot motion can be controlled. The consistent output of a robotic system along with quality and repeatability are unmatched. This robot can be reprogrammable and can be interchanged to provide multiple applications.

Robotic system having two arms that is suitable of motion in uneven surfaces as well as climbing ladders. Ladder climbing is an essential mode of locomotion for navigating industrial environments and conducting maintenance tasks in buildings, trees and other man-made structures. The motion of robot is mapped by hand movements. An Arduino board is used to control the wireless control whole operation. It collects data from the controller and sends it to the robot (wireless communication). The final product is an autonomous robot that is able to climb the ladder successfully. Main Frame, Rack, Pinions, Arms, MS Angle Guides, Threaded rods, Nylon Rollers with a bearing number 6201Z, Motor Support flat plates with drilled holes, D.C. High Torque Motors, Remote, Receiver, Battery, Battery Charger, Main Frame made of Mild Steel, Wiring.

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CHAPTER 1

INTRODUCTION

1.0 ROBOTICS

Robotics is the branch of technology that deals with the design, construction, operation, and application of robots, as well as computer systems for their control, sensory feedback, and information processing. These technologies deal with automated machines that can take the place of humans in dangerous environments or manufacturing processes, or resemble humans in appearance, behavior, and/or cognition. Many of today's robots are inspired by nature contributing to the field of bio-inspired robotics. Many robots do jobs that are hazardous to people such as diffusing bombs, exploring mines and shipwrecks. Ladders are present in our man-made environments. They are designed to help humans to bridge vertical distances easily. However, this man-made structure poses a serious challenge to vehicles and robots. Thus, in order for robots to operate efficiently and effectively in urban environments; this challenge has to be addressed. Autonomous ladder climbing robot has been the subject of ongoing research in the last few years. Most of the robots use only leg-like mechanism [1, 2], while some of them use track mechanism [3]. The main disadvantage of these mechanisms is that we cannot control the speed, inclination, and even if errors occur, we cannot correct it at that instant. As a result, a hybrid design is proposed here. The robot can move fast on flat surfaces and limb like mechanism is used to climb up and down ladders. It can climb ladders that are higher than the robot.

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A ladder is provided where vertical transportation and load carriage are confined to a small work space. For example, in various workplaces such as towers, manholes, tunnels, and bridges, workers often carry their own tools or equipment and climb ladders for maintenance or inspection tasks.

Ladders are used to transport loads to high places in warehouses, attics, etc. However, there are some disadvantages when using certain types of ladders in conditions such as steep slopes and narrow steps, when compared to stairs. Due to these disadvantages, when people climb ladders to transport loads, they are subject to various problems such as fatigue, difficulty to maintain balance while climbing, and the risk of falling of both workers and loads. Due to these factors, there is a generic limit on the size and the weight of a load that can be transported at one time by people using a ladder. To solve these problems, there have been several studies and developments with ladder-climbing equipment and robots for load carriage. However, most machines require special ladders or are designed to fit only a particular type of ladder.

Meanwhile, currently, there is no standard specification on ladders; thus, existing ladders have a range of rung intervals, inclination angles, etc., depending on each location and application. However, there are some existing robots that are capable of climbing ladders and that are designed to work on a diverse variety of ladders. However, these robots are not really designed to transport loads. Typically, they involve complicated mechanisms using many servo motors and are not sufficiently powerful to carry loads.

Therefore, in this study, we aimed to develop a ladder-climbing mechanism for a load-carriage device, which can be applied to various types of existing ladders. More specifically, the developed climbing mechanism could manage multiple parameter

variations due to the ladder diversity. In scenes that could not be transported by the ladder cannot afford the space and load capacity to both people and cargo climb, the ladder climbing device will lead to energy saving as alternative to forklift and crane.



FIG.1



FIG.2

Fig.1 & fig.2. Risk of falling & injuries

1.1 Robotic Part

At the robotic section, the main parts include six high power servo motors, a heavy base with four wheels, an Arduino board and a receiver. The motion of the whole system will be based on the movement of the hands. Based on the output from the controller part, the Arduino board moves the servo motors. There is no separate control for the wheels on the base. A heavy base is used to adjust the Centre of gravity to maintain the stability of the system. In accordance with the rotation of the servo motor, the robot is able to move either horizontally or vertically. Vertical motion of the robot is brought about with the help of two robotic arms which are fixed at the base. Vertical motion of the robot requires the use of a specially designed ladder whose dimensions are in accordance with the dimension of the robotic arm. Robotic arm

completely programmable and controllable through an Arduino board is used. Arduino software allows easy to use interface for movements and programming sequences. Once the sequence is programmed a program for Rhino Robot Controller Board or Arduino can be generated directly from software so that the arm can be controlled independently.

It can also be controlled through Rhino Robot Control Board, Arduino or any other microcontroller capable of driving six RC Servos to control the robotic arm directly. With optional Bluetooth module mounted on servo controller pcb – the arm can be controlled wirelessly over blue-tooth from PC. Apart from arm extra servos can also be connected to the controller Each arm consists of three links and is used primarily for climbing up and down the ladder. When the robot is not climbing the arms can be used as gripper to clear or remove unwanted obstacles in front of the robot or for transportation of items. It has one servomotor attached to each link.

1.2 Method of Climbing the Ladder

Before the robot starts to climb, it will have to be positioned in front of the ladder and ground with its two arms folded. This is designated as the initial mode or position. According to the motion of the user's hand, the robotic arms will move. The user will provide adequate hand movements so that the robot will keep one of its arms on the first rung of the ladder. He then makes the robot place its other hand on the rung. After placing both the hands on the first rung, first arm is detached and then placed on the second rung. Then the next arm is placed in the same manner. This process continues till robot reaches top of the ladder. Basic working principle includes working of both controller and robotic part. In the controller part flex sensors bend according to movement of user's arm. Resistance variations are produced which give rise to corresponding voltage variations (0-5V). These voltage variations are analog in nature. These analog values are mapped to corresponding digital values from (0-1023). This is due to the fact that AT Mega is an 8-bit processor. Analog to digital conversion is done

by an inbuilt ADC in Arduino controller. These values are converted or mapped to corresponding angle variations and transmitted using ZigBee transceiver. Power supply is given by USB connection from PC. In robotic part the ZigBee transceiver acts as receiver which receives the angular values and produces corresponding rotations in servomotors. Power supply is given by a battery source. On rotation of servomotors the robotic arm bends at different degrees initiating ladder climbing motion.

1.3 Electrical Wiring

- Electrical wiring is an electrical installation of cabling and associated devices such as switches, distribution boards, sockets, and light fittings in a structure.
- Wiring is subject to safety standards for design and installation.
- Allowable wire and cable types and sizes are specified according to the circuit operating voltage and electric current capability, with further restrictions on the environmental conditions, such as ambient temperature range, moisture levels, and exposure to sunlight and chemicals.

CHAPTER 2

LIETRECHER REVIEW

2.0 LADDER

- A ladder is a vertical or inclined set of rungs or steps.
- There are two types: rigid ladders that are self-supporting or that may be leaned against a vertical surface such as a wall, and rollable ladders, such as those made of rope or aluminum that may be hung from the top. The vertical members of a rigid ladder are called stringers or rails (US) or stiles (UK).
- Rigid ladders are usually portable, but some types are permanently fixed to a structure, building, or equipment. They are commonly made of metal, wood, or fiberglass, but they have been known to be made of tough plastic.

2.1. TYPES OF LADDERS

2.1.1 Rigid ladders

- Accommodation ladder is portable steps down the side of a ship for boarding.
- Assault ladder, used in siege warfare to assist in climbing walls and crossing moats.
- Attic ladder, pulled down from the ceiling to allow access to an attic or loft.
- Bridge ladder, a ladder laid horizontally to act as a passage between two points separated by a drop.
- Boarding ladder, a ladder uses to climb onto a vehicle. May be rigid or flexible, also boarding step(s), and swim ladder
- Cat ladder (US chicken ladder), a lightweight ladder frame used on steep roofs to prevent workers from sliding.
- Christmas tree ladder, a type of boarding ladder for divers which has a single central rail and is open at the sides to allow the diver to climb the ladder while wearing swim fins.

- Counterbalanced ladder, a fixed ladder with a lower sliding part. A system of counterweights is used to let the lower sliding part descend gently when released.
- Extension ladder or "telescopic ladder", a fixed ladder divided into two or more lengths for more convenient storage; the lengths can be slid together for storage or slid apart to expand the length of the ladder; a pulley system may be fitted so that the ladder can be easily extended by an operator on the ground then locked in place using the dogs and pawls. 65 ft (20 m), 50 ft (15 m) and some 35 ft (10 m) extension ladders for fire service use "Bangor poles", "tormentor poles" or "stay poles" to help raise, pivot, steady, extend, place, retract and lower them due to the heavy weight.
- Fixed ladder, two side members joined by several rungs; affixed to structure with no moving parts.
- Folding ladder, a ladder in the step ladder style with one or more (usually no more than three) one-way hinges. Ideal for use on uneven ground (e.g., stairs), as a trestle or when fully extended a fixed ladder. Some variations feature a central one-way hinge with extensible locking legs.
- Hook ladder or pompier ladder, a rigid ladder with a hook at the top to grip a windowsill; used by firefighters.
- Mobile Safety Steps are self-supporting structures that have wheels or castors making them easy to move. They sometimes have a small upper platform and a hand rail to assist in moving up and down the steps.
- Orchard ladder, a three-legged step ladder with the third leg made so that it can be inserted between tree branches for fruit picking.
- Platform ladder, a step ladder with a large platform area and a top handrail for the user to hold while working on the platform.
- Retractable ladder, a ladder that looks like a drainpipe but can be deployed instantly when required.

- Roof ladder, a rigid ladder with a large hook at the top to grip the ridge of a pitched roof.
- Sectional ladder, also known as a builder's ladder, has sections that come apart and are interchangeable so that any number of sections can be connected.
- Step ladder, a self-supporting portable ladder hinged in the middle to form an inverted V, with stays to keep the two halves at a fixed angle. Step ladders have flat steps and a hinged back.
- Swim ladder, a ladder used by swimmers to get out of the water, often on boats.
- Telescoping ladder, commonly used to refer to a hybrid between a step ladder and an extension ladder with 360-degree hinges; has three parts and can be taken apart to form two step ladders; e.g., Little Giant.
- Trestle ladder, an "A-Frame"-style ladder with a telescoping center section.
- Turntable ladder, an extension ladder fitted to rotating platform on top of a fire truck.
- Vertically rising ladder, designed to climb high points and facilitate suspending at said high points.
- X-deck ladder, a US patented ladder design that is a combination ladder and scaffold.
- Rigid ladders were originally made of wood, but in the 20th century aluminum became more common because of its lighter weight. Ladders with fiberglass stiles are used for working on or near overhead electrical wires, because fiberglass is an electrical insulator. Henry Quackenbush patented the extension ladder in 1867.

2.1.2 Flexible ladders

Rope ladders or Jacob's ladders are used where storage space is extremely limited, weight must be kept to a minimum, or in instances where the object to be climbed is too curved to use a rigid ladder.

- They may have rigid or flexible rungs.
- Climbing a rope ladder requires more skill than climbing a rigid ladder, because the ladder tends to swing like a pendulum.
- Jacob's ladders used on a ship are used mostly for emergencies or for temporary access to the side of a ship.
- Steel and aluminum wire ladders are sometimes used in vertical caving, having developed from rope ladders with wooden rungs.
- Flexible ladders are also sometimes used as swim ladders on boats.

2.1.3 Safety

- The most common injury made by ladder climbers is bruising from falling off a ladder, but bone fractures are common and head injuries are also likely, depending on the nature of the accident.
- Ladders can slip backwards owing to faulty base pads which usually fit into the ladder stiles. If badly worn, they can allow the aluminum to contact the ground rather than plastic or rubber, and so lower the friction with the ground. Ladder stabilizers are available that increase the ladder's grip on the ground.
- One of the first ladder stabilizers or ladder feet was offered in 1936 and today they are standard equipment on most large ladders.
- A ladder standoff, or stay, is a device fitted to the top of a ladder to hold it away from the wall. This enables the ladder to clear overhanging obstacles, such as the eaves of a roof, and increases the safe working height for a given length of ladder because of the increased separation distance of the two contact points at the top of the ladder.
- It has become increasingly common to provide anchor points on buildings to which the top rung of an extension ladder can be attached,

- especially for activities like window cleaning, especially if a fellow worker is not available for "footing" the ladder.
- Footing occurs when another worker stands on the lowest rung and so provides much greater stability to the ladder when being used. However, footing a ladder should be seen as a last resort for a safe placement.
- The anchor point is usually a ring cemented into a slot in the brick wall to which the rungs of a ladder can be attached using rope for example, or a carabiner.
- If a leaning ladder is placed at the wrong angle, the risk of a fall is greatly increased. The safest angle for a ladder is 75.5°; if it is too shallow, the bottom of the ladder is at risk of sliding, and if it is too steep, the ladder may fall backwards.
- This angle is achieved by following the 4 to 1 rule for a ladder placed on a vertical wall: for every four feet of vertical height, the ladder foot should move one foot from the wall.
- Both scenarios can cause significant injury, and are especially important in industries like construction, which require heavy use of ladders.

2.1.4 Ladder classes

- The European Union and the United Kingdom established a ladder certification system – ladder classes - for any ladders manufactured or sold in Europe.
- The certification classes apply solely to ladders that are portable such as stepladders and extension ladders and are broken down into three types of certification.
- Each ladder certification is color-coded to indicate the amount of weight the ladder is designed to hold, the certification class and its use.
- The color of the safety label specifies the class and use.
- Class 1 ladder - for heavy-duty industrial uses, maximum load of 175 kg. Color-coded blue to identify.

- Class EN131 ladders - for commercial uses, maximum load of 150 kg. No specific color codes.
- Class III ladders - for light, domestic uses, maximum load of 125 kg. Color-coded red to identify.
- In the UK there are a number of British standards included in the three main ladder certifications relative to the particular ladder type.
- Relevant classifications include BS 1129:1990 (British) which applies to Timber Ladders and Steps; BS 2037:1994 (British) which applies to Metal and Aluminum Ladders and Steps and BS EN 131:1993 (European) which applies to both Timber and Aluminum Ladders and Steps.

2.2 TYPES OF LADDER CLIMBING DEVICES

2.2.1 Ladder climber

This paper presents a new robot for climbing a ladder. The new climbing mechanism which we called the “Ladder Climber” is based on pendulum type. The key mechanical elements consist of a mover with crawlers and a pendulum with a heavy load. The rolling crawlers attached to both sides of the mover are driven two actuators placed on the pendulum. The actuator torque is transmitted to the climbing mover by using a timing belt, which makes the mover climb up the ladder slope. At the same time, the torque makes the pendulum swing with small oscillations and keeps the angle of the pendulum constant. First, we introduce the advantages of our mechanism by comparing it with traditional climbing carts. Next, in order to explain the mechanism, we derive the dynamical model of our robot, and discuss natural frequency, static stability, and dynamic stability. Then we develop our prototype, the “Ladder Climber” and present the result of a basic experiment. Finally, we summarize our obtained results and future work.

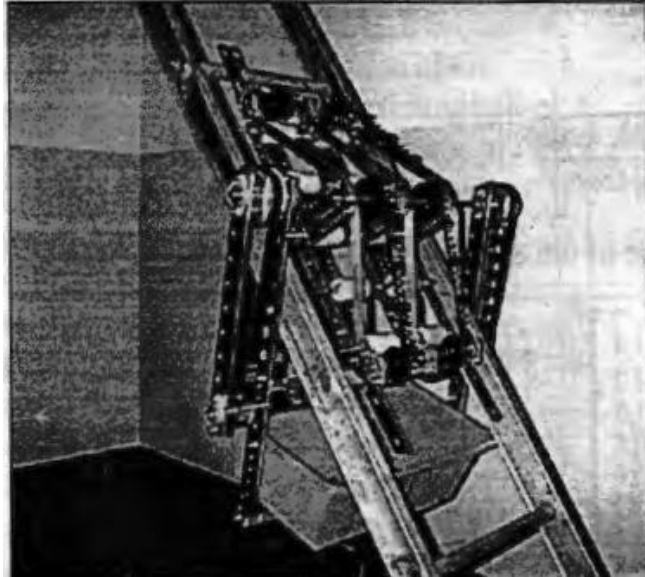


Fig.3. Ladder climber

2.2.2 Ladder climbing carrying device

Ladders are used in various places and for a variety of applications such as to access attics in houses, warehouses, plants, and sewage systems. This is because ladders do not need to be installed in large spaces or specific structures, as opposed to stairs. However, humans carrying heavy loads when using a ladder are subject to fatigue and the risk of falling. Therefore, various robots that are capable of climbing ladders to transport loads have been studied. However, so far, these robots were not designed to fit various types of ladders and were built with complicated mechanisms. Hence, in this study, we have pursued the development of a robot that is capable of climbing various types of ladders using a simple link mechanism. We created an experimental unit and verified its performance through simulation experiments using a configurable ladder in various inclinations and using different loads.

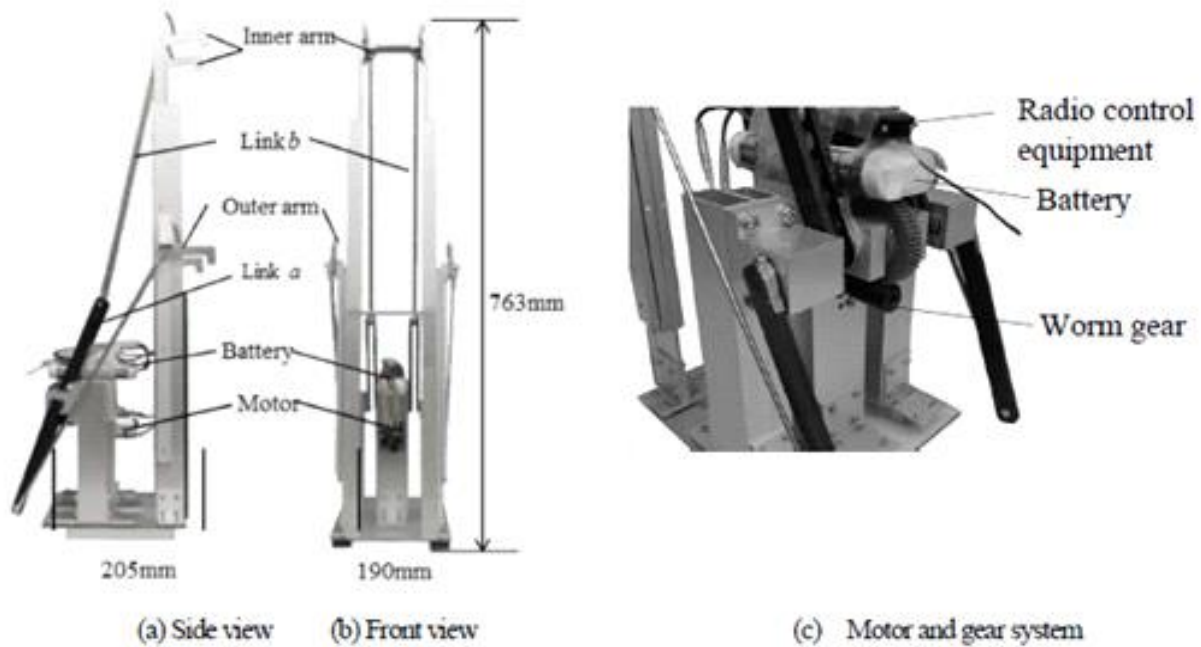


Fig.4. Ladder climbing carrying device

Roy et al.[1], detailed information about the very first jack which was been introduced in the automobile industry. The jack used earlier need much effort to lift the vehicle for changing the tire. But now the changing of the tires has been easy, due to the introduction of the new pneumatic jack. The working of that pneumatic jack was simple, the person just needs to connect the jack to the electrical driven compressor or compressor driven by engine doing so the jack use to get working the vehicle use to get lifted. The jack was stable and easy to operate. Inflation pressure for most standard-sized cars is in the range of 20-25 psig. The pneumatic jack was compact and so it can be stored within the spare wheel. Today's automobile offers limited space and uncertain lifting methods and so this offers the chassis engineer considerable freedom of choice.

Nitinchandra et al.[2], the study related to the toggle jack design, testing and result obtained with different materials. It was found that the toggle is compact and easy to use as compared to the other jack that are available in the market.

In this toggle jack it was found that the distribution of load is symmetric and uniform. The Toggle jack reduce the force required for lifting the vehicle in order to change tire or minor repair. The toggle jack design is simple and consist of the eight main components I.e., the four parts are power screw driven and other four parts are for loading conditions. Here the unique design of the toggle jack been introduced to lift heavy loads at the stable state with the unique conditions. The main parts of the toggle jack are screw and nut, the screw is the moving part and the nut is the stationary part. The materials of the screw and nut were been checked for different materials and loading conditions from 1kN to 5kN, it was found that the alloy steel for screw and phosphorus bronze for nut was the best suitable combination

Sainath. Etal.[3], the information about the basic jack along with the types of Jack's used in the automobile industry, the design procedure of mechanical hydraulic jack is also been studied. The classification of the jack is based on the forces employed, the mechanical jack includes car jack and house jack, the other is the hydraulic jack they are bottle jack and floor jack.

After the proper study and research, it was found that the hydraulic jack is stronger and can lift the heavy loads at the height required. The hydraulic jack are the most efficient and reliable jack available in the market, they lift the vehicle with the less human effort and with the help of the pressure generated inside the cylinder and oil present inside the cylinder. The calculation are been done in order to get the proper dimension of the jack and make the jack more efficient than the earlier.

Pawar etal. [4], the design of a screw jack and its automation are been introduced. The jack operation was easy and less effort was required to lift the jack it was also much more reliable than the usual basic jack that are manually operated and were used earlier. Now the modification are been done in the screw jack made the operation automatic I.e the motorised screw jack was introduce in the automobile industry, the jack was compact and much more reliable. After several studies and researches the screw jack it was been found that the jack was easy to operate, reliable, easy to move and store due to desirable size.

Asonye et al. [5], the study is about the design and fabrication of hydraulic jack using smart phone-controlled system and the jack is tested for its effectiveness by varying loads up to 5tons. The hydraulic jack available in the market are manually operated and required more efforts to lift the load. Taking into consideration the effort required for lifting the load which was not easy to operate the smart phone -controlled system for hydraulic jack was been introduced. This jack was smart phone ly controlled so its was easy to operate as compared to the usual jack available in the market. The main components used were a 12V battery, DC Motor, Crank lever mechanism. The aim of making this jack was to reduce the effort required to lift the load and make its easy and simple for operation at any loads. The results obtained were very effective and it was found that the time required to lift was minimum depending upon the weight, this smart phone controlled system jack was found reliable than the manual jack available in the market.

Sudarsan et al. [6], they have designed an automatic hydraulic Jack. The motive of design this project is to provide a button to lift heavy load, because there are mechanical Jack's which is difficult to operate and requires more effort and also the Jack are to huge to carry, during the tire puncher in the ruler area, hilly regions, forest area etc. It is difficult to charge the tire with the mechanical Jack, so they have designed an automatic hydraulic Jack which is easy to operate and carry. The automatic Jack is operated by pressing a button which is mounted on a dashboard.

Masiwal et al. [7], they have designed a hydraulic Jack for four wheelers, the purpose of designing this project is to reduce the mechanical effort and it helps to save lots of time while repairing the puncher tire as compared to earlier method. It consists of main components like piston cylinders which is welded on the chassis of vehicle. When the driver presses the brake pedal the pressurized brake oil passes through non-retune valve and move to the piston, the piston cylinder which result in lifting, the puncher side of the vehicle.

Jayapradha et al. [8], they have designed the hydraulic jack of self-jacking the main purpose of design is that the driver can operate inside the car itself and it also consumes less effort and time compared to mechanical Jack's. The hydraulic Jack are mounted on the frame and the motors are used to control the jack and it connected with the crankshaft and also the suspension springs are attached on the side, the 12v battery is provided to run the motor, the hydraulic Jack is operated by the help of button which is mounted on the dashboard. This project is easy to mount on chassis or frame and it's easy to servicing of vehicles. When the vehicle gets punctured this system is very helpful to replace the tires and no need to carry external Jack.

Sharvanan [9], lifting of Automobiles vehicle has used by built-in hydraulic jack it's consists of main parts like hydraulic cylinders, lead screw and solenoid valves. It's operated by pressing a button that has been provided on dashboard. The hydraulic jack is self-lubricated and fixed asset with a pump, which helps to a fluid to force into a cylinder. A vehicle is lifted by the help of lead screw and the DC motor. The main motive to design this project is to reduce the human efforts while lifting of a vehicle.

Kamalakkannan et al. [10], they have fabricated the manually operated screw Jack to a motorized screw jack to lift the heavy loads. The manually operated screw jack required more effort to lift the load compare to motorized screw Jack. The motorized screw Jack is easy to operate by pressing a given button to lift the loads, it is very useful in Automobile service Centre to service a car. The main reason to design the motorized screw jack is to keep away from the tiredness of a human during lifting of the load. The cost of this project is less and its efficient to operate.

Barewar et al. [11], they have fabricated a screw jack to automatic. The screw jack is a device which is used to lift the heavy loads with the application of small force. The effort which is required to operate the screw jack is made easy and reliable by using 12V DC motor, the motor works with the battery used in vehicle. The rotary motion is transferred from motor to lead screw through worm gear drive. The gear which is mounted on motor shaft is pinion and the driver gear is mounted on lead screw caused to transfer rotary motion. By fabrication of screw Jack, it is easy to operate and lift the heavy loads by pressing the switch.

Batriwala et al. [12], they have review on failure of screw Jack which is used to lift light motor vehicles during servicing. This review is mainly target that the how much scissor jack can sustain the load and also the stresses analysis and life of various parts like power screw, base plate etc. Their main aim is to make the Jack light and chipper and strength.

Brigham et al. [13], in UG engineering courses slider crank mechanism is used for examining machine kinematics and resulting dynamic forces. Determination of the position, velocity, acceleration, and shaking forces generated by slider crank mechanism during an operation can be obtained analytically. From analytical calculations certain factors are often neglected, that cause difference between results and experimental data. Record of kinematics and Dynamics forces data during operation can be made which can be further compared to analytical values by mounting transducer to mechanism.

Chandrakarv et al. [14], in the field of mechanical engineering the mechanism which is mostly used is slider crank mechanism. Combustion ignition and spark ignition engine use slider crank mechanism and in today's era it plays absolute necessity. Over past 20 years, extensive work has been conducted in the study of dynamic behavior of interconnected rigid or flexible bodies, i.e., kinematics and dynamics effects of the slider and crank mechanics. Design software such as MSC. ADAMS were used to develop the simulation model of slider and crank mechanism. Response of reaction forces at joint between crank shaft and connecting rod is observed by performing simulation at different crank speed. An artificial intelligence technique predicts the design parameter based on simulation model.

Venkateswarlu et al. [15], Power electronic converter controls various electrical machine-like DC motor, brushless DC motor, permanent magnet DC motor. With the invention of micro controller and power devices like IGBT, power MOSFET controls have become more precise. An attempt to imitate the appearance or character of a speed control of separately excited DC motor with PID and fuzzy controller has come in light in this paper. Providing efficient method to control speed comprehensive study of modelling analysis and speed control design methods has been demonstrated in this paper. Fuzzy controller for comprehensive study of modelling

analysis and speed control design method has been demonstrated with the availability of MATLAB/SIMULINK.

Tae – Yang et al. [16], a light weight library to develop Bluetooth related application in Android environment for wireless sensor network is presented. Enquiry, authorization and connect are some basic steps which can be applied for Bluetooth based communication. Beginners find the development difficult to handle Bluetooth even though google provided a Bluetooth handling API as an Android SDK and a tutorial. For an ease to use API in Android platform considering the difficulties, to help developers develop Bluetooth application easily they designed a standard library which is called Mosca Bluetooth.

Yang-Hang et al.[17], location of target or cell phone position from the measured RSSI (received signal strength Indication) strength is abled using the built in Bluetooth in the cell phone as the positioning device. In this paper, the use of 3-point localization method helps to determine the location of a target node, 3 RSSI values are collected from 3 test points in this method.

Kshirasagar et al. [18], unknown special characteristics of co channel interference which were discussed till date are revealed in this paper. In Bluetooth piconet, master's device address and its native clock determine the channel hop frequency at any instant of time. The Bluetooth device address and the asynchrony among their native clock determines the packet interference rate in a certain cluster of Bluetooth masters.

Poonam et al. [19], Bluetooth Based Smart Automation System Using Android, in this project they focused on to reduce human effort. As the word automation is automatic control of operating devices which helps to reduced human efforts. In today's world, wireless technology plays important role in the automation. Home automation is one of the technologies emerging these days. It can be operated with in 100m and the Bluetooth which is mainly used for data exchange, the idea behind this paper is to control home appliances like lights, fan and also it provides home security and emergency alerts to be activated. It also helps in saving the energy at the night. This project is not going to help common people but also it helps disable and senior

citizens.

Cotta et al. [20], the transfer of information between 2 or more points that are not connected by an electrical conductor is called wireless communication. Among wireless technologies radio is most commonly used. IR wireless communication, satellite communication, broadcast radio, microwave radio, Bluetooth, Zigbee are different types of wireless communication. Wireless communication using HC 05 Bluetooth module, network topology and interfacing Bluetooth with Arduino has been discussed in this paper.

Wadhani et al. [21], the brief idea about the use of IoT (internet of things) and how this technology been used in day to days life making the life of the human being easy and simple. IoT is the technology which is related to all the wireless devices which controls the several devices from one device, the project has made use of this IoT technology in automation of smart home and security techniques. The Arduino is used for interfacing the sensors. The components in use are Arduino UNO Board, Relay, DC Motor, Flex sensor, Wi-Fi Module, Reed Relay sensor, Flame sensor, Accelerometer, Arduino IDE, LDR. The electronically control device data is been uploaded on the cloud and control through the programmed wireless device. The aim of the project was the application of IoT in smart home automation and security system making the home more secured for human beings.

Kang et al. [22], the project is about the IoT (Internet of Things) along with uses and application. The user has to just provide the input and the output is obtained it may be work done or machine or some other wireless device. Due to this IoT technique may several devices can be controlled through one single device for this both the device is connected to the same network. The study gives the idea of how IoT is used everywhere and made reliable for use. Using this technique, the user just needs to provide command feed and the other side we get output within in seconds, for e.g., if an operator gives input to operate the machine using a wireless device the operator command is passed on the machine and the machine does the job. With the use of IoT the user can get the output or work done with or without His/her presence.

Bhagat et al. [23], the study of IoT and its application in the automobile sector. As now the car

parking has become the most major problem, to park car in public places like market place, malls etc. the driver needs to first find out the empty space in which the most of the car fuel gets used just only to find the space for parking a car. This IoT technology has solved this problem of finding the space for car parking at public. The operation is simple as soon as the car enter the parking place the systems detect the empty space and informs to the system and then space gets reserves the space by not allowing the many user to reserve the same parking space, to avoid the multi-user approach problem (MUAP) during parking reservation procedure the system has a Multi-Queuing Mechanism (MPQM)

CHAPTER 3

AIM AND SCOPE OF THE PRESENT INVESTIGATION

3.0 Project objective

- Two objectives should be achieved from this project:
- To design a new safer ladder climbing mechanism that is high stability and portable.
- To fabricate and test the prototype of new ladder climbing mechanism. The fabrication processes involve various processes. The test run analysis of the new ladder climbing mechanism done by applying load and tries to lift it up. It will show whether the ladder climbing mechanism can work effective and smooth or any problem occurs.

3.1 Project Scope

- This project fabricates the prototype of ladder & ladder climbing mechanism. The mechanism parts are not in original sizes. Otherwise, the shape and design of each part is closely similar with the original design. Since we only fabricate the prototypes, during the test section, the maximum load apply is lower than what we expect for the exact design.
- This new design of ladder climbing mechanism can reach up to a certain height. The parameters and design of each part depends on these scopes. A mechanism which clearly can reach this scope level is select and chosen.

- This new design of ladder climbing mechanism is for heavy-duty work. The design and selection of material element and parameters depends on this scope which can undergo heavy-duty work. The cost and processing time can be due to this scope.
- This new design of ladder mechanism is suitable for load carriage applications. Since the function is for heavy-duty work, we expect that this new ladder climbing mechanism design is suitable & used for indoor/outdoor tasks.

3.2 Present Investigation

- Nowadays, many ladder accidents were happened causing by using a portable ladder which is unstable and unsafe of design and mechanism. These mechanical problems can influence our health and life. So, this project is to develop and design a new mechanism of ladder which is stable and safe to apply without worry about an accident. There are six problems or factor that's making or causing a ladder unstable and unsafe to use:
- The ladder base may slip out of position when the ladder is at wrong angle, workers climb too fast or the surface below the ladder is wet, bumpy or uneven. Ladder must be use at exactly preferred angle. Liberty Mutual researchers found that adjusting a ladder's angle a mere 10 degrees from 75 to 65 degrees almost doubles the friction required to hold the ladder in place. If you increase the worker's climbing speed, the friction required jumps again by 7 percent. However, in the real world, most workers have no way to measure ladder angle. In fact, several studies show that when workers set up a ladder at 75 degrees without a measurement device, resulting angles vary from 67.3 to 76.2 degrees. This condition can cause a ladder accident. The slip resistant feet also cannot work properly if the angles are wrong or the floor is in slippery condition.

- Nowadays, ladders are less of stability during their applications. For example, we have to be careful for the whole of a job when using the ladder. We need to balance our body position on the ladder which has to limit our motions and movements. It's hard to make two jobs instantaneously. This situation will increase the probability of ladder accident.
- All ladders today required the user to climb on it. We may lose our step or stability during climbing up the ladder especially when carrying a tools or materials. So this condition exactly will influence the users balancing and causing the ladder not stable and safe in design and mechanism. There are many ladder accidents occur because of the ladder has not been secured and starts to slip. An unsecured ladder is often made more unstable by the practice of climbing while carrying loads and of overreaching and overbalancing. Climbers are frequently hit by passing carts, cars and even trains.
- In some cases, federal codes require spotters and barricades. Ladders propped on top of another object to gain height or convenience often move. If the floor surface or the upper surface is slippery, the ladder may slide away from the climber. That's why the ladder mechanism is not safe to apply. When we climb up the ladder, an increasing of height level is constant due to the distance between the rungs of the ladder. We cannot reach the exactly height. Fixed height problem that occurs tends user to make much movement on the ladder in order to reach the desired level. This situation will make the ladder less stability and unsafe to use.

CHAPTER 4

EXPERIMENTAL OR MATERIALS AND METHODS ALGORITHMS

4.0 Experimental of Prototype Model

As there is a responsibility to safeguard human from injuries those who are climbing ladders with loads, we are adopting the ladder climbing carrying robots to transport the loads to required height.

As we already discussed, there are many robots are designed and fabricated, but as if they are not provided with simple mechanisms & that costs high to a common man, we are implementing very less and effective operating mechanism and transport loads from one place to another place.

Finally, we are going to fabricate a ladder climbing carrying robot which performs all the functions that other ladder climbing carts/robots does.

The main asset of this project is “Ladder”. The robot comprises of Main frame, Upper arm, Lower arms, Threaded rods, Hollow cylindrical shafts, Guide ways, Rack & Pinion, Flat Plates, , Nylon Rollers, D.C. Motors, Battery, Remote, Receiver, Wiring and finally a programmable/configurable data for a perfect operation with remote.

This is very compact in size and efficient.

These possess simple structure and less weight.

This provides safer transportation of loads and helps mankind an effortless operation

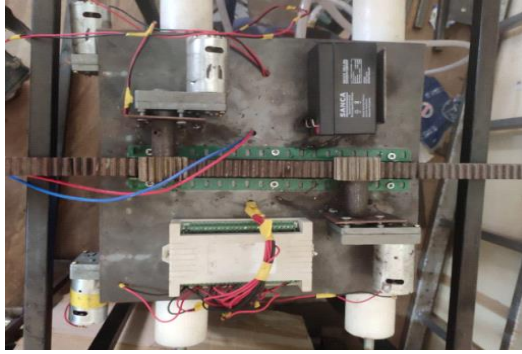


FIG.4.1 VIEW OF LADDER CLIMBING CARRYING ROBOT



FIG.4, 2 LADDER CLIMBING CARRYING ROBOT ON LADDER

4.1 Working Methodology

- Initially arms attached with the body will hold the ladder by rotating +90 Deg.
- Pinion on body will rotate to ascend the rack to next level of ladder, once the rack top reaches next level of ladder, pinion will stop rotating.
- Arm mounted on top end of the rack will hold the ladder by rotating +90 Deg.
- Now arms attached with the body will release ladder by rotating -90 Deg.
- Pinion on the body will rotate in reverse direction to descend the rack.

- However, the upper end of the arm is held at next level of ladder the body will be dragged to the next level of ladder.
- Once body reaches next level arms attached with the body will hold the ladder by rotating +90 Deg and Arm mounted on top of the rack will release ladder by rotating -90 Deg.
- The process will continue till the desired level of ladder is reached.
- In this project ladder climbing process is achieved by movement of rack and holding arms.
- Pinions and arms used in this project are driven by box type high torque geared DC motors.
- Rack is guided by MS guides on both the sides to avoid side wise movement.
- Entire operation is carried out by using remote control.
- Battery mounted on the body will power the drive motors attached to arms and pinions.

4.2 Adriano Controlling System

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). A Software Serial library allows for serial communication on any of the Uno's digital pins. The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

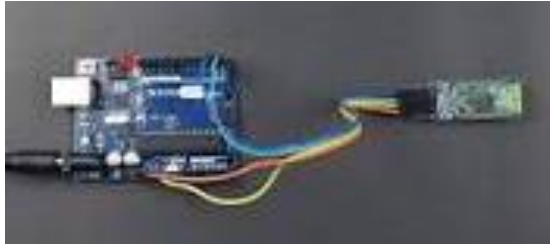


Fig: 4.3 Arduino Uno

4.3 Bluetooth Module

Arduino-Uno board doesn't support Bluetooth connection on its own, which makes the idea of connecting it wirelessly to an Android device impossible. So a medium between the Arduino-uno board and android device is needed and in this project it is a Bluetooth module specifically the HC-05 Bluetooth module. The HC-05 is a user friendly need only basic knowledge and it is programmable using the AT commands.



Fig: 4. 4 Bluetooth connection

4.4 Software Implementation

The programming operation was performed by C language using arduino IDE. Every program had its special function. The Arduino language is merely a set of C/C++ functions that can be called from your code. Your sketch undergoes minor changes (e.g. automatic generation of function prototypes) and then is passed directly to a C/C++ compiler.

4.5 Motor Driver L298

The drive circuitry for an H-Bridge is basically the electronics that sits between the PWM (and potentially other) digital control inputs and the MOSFET gates. It has two major purposes: ♣ Translate the input voltages to suitable levels to drive the gates. ♣ Provide enough current to charge and discharge the gates fast enough .



Fig: 4.5 L298d

H-Bridges are typically used in controlling motors speed and direction, but can be used for other projects such as driving the brightness of certain lighting projects such as high powered LED arrays. An H-Bridge is a circuit that can drive a current in either polarity and be controlled by Pulse Width Modulation (PWM). * Pulse Width Modulation is a means in controlling the duration of an electronic pulse.

4.6 Ball Bearings

A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races.

The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads.

It achieves this by using at least two races to contain the balls and transmit the loads through the balls.

In most applications, one race is stationary and the other is attached to the rotating assembly (e.g., a hub or shaft).

As one of the bearing races rotates it causes the balls to rotate as well. Because the balls are rolling they have a much lower coefficient of friction than if two flat surfaces were sliding against each other.

Ball bearings tend to have lower load capacity for their size than other kinds of rolling-element bearings due to the smaller contact area between the balls and races. However, they can tolerate some misalignment of the inner and outer races.

4.7 Deep-Groove Ball Bearings

In a deep-groove radial bearing, the race dimensions are close to the dimensions of the balls that run in it.

Deep-groove bearings support higher loads than a shallower groove. Like angular contact bearings, deep-groove bearings support both radial and axial loads, but without a choice of contact angle to allow choices of relative proportion of these load capacities.

They are commonly used in electric motors, compressors, fans, and conveyors.

4.8 Benefits

Versatility – because they can carry radial and axial loads, they have a wider range of applications for many industries

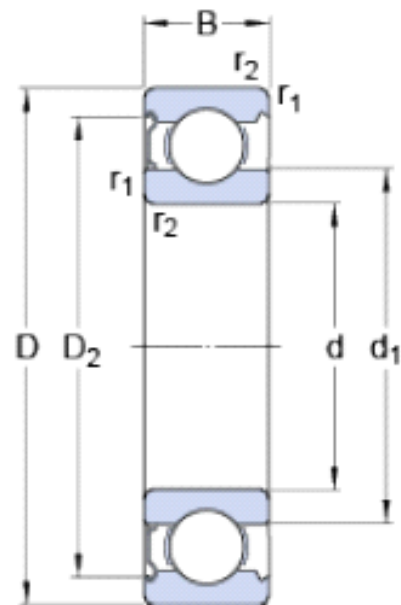
Cost savings – Deep groove ball bearings create less friction torque. This lowers operating temperature (which extends the life of the bearing) and reduces energy cost of running equipment (such as conveyor belts).

Less upkeep – Because of their simple design, low operating temperature, and low friction, deep groove ball bearings have a longer expected shelf life than other bearings.

They do not require additional lubrication after installation, which also means less maintenance downtime.

4.9 Design Specifications

Dimensions



d	12	mm
D	32	mm
B	10	mm
d_1	$\approx$ 18.45	mm
D_2	$\approx$ 27.34	mm
$r_{1,2}$	min. 0.6	mm

TABLE.4.1. DIMENSIONS

Abutment dimensions

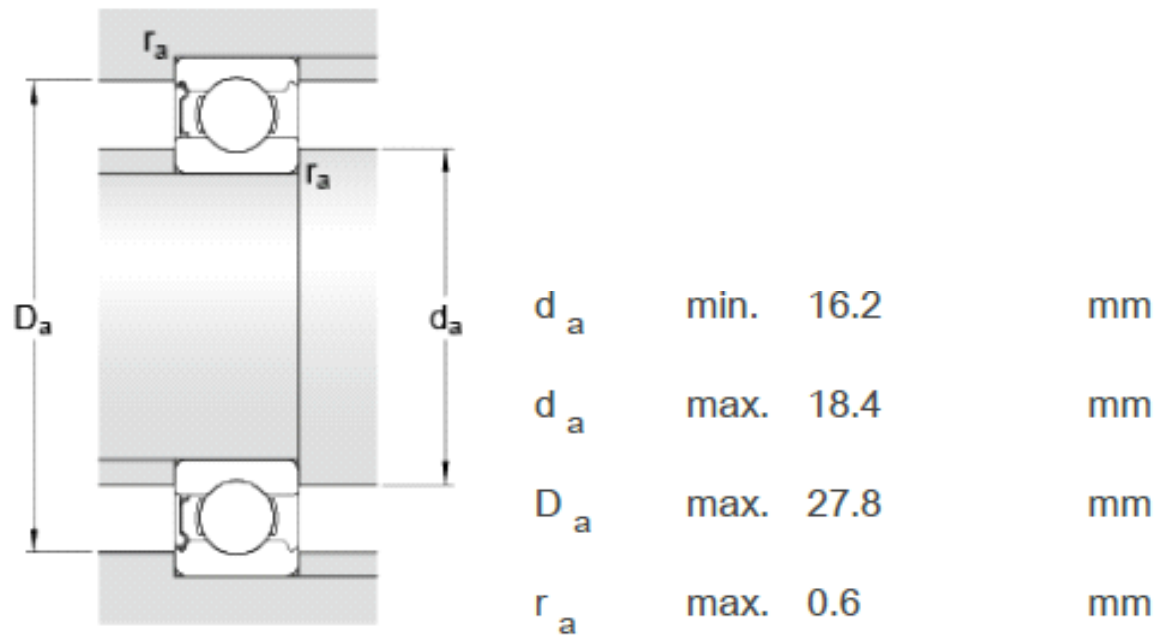


TABLE 4.2. ABUTMENT DIMENSIONS

Calculation data

Basic dynamic load rating	C	7.28	kN
Basic static load rating	C_0	3.1	kN
Fatigue load limit	P_u	0.132	kN
Reference speed		50000	r/min
Limiting speed		32000	r/min
Calculation factor	k_r	0.025	
Calculation factor	f_0	12	

TABLE4.3. CALCULTION DATA

4.10 D.C. Motors

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy.

The most common types rely on the forces produced by magnetic fields.

Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current flow in part of the motor.

DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems.

A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings.

Small DC motors are used in tools, toys, and appliances.

The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances.

Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills.

The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

They offer higher starting torque & increased speed control over a wide range.

They are ideal for low cost operation & are devoid of the Harmonic Effect.

hey give you quick control over the motors & offer improved speed regulation.

The Electronics and Rectification are minimal.

Here, in this project we used box type high torque geared DC motors.



FIG.4.6 . BOX TYPE HIGH TORQUE GEARED DC MOTORS

4.11 Battery

The lead–acid battery was invented in 1859 by French physicist Gaston Plante and is the earliest, yet still most widely used, type of rechargeable battery.

Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, its ability to supply high surge currents means that the cells have a relatively large power-to-weight ratio.

These features, along with their low cost, make them attractive for use in motor vehicles to provide the high current required by automobile starter motors.

As they are inexpensive compared to newer technologies, lead–acid batteries are widely used even when surge current is not important and other designs could provide higher energy densities.

The electrical energy produced by a discharging lead–acid battery can be attributed to the

energy released when the strong chemical bonds of water (H_2O) molecules are formed from H^+ ions of the acid and O^{2-} ions of PbO_2 .

Conversely, during charging the battery acts as a water-splitting device, and in the charged state the chemical energy of the battery is stored in the potential difference between the pure lead at the negative side and the PbO_2 on the positive side, plus the Sulphuric Acid in aqueous condition.

Lead–acid batteries are used in emergency lighting and to power sump pumps in case of power failure.

Traction (propulsion) batteries are used in golf carts and other battery electric vehicles.

Large lead-acid batteries are also used to power the electric motors in diesel electric (conventional) submarines when submerged, and are used as emergency power on nuclear submarines as well.

Valve-regulated lead acid batteries cannot spill their electrolyte. They are used in back-up power supplies for alarm and smaller computer systems (particularly in uninterruptible power supplies; UPS) and for electric scooters, electric wheelchairs, electrified bicycles, marine applications, battery electric vehicles or micro hybrid vehicles, and motorcycles.

Many electric forklifts use lead-acid batteries, where the weight is used as part of a counterweight. Lead-acid batteries were used to supply the filament (heater) voltage, with 2 V common in early vacuum tube (valve) radio receivers.

Portable batteries for miners' cap lamps headlamps typically have two or three cells.

Ammonia can neutralize spilled battery acid. Surplus ammonia and water evaporate, leaving an ammonium sulfate residue. Sodium bicarbonate (baking soda) is also commonly used for this purpose.

Lead–acid battery recycling is one of the most successful recycling programs in the world.

An effective pollution control system is a necessity to prevent lead emission.

Continuous improvement in battery recycling plants and furnace designs is required to keep pace with emission standards for lead smelters.

Here, in this project, we have used 12 V, 3.5 Amps battery.



FIG.4.7 BATTERY

4.12 Fabrication Of Ladder

A ladder consists of props and rungs.

A ladder's configuration depends solely on the width, rung interval, inclination angle, rung shape, and whether props are used.

Each of these elements is used as parameters to indicate the versatility of ladders.

Specifically, the rung interval was defined as i , the width was defined as w , and the inclination angle was defined as ψ .

Material for the prop used is M.S Box Channel of 50*25 mm size and of length around 3657.6 mm (12 feet).

Material for rungs used is M.S Box Channel of size 25*25*13 Inch and rung interval (i) between rungs is 304.8 mm (12 Inch). Rung width (w) is of 330.2 mm (13 Inch).

Inclination angle is however will be around 70-80 Degrees.

Zinc oxide is used for coating/painting the ladder to protect from rust.

Electric arc welding is used for joining process of prop & rungs at a voltage of 120 Volts.



FIG.4.8 PREPARING THE PROP FOR JOINING THE RUNGS



FIG.4.9 MARKING THE RUNG MATERIAL FOR CUTTING RUNGS



FIG.4.10 CUTTING OF THE RUNGS



FIG.4.11 GRINDING THE FACES OF THE RUNGS FOR SMOOTHNESS



FIG.4.12 JOING THE RUNGS & PROP



FIG 4.13 FINISHED LADDER

4.13 Fabrication Of Main Frame

- The main frame is the skeletal structure of the robot.
- It acts as the chassis for the system.
- All the loads applied are distributed over the frame.
- Components and attachments are affixed to the main frame for support and balance.
- The material used is M.S Flat Plate of 300*305*2.5 mm.



FIG 4.15 CUTTING THE MAIN FRAME FROM RAW MATERIAL



FIG 4.16 MARKING THE DIMENSIONS FOR SETTING GUIDE WAYS

4.14 Assembly of m.s. Angle guides

- The M.S. Angle Guides are one of the important elements of robot & its main function is to make sure that the rack moves along predetermined path
- The motion of rack is generally straight line in between the angle guides.
- They have high rigidity.
- The surface of angle guides has greater accuracy and surface finish.
- They provide high accuracy of travel.
- They are durable.



FIG 4.17 VIEW OF M.S. ANGLE GUIDES ON THE MAIN FRAME

4.15 Assembly Of Rack & Pinions

- Rack and pinion combinations are often used as part of a simple linear actuator, where the rotation of a shaft powered by hand or by a motor is converted to linear motion.
- The rack carries the full load of the actuator directly and so the driving pinion is usually small, so that the gear ratio reduces the torque required.
- This force, thus torque, may still be substantial and so it is common for there to be a reduction gear immediately before this by either a gear or worm gear reduction.

- Rack gears have a higher ratio, thus require a greater driving torque, than screw actuators.



FIG 4.18 RACK & PINION ASSEMBLY

- A rack and pinion is a type of linear actuator that comprises a circular gear (the pinion) engaging a linear gear (the rack), which operate to translate rotational motion into linear motion.
- Driving the pinion into rotation causes the rack to be driven linearly.
- Driving the rack linearly will cause the pinion to be driven into a rotation.
- The material used is M.S. The length of the rack is about 3 feet with 115 teeth throughout its length of pitch 6 mm.

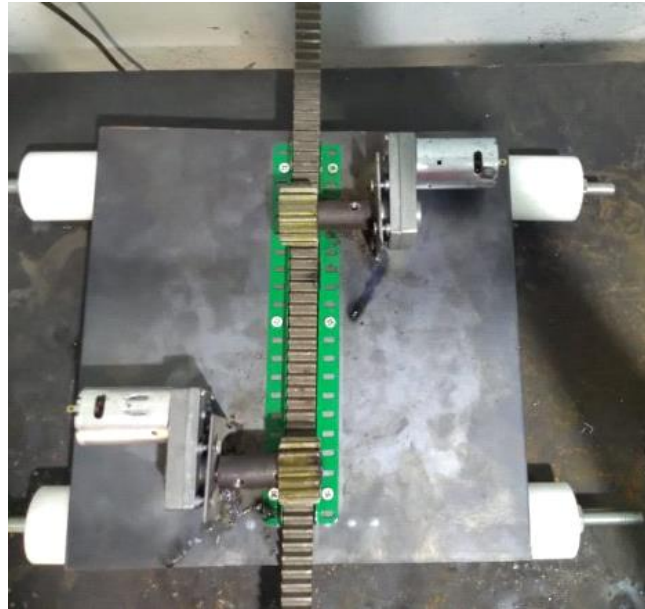


FIG 4.19 VIEW OF RACK & PINION WITH IN THE GUIDEWAYS ON MAIN FRAME

4.16 Motor Support Plates

- It is a plate that supports the motors with the help of screw fittings. They are welded to main frame using one of its bases.
- Drill bits of 12.5 mm, 5 mm & 6 mm are used.



FIG 4.20 MARKING OF DIMENSIONS ON MOTOR SUPPORT PLATE



FIG 4.21 VIEW OF MOTOR SUPPORT PLATE AFTER MARKING



FIG 4.22 DRILLING CENTRE HOLE USING DRILL BIT @12.5 MM



FIG 4.23 DRILLING 4 HOLES USING DRILL BIT @ 5 MM



FIG 4.24 Robotics DRILLING 4 HOLES USING DRILL BIT @ 6 MM IF OVERSIZE IS REQUIRED

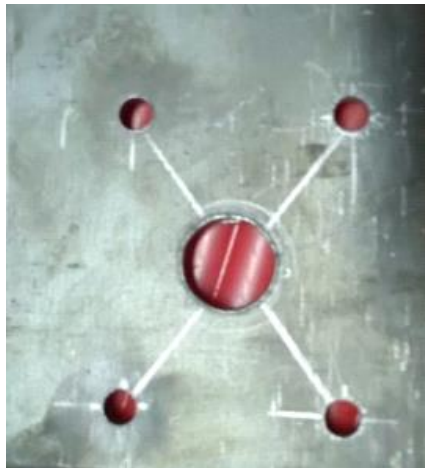


FIG 4.25 VIEW OF MOTOR SUPPORT PLATE AFTER DRILLING REQUIRED HOLES



FIG 4.26 REDUCING SCREW LENGTH TO FIT EXACTLY INTO MOTOR THREADING



FIG 4.27 VIEW OF MOTOR SUPPORT PLATE AFTER FITTING TO A D C MOTOR



FIG 4.28 VIEW OF WELDING OF MOTOR SUPPORT PLATE TO THE MAIN FRAME

4.17 Threaded Rods & Roller Assembly

- A threaded rod, also known as a stud, is a relatively long rod that is threaded on both ends; the thread may extend along the complete length of the rod.
- They are designed to be used in tension. Threaded rod in bar stock form is often called all-thread.



FIG 4.29 THREADED RODS



FIG 4.30 VIEW OF THREADED RODS AFTER WELDING TO MAIN FRAME

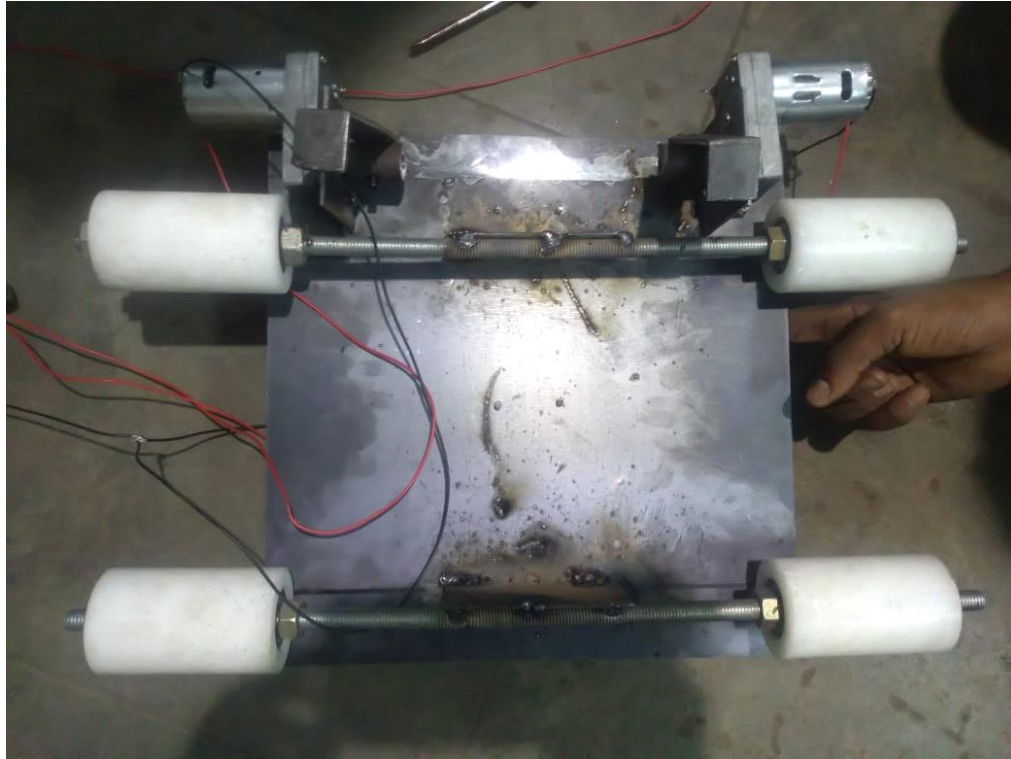


FIG 4.31 VIEW OF THREADED RODS WITH NYLON ROLLERS

Nylon rollers are used for a smooth movement of the robot on the prop of the ladder.

It has outer diameter of 52 mm & Inner diameter of 32 mm

These are basically placed on threaded rods; hence they rotate during the movement of the robot and travels smoothly with negligible amount of vibration.

It comprises Deep groove ball bearings named BRG-6201Z and related info is discussed in detail below.

Totally 4 Nylon rollers are used for the robot on its four contact places between the prop and robot.



FIG 4.32 NYLON ROLLERS

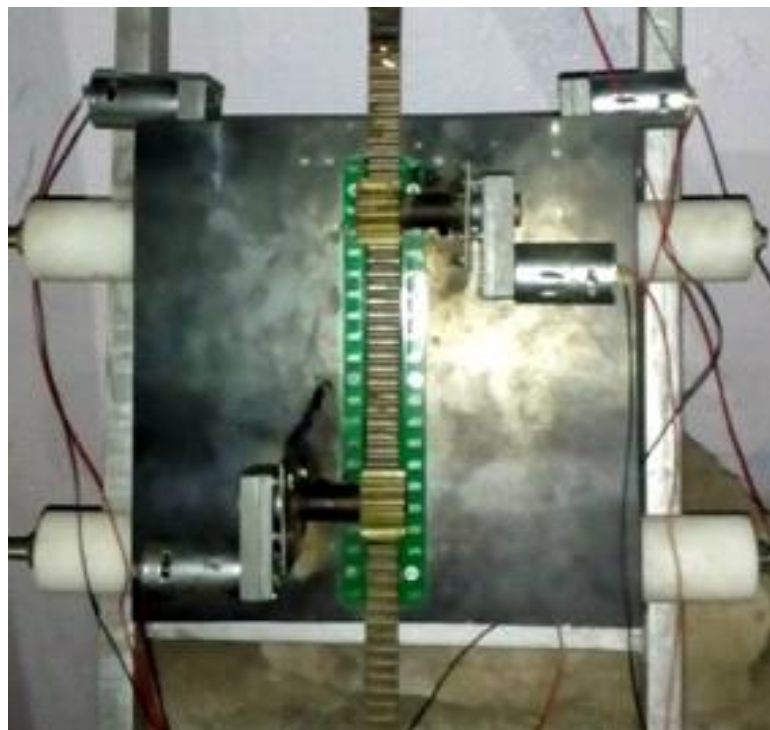


FIG4.34 VIEW OF NYLON ROLLERS ON ROBOT

4.18 Upper Arm

Usually Upper Arm is the first arm that is situated at the top of the rack, (especially one of the parts of the robot) welded to a hollow cylindrical shaft attached to the motor shaft with the help of a grub screw.

It bears robot load as well as the weight carried by the robot. Here the motor is connected to its support plate with 3/8 inch screw fittings and this plate is welded to the edge of the top of the rack on its plane side.

So this provides the motion to the upper arm to hold/ release onto/from the rungs at a specific time to travel from one rung to another.



FIG 4.35 CUTTING OF ARM @ 125 MM



FIG 4.36 BENDING OF M.S.FLAT



fig 4.37 view of upper arm on robot

4.19 Lower Arms

Usually Lower Arms are the secondary arms that are situated at the top and backside to the main frame of the robot that holds the rungs till the upper arm travels to a specific rungs. After upper arm holds a specific rung, then the lower arms get released from the rungs and after travelling to a specific rung, these arms hold the rungs again.

Here the motor is connected to its support plate with 3/8 inch screw fittings and this plate is welded on the main frame as earlier discussed. So this provides the motion to the lower arms to hold/release onto/from the rungs at a specific time to travel from one rung to another.

These arms are also welded to a hollow cylindrical shaft attached to the motor shaft with the help of a grub screw.



FIG 4.38 CUTTING OF ARM @ 115 MM



FIG 4.39 BENDING OF M.S.FLAT



FIG 4.40 VIEW OF LOWER ARMS ON THE LADDER

4.20 Motor Shaft Coupling

- These are used as intermediate element between the arms and the motor as well as to hold the pinion gear on its turned part on one side. Grub screw is fitted into the threading to arrest the movement of this shaft on motor shaft and fit tightly, so movement is provided for the end parts such as arms & pinion gear.



FIG 4.41



FIG 4.42



FIG 4.43

FIGURES. 46, 47, 48. PINION GEAR & CYLINDRICAL SHAFT ARRANGEMENT



FIG 4.44 CYLINDRICAL SHAFT SURFACE GRINDING



FIG 4.45 DRILLING @ 10 MM TO PROVIDE CLEARANCE B/W SHAFT AND PINION



FIG 4.46 VIEW OF CYLINDRICAL SHAFT AND PINION GEAR



FIG 4.47 JOINING OF CYLINDRICAL SHAFT & PINION GEAR USING ARC WELDING



FIG 4.48 SURFACE GRINDING AFTER JOINING PROCESS



FIG 4.49 CYLINDRICAL SHAFT WITH THREADING WELDED TO ARM



FIG 4.50 ARC WELDING PROCESS OF CYLINDRICAL SHAFT & ARM



FIG 4.51 VIEW OF CYLINDRICAL SHAFT AND ARMS

4.21 CALCULATIONS

4.21 Motor Power Calculation for Pinion

- Mass of Robot = 10 kg
- Mass to be ascended by each pinion = 5 kg
- Radius of Pinion (r) = 0.0127m
- Force (F) = $m \times g$ = $5 \times 9.81 = 49.05$ N
- Torque (T) = $r \times F$ = 0.0127×49.05
= 0.62 N-M
- Speed of motor (N) = 10 rpm.
- Power = $2 \times 3.14 \times 10 \times 0.62/60$
= 0.62 W
- Maximum power required is 12.83W and selected motor power rating is 30W which is higher than required.

4.22 Top Holding (Upper) Arm Calculation

- Mass of Robot = 10 kg
- Mass acting on holding arm = 10 kg
- Radius of Arm (r) = 0.125m
- Force (F) = $m \times g$ = $10 \times 9.81 = 98.1$ N
- Torque (T) = $r \times F$ = $0.125 \times 98.1 = 12.26$ N-M
- Speed of motor (N) = 10 rpm.
- Power = $(2 \times 3.14 \times 10 \times 12.26)/60$
= 12.83 W

4.23 Side Holding (Lower) Arm Calculation

- Mass of Robot = 10 kg
- Mass acting on each holding arm = 5 kg
- Radius of Arm (r) = 0.125m
- Force (F) = $m \times g$ = $5 \times 9.81 = 49.05 \text{ N}$
- Torque (T) = $r \times F$ = 0.125×49.05
= 6.13 N-M
- Speed of motor N = 10 rpm.
- Power = $2 \times 3.14 \times 10 \times 6.13/60$
= 6.42 W

CHAPTER 5

RESULTS AND DISCUSSION PERFORMANCE ANALYSIS

5.0 Introduction to Cad

Computer-aided design (CAD), also known as computer-aided design and drafting (CADD), is the use of computer technology for the process of design and design-documentation. Computer Aided Drafting describes the process of drafting with a computer. CADD software, or environments, provides the user with input-tools for the purpose of streamlining design processes; drafting, documentation, and manufacturing processes. CADD output is often in the form of electronic files for print or machining operations. The development of CADD-based software is in direct correlation with the processes it seeks to economize; industry-based software (construction, manufacturing, etc.) typically uses vector-based (linear) environments whereas graphic-based software utilizes raster-based (pixilated) environments.

5.1 SOLIDWORKS

Solid Works is mechanical design automation software that takes advantage of the familiar Microsoft Windows graphical user interface.

It is an easy-to-learn tool which makes it possible for mechanical designers to quickly sketch ideas, experiment with features and dimensions, and produce models and detailed drawings.

A Solid Works model consists of parts, assemblies, and drawings.

- Typically, we begin with a sketch, create a base feature, and then add more features to the model. (One can also begin with an imported surface or solid geometry).
- We are free to refine our design by adding, changing, or reordering features.
- Associativity between parts, assemblies, and drawings assures that changes made to one view are automatically made to all other views.
- We can generate drawings or assemblies at any time in the design process.
- The SolidWorks software lets us customize functionality to suit our needs.

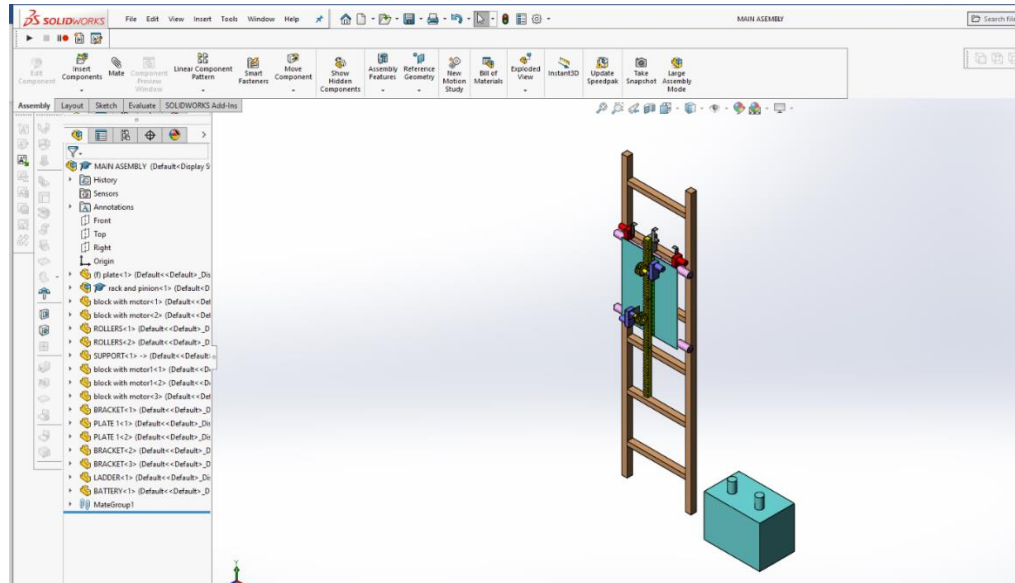


Fig 5.1.0 Design of Ladder climbing robot

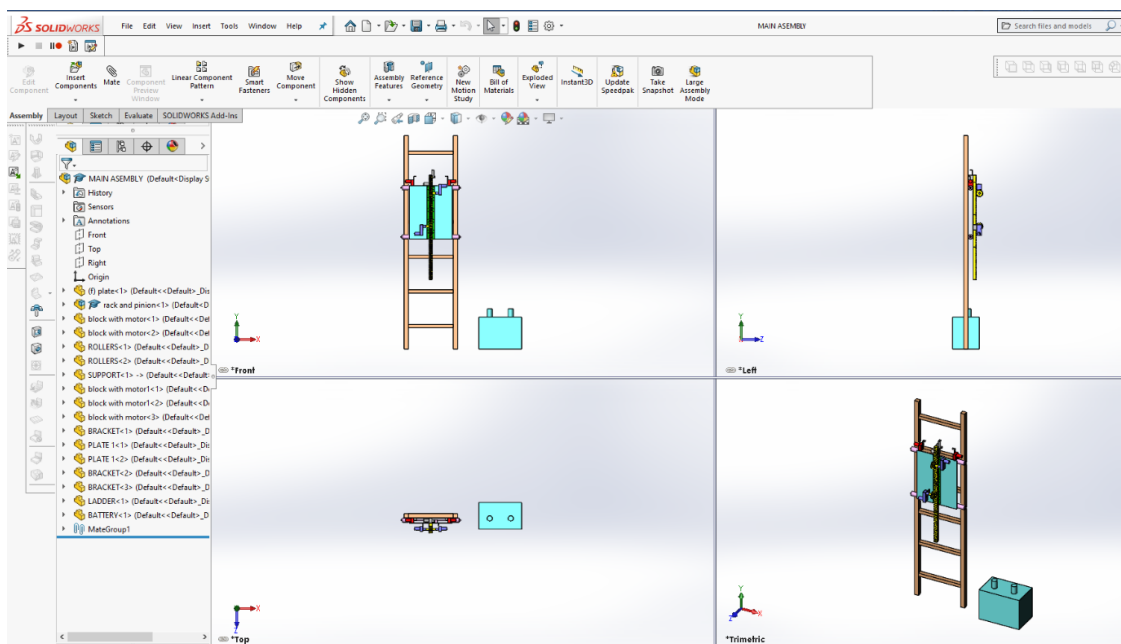


Fig 5.1.1 Design of ladder with top view, Side view, Front view and Normal

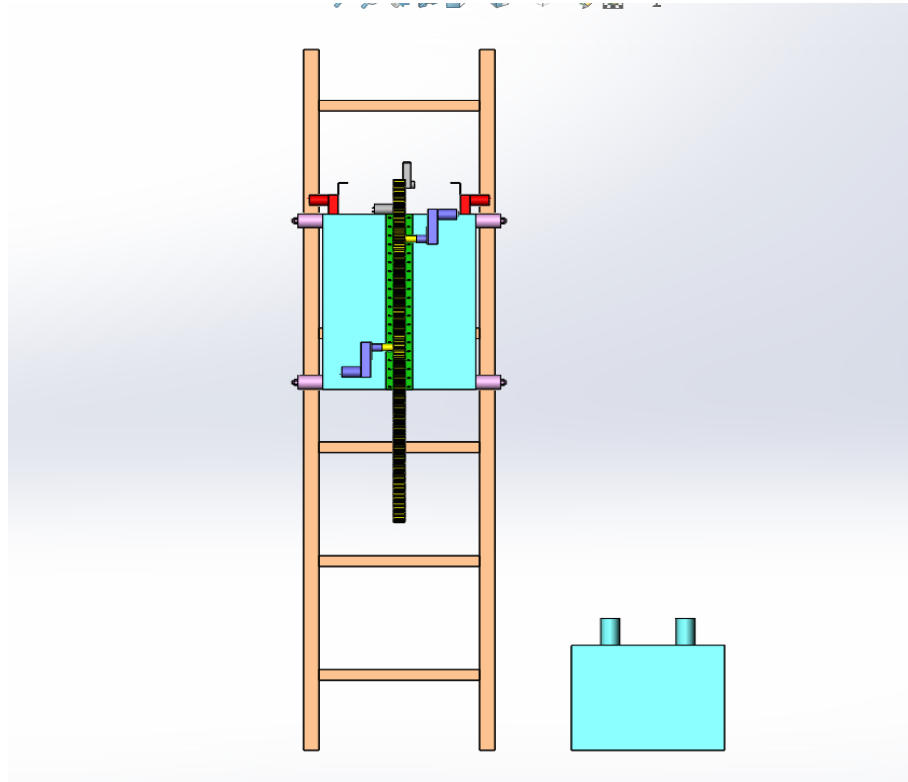


Fig 5.1.2 Design of ladder climbing Robot and Battery

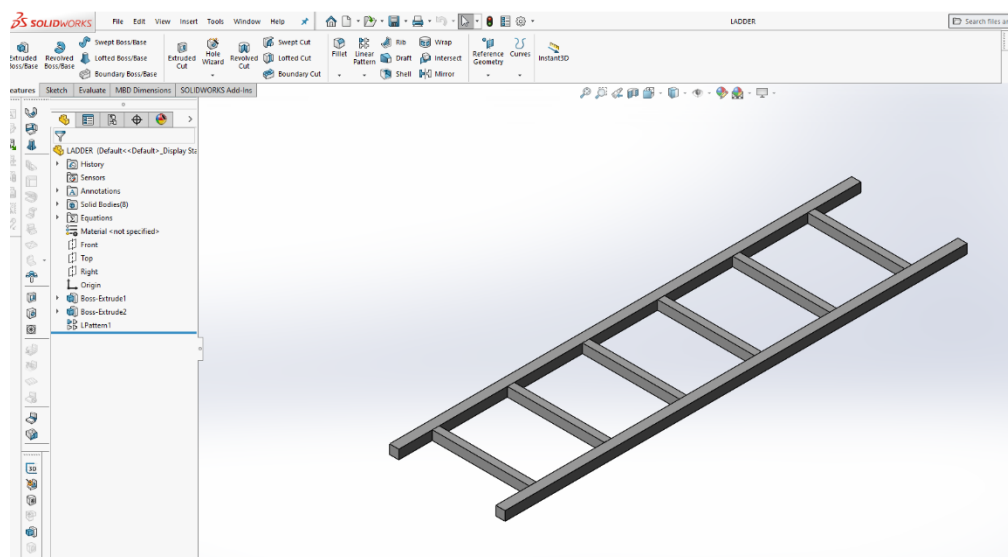


Fig 5.1.3 Design of ladder

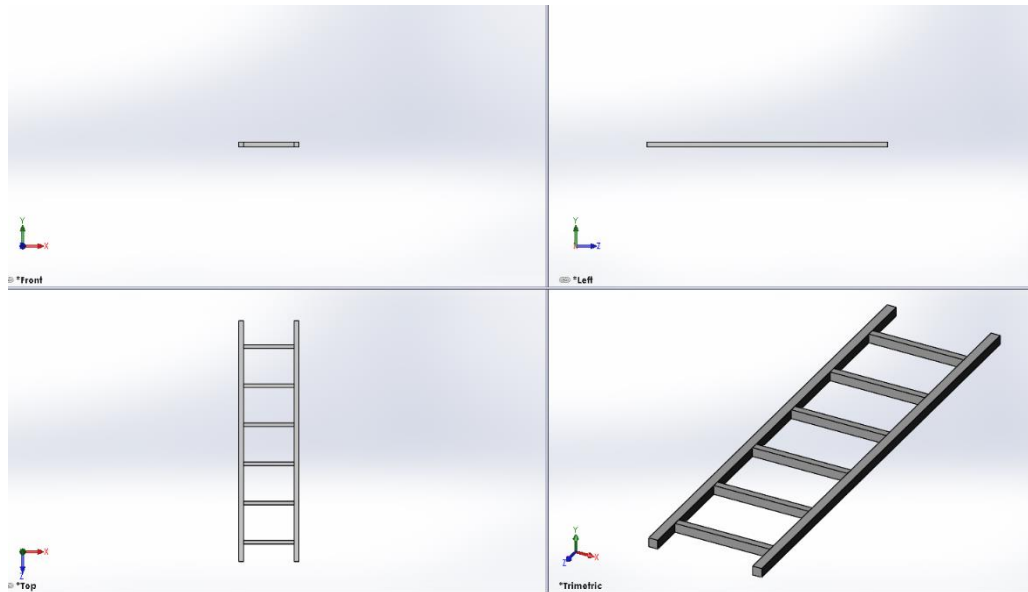


Fig 5.1.4 Design of ladder In all 4 views

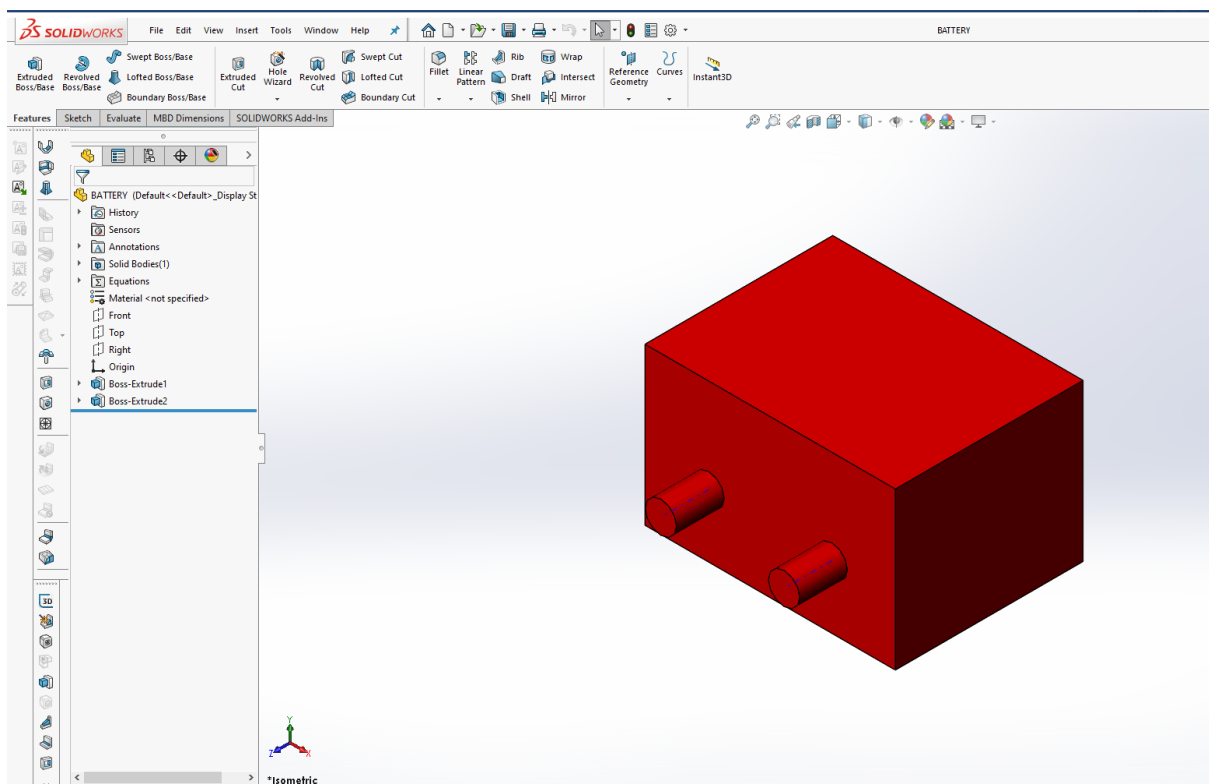


Fig 5.1.5 Design of Battery

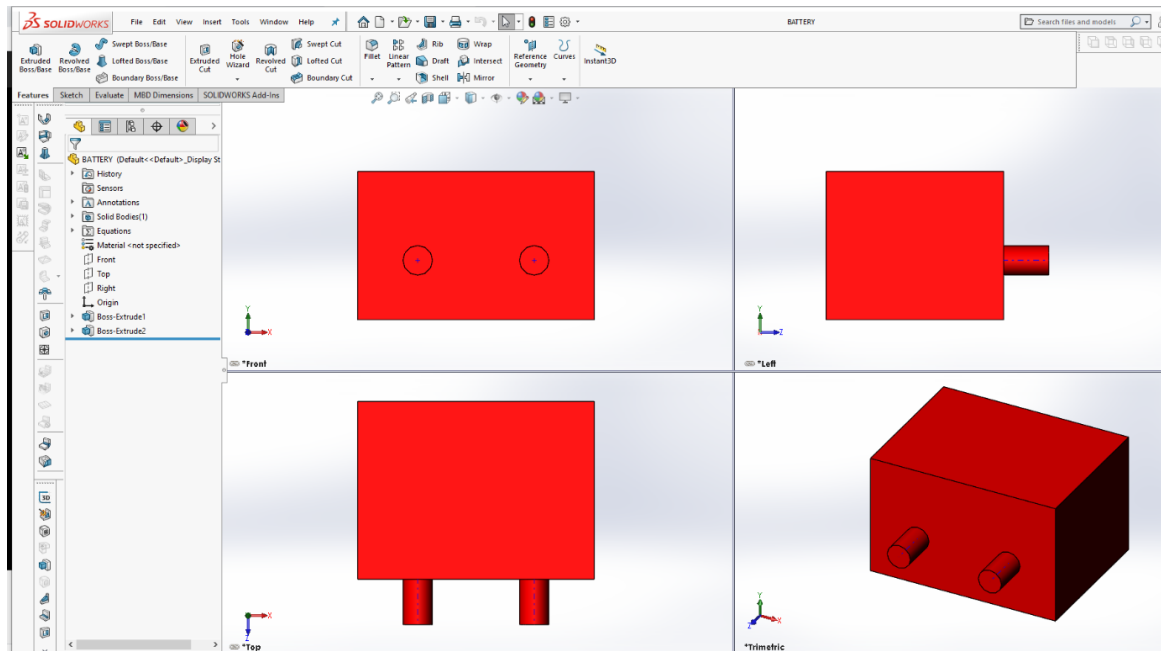


Fig 5.1.6 Design of Battery in 4 views

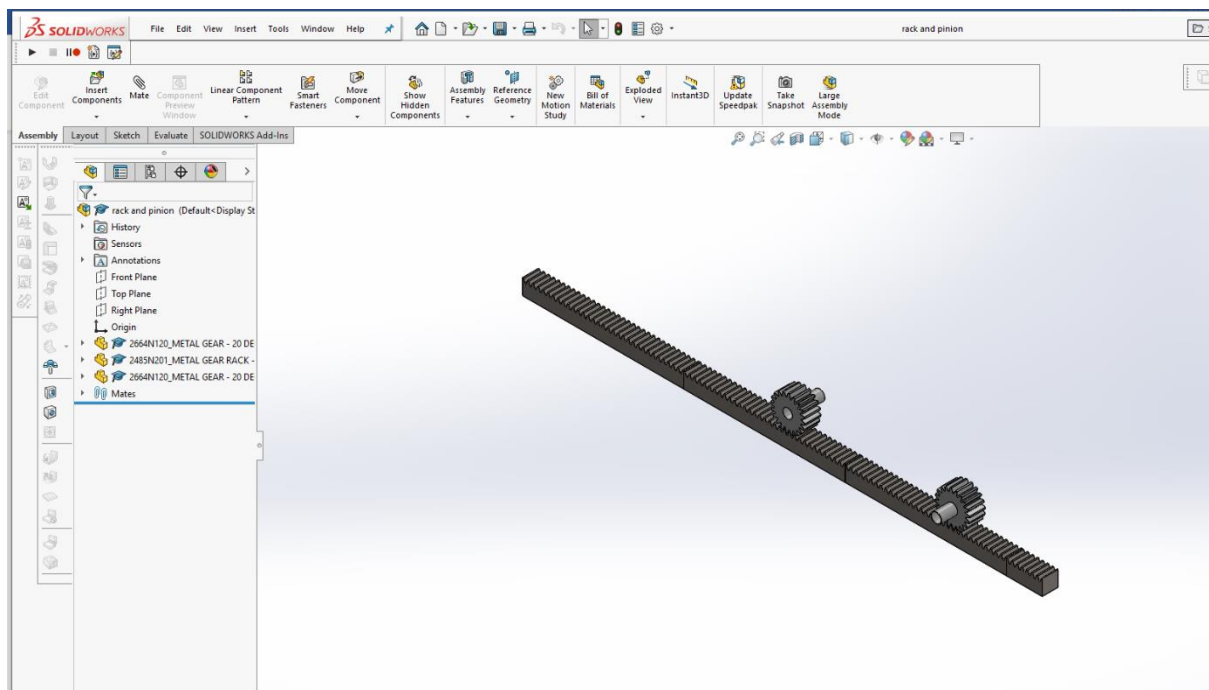


Fig 5.1.7 Design of Rack and pinion

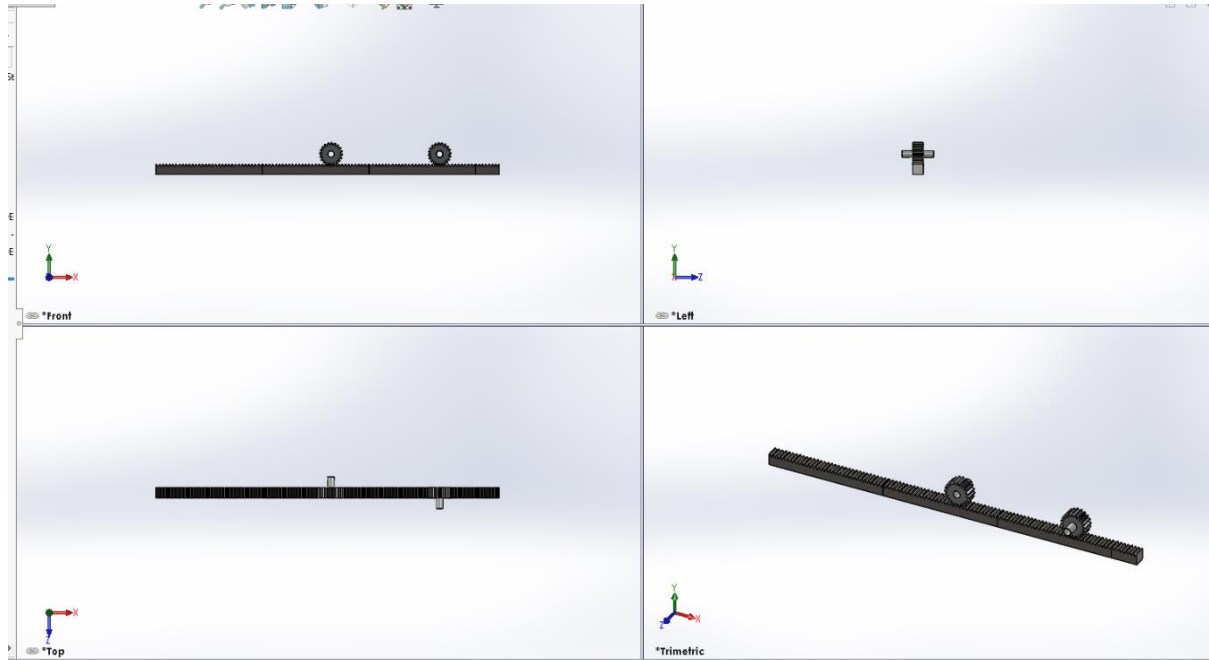


Fig 5.1.8 Design of Rack & Pinion In all 4 views

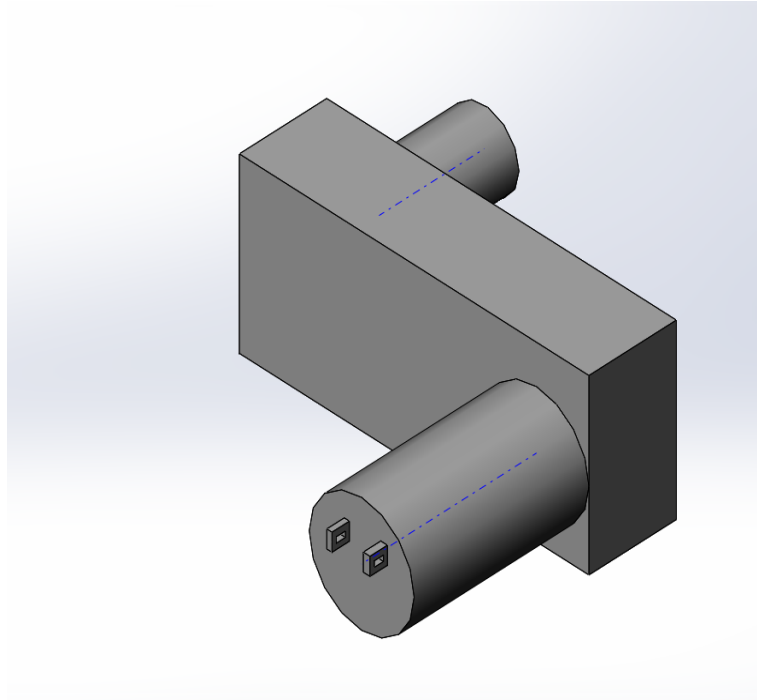


Fig 5.1.9 Design of Box Type high torque geared DC motor

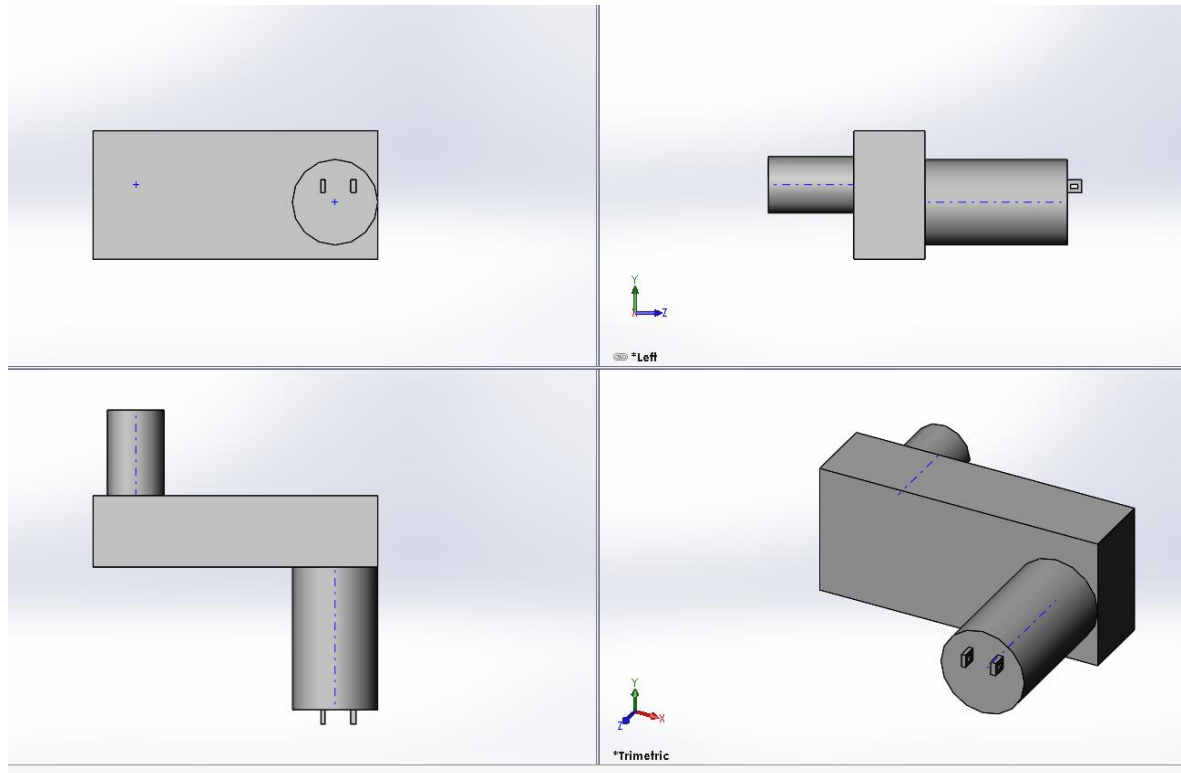


Fig 5.1.10 Design of Box Type high torque geared DC motor in 4 views

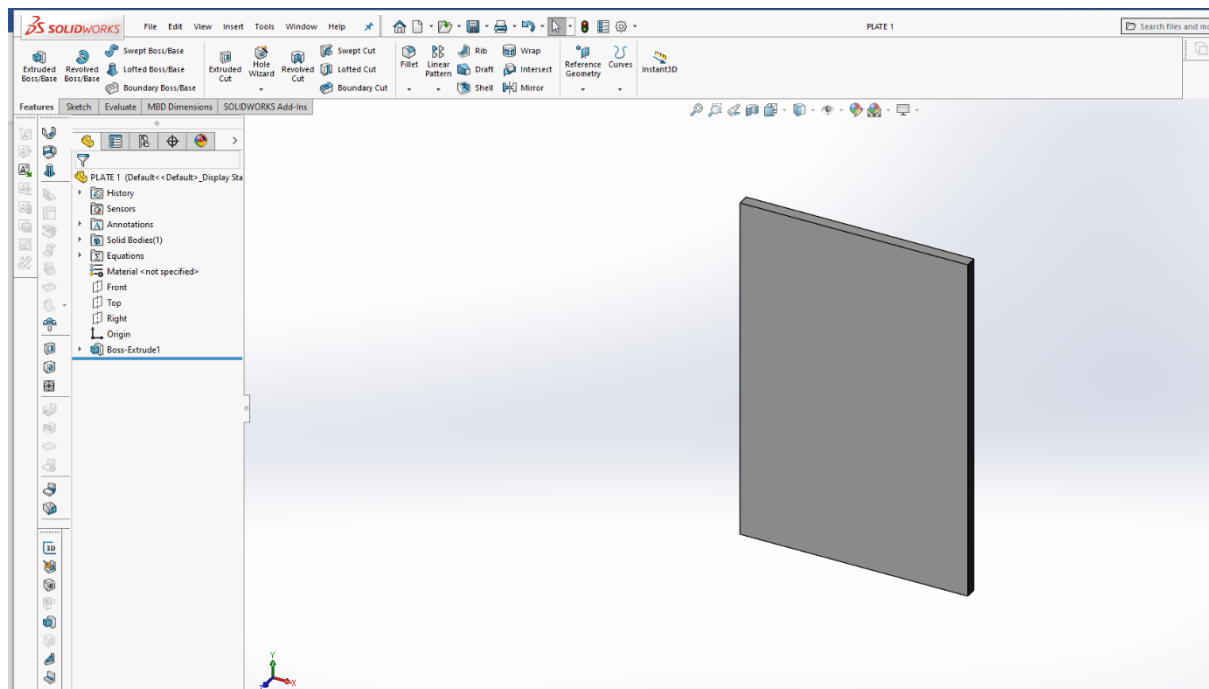


Fig 5.1.11 Design of Frame

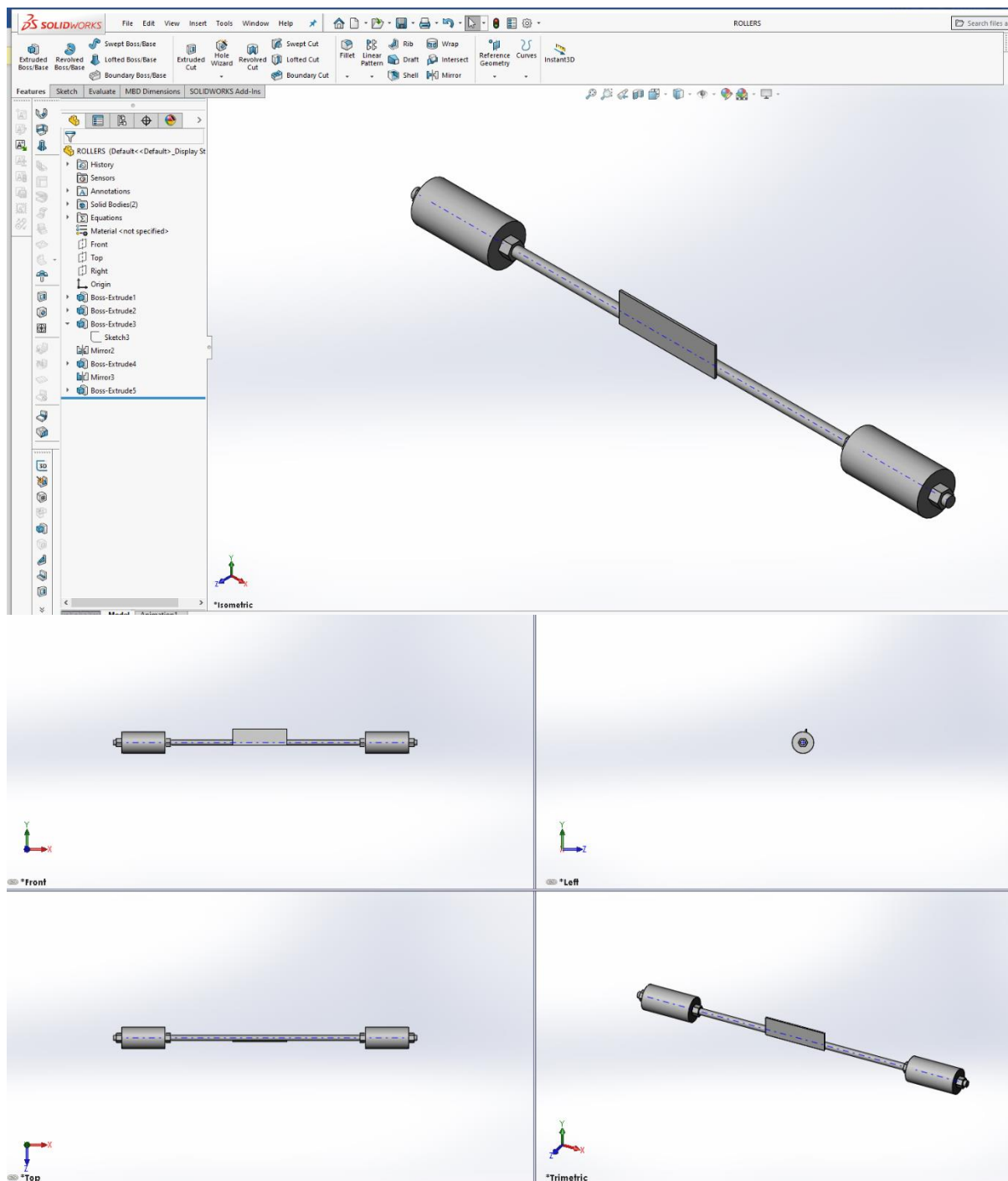


Fig 5.1.12 Design of Threaded rods with Nylon Rollers in 4 views

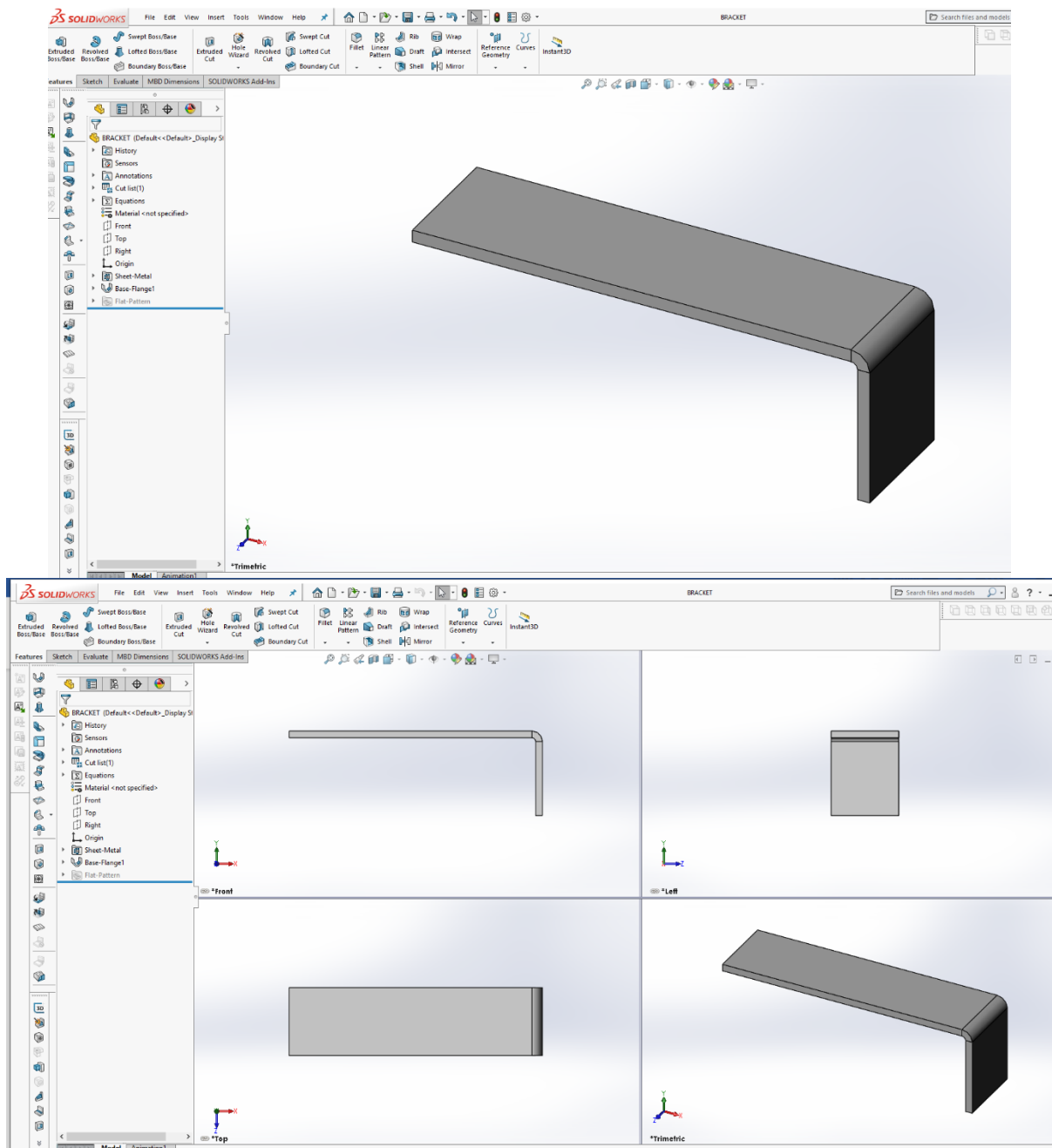


Fig 5.1.13 Design of Upper arm in 4 views

5.2 Advantages over existing devices

5.2.1 Advantages over single motor type

- Our model can ascend as well as descend on ladder which is not possible for single motor design.
- Process is cyclic; hence we can repeat operations multiple times.
- The model can adopt various sizes of ladders (Width & Intervals)

5.2.2 Advantages over Pendulum Type

- Weight of our machine is less, hence require less power
- The model can adopt various sizes of ladders (Width & Intervals)
- Chances of slippage are less

5.3 Applications

Transportation & Logistics

Used for carrying the workers own tools or equipment for maintenance or inspection tasks in workplaces such as towers, manholes, tunnels, and bridges.

In scenes that could not be transported by the ladder cannot afford the space and load capacity to both people and cargo climb, the ladder climbing device will lead to energy saving as alternative to forklift and crane.

- In the field of rescue operations.
- Spying works for security issues.
- Monitoring purposes using fixed surveillance cameras.
- Cleaning walls of sky scrapers without risk of accidents
- In nuclear power plants.
- In applications like automated or tele – remote controlled (semi-automated) construction.
- In firefighting robots that can climb over rough terrain along with carriage of water hoses.
- Increased portability due to light weight design.
- Capable of sustained motion for extended periods of operation.

5.4 Future Scope

Ladder climbing robot can be provided with high precision sensors to operate independently however it requires high level programming and expensive sensors

CHAPTER 6

SUMMARY AND CONCLUSIONS

6. Conclusion

Here a robotic system having three arms which is capable of motion in uneven surfaces as well as climbing ladders is discussed. This machine has two parts: the controller part and the robotic part. We make use of Arduino board to control the whole operation. The motion of the robot is mapped by hand movements. It has the ability to reduce human work to a great extent. It is designed to move in both vertical as well as horizontal directions. It uses a ZigBee transmitter module and receiver module for transmission from basic controller part and reception by robotic part for perfect mapping. It is compatible with any model of ladder. The operation is completely user controlled and hence error rate is minimum. The heavy battery drainage and inability to carry heavy loads are the major drawbacks. Power saving must be taken to consideration in next stages. As the number of sensors increase the mapping of motion of arms become easier. More number of sensors can be introduced. High power servomotors can be used to increase the load carrying capacity.

- Selected motors are delivering required torque for ladder climbing operation. Pinions, side arms and top arm motors are able to take reverse torque without failing.
- Present design allows us for various widths and intervals of ladders.
- Robot is able to ascend and descend on ladder without any slippage.
- Provided on board battery helped avoiding external wiring.
- Robot is tested for ascending and descending using remote control.

6.1 Future Scope of Work

The following directions could be pursued for the future enhancement of the present project in Terms of fully or partial (function specific) autonomous operation:

- Develop control algorithms and sensing techniques that allow the hybrid mobile robot
- System to operate autonomously in unstructured environments.
- Redesign the system for overall weight reduction without trading off with its payload
- Capacity.
- In the future work, sensors, cameras, manipulators can be added to the robot frame. The
- Robot can then serve complex tasks in dangerous areas remotely.

REFERENCE

- [1]. Roy L. Orndoff and James Sidles, "A New Automotive jack," SAE Technical paper 700179, 1970, ISSN:0148- 7191, <http://doi.org/10.4271/7001179>
- [2]. Prof. Nitinchandra R. Patel, Sanketkumar Dalwadi, Vijay Thakor and Manish Bamaniya, "Design of Toggle jack considering material selection of screw-nut combination," International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 5, May 2013 www.ijirset.com
- [3]. K. Sainath, MohdSalahuddinbMohdJibranBaig, MdAzam Ali Farooky, Mohammed Siddique Ahmed, MohdRiyazUdin, Faraz Ur Rehman Azhar and Md Shaffi, "Design of Mechanical Hydraulic Jack" IOSR Journal of Engineering (IOSRJEN), ISSN (e): 2250-3021, ISSN (p): 2278-8719, Vol. 04, Issue 07 (July. 2014), ||V1|| PP 15- 28, www.iosrjen.org.
- [4]. Pawar R. R, Shinde M.S., Shinde A.B., Garde M. B and Prof. Bhane A.B. Recent "Technologies in Automobile: Need of Motorised Screw Jack: A Review" International Journal of Recent Development in Engineering and Technology, (ISSN 2347-6435(Online) Volume 4, Issue 4, April 2015), www.ijrdet.com
- [5]. ASONYE G. U., Nnamani C.E. and Alaka and C.A, "Design and fabrication of Smart phone Controlled System for Hydraulic Jack", International Research Journal of Engineering and Technology (IRJET), Volume: 02 Issue: 07, Oct-2015, www.irjet.net
- [6]. R. Sudarsan, Salin Sasankan and P. Nicholas Niranjan, Automatic Hyadrulic jack, International Journal of Innovative Research in Technology (IJIRT) 144625, June 2017, Volume :4 Issue: 1, ISSN: 2349-6002, www.ijirt.net

- [7]. Aditya Masiwal, Aman Kanungo, Ishan Rawley, Devendra Jha, Ashutosh Singh, Dhruv Kumar and Ram Jatan Yadav, Design and fabrication of Hydraulic Jack system for four wheelers, International Research Journal of Engineering and Technology (IRJET), Volume: 05 Issue: 04, Apr-2018, www.irjet.net
- [8]. Jayapradha P, Krishna Kumar and Priyadarshini, Design and Fabrication of Hydraulic Jack (Self Jacking), International journal of Engineering Development and Research (IJEDR), 2019, Volume 7 Issue 3, ISSN: 2321- 9939, www.ijedr.org
- [9]. R. Sharvanan, Design of Built-In Hydraulic Jack for Light Motor Vehicles, Volume:8 Issue:8, August 2017, ISSN Print: 0976-6340 and ISSN Online: 0976-6359, pp1649–1655, Article ID: IJMET_08_08_179, <http://www.iaeme.com/IJMET/issues.asp?JType=IJMET &VType=8&IType=8>
- [10]. Kamalakkannan. A, Kalaiselvan.P, Isaac.R and Vijay. V, Automatic motorized screw jack to reduced man power, International Journal of Scientific & Engineering Research, Volume:7, Issue:5, May-2016, ISSN 2229-5518 <http://www.ijser.org>
- [11]. Abhishek Madhukar Barewar, Abhishek Ashok Padole, Yugal Dhanpal Nagpure, Pranav Shivraj Gaupale, Sagar Bhimraoji Nagmote, Chandankumar Ram and Rupali Suresh Raut, Fabrication of automatic screw jack, International Journal of Advance Research and Development Volume3, Issue4, www.ijarnd.com
- [12]. Batriwal Taha, Kathiria Qutbuddin, Koonath Shreyas, Labana Khushwant and Mr. Saksena Nirav, A Review on Failures of Scissor Jack International Conference on Current Research Trends in Engineering and Technology 2018 IJSRSET, Volume 4 Issue 5 Print ISSN: 2395-1990, Online ISSN:2394-4099, 10-April2018,March-April-2017 (4) 5: 554-560 www.ijsrset.com
- [13]. Eric Brigham, Chris Destefano and Zachary Killoy, “Slider crank Mechanism for demonstration And Experimentation”, April 25, 2013, <http://web.wpi.edu>

- [14]. Bhupesh Chandrakarv and Manmohan Soni, "Design and Optimization of Slider and Crank Mechanism with Multibody Systems" International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2013): 6.14, Impact Factor (2013): 4.438.
- [15]. Dr. Ch. Chengaiah and Venkateshwarlu, Comparative Study on DC motor speed control using various controllers, Volume: 3 Issue;1, jan 2014 <http://www.ijareeie.com>
- [16]. Tae-Yang Lee, Ki-Hoon Kim and Gu-Min Jeong, "Design of an Easy-to-Use Bluetooth Library for Wireless Sensor Network on Android" , Contemporary Engineering Sciences, Vol.7, 2014, no. 16, 801 – 805 HIKARI Ltd, <http://dx.doi.org/10.12988/ces.2014.4694>
- [17]. Yang-Hang Lee, Kuo-Wei Ho, Hsien-Wei Tseng, ChihYuan Lo, Tzu-Cheng Huang, Ji-Yu Shih and Tsai-Hua Kang,, "Accurate Bluetooth Positioning Using Large Number of Devices Measurements", Proceedings of the International Multiconference of Engineers and Computer Scientists 2014 Vol II, IMECS 2014, March 12 - 14, 2014, Hong Kong
- [18]. Kshirasagar Naik, Veluppillai Mahinthan, "Impacts of Bluetooth Device Addresses and Native Clocks on Packet Interference in Piconets", Journal of Wireless Networking and Communications 2014, 4(2): 42-48 DOI: 10.5923/j.jwnc.20140402.02
- [19]. Poonam V. Gaikwad, and Yoginath R. kalshetty Bluetooth based smart automation system using android, international journal of science and research (IJSR), ISSN(Online): 2319-7064, volume: 6 Issue:05, May 2017, www.ijsr.net
- [20]. Mrs. Anisha Cotta, Miss. Naik Trupti Devidas and Miss. Varda Kalidas Naik Ekoskar, "Wireless Communication using HC-05 Bluetooth module interfaced with Arduino, ISSN: 2278 – 7798 International Journal of Science,
- [21] T.Bretl : Motion Planning of Multi-Limbed Robots Subject to Equilibrium Constraints: The Free-Climbing Robot Problem, International Journal of Robotics Research 4; 317-342, 2006

- [22] H. Iida, H. Hozumi and R. Nakayama: Development of Ladder Climbing Robot LCR-1, Journal of Robotics & mechatronics, vol 1.1, No.4, pp 311-316,1989.
- [23] Fujii S, Inoue K, Takubo T, Mae Y: Ladder climbing control for limb mechanism robot "ASTERISK", IEEE International Conference on Robotics and Automation ICRA 2008.
- [24] Yoneda, H, Micro-Nano Syst. Eng, Nagoya Univ, Nagoya, Sekiyama, K., Hasegawa Y, Fukuda T: Vertical ladder climbing motion with posture control for multi-locomotion robot, IEEE/RJS International Conference on Intelligent Robots and Systems,2008.
- [25] K. Bouyarmane, J. Vaillant, F.Keith, and A. Kheddar : Exploring humanoid robot locomotion capabilities in virtual disaster response scenarios, In Proc. 2012 IEEE-RAS Int. Conf. on Humanoid Robots, pages 337–342, Osaka, Japan, Dec. 2012
- [26] K. Hauser, T. Bretl, K. Harada, and J.-C. Latombe. Using motion primitives in probabilistic sample-based planning for humanoid robots. In Workshop on the Algorithmic Foundations of Robotics (WAFR), 2006
- [27] K. Hauser, T. Bretl, and J.-C. Latombe: Non-gaited humanoid locomotion planning, In Proc. IEEE-RAS Int. Conf. on Humanoid Robots, pages 7–12, Dec. 2005
- [28]. H. Iida, H. Hozumi and R. Nakayama, "Development of ladder climbing robot LCR-1", Journal of Robotics and Mechatronics, vol. 1, (1989), pp.311 -316.
- [29]. Eguchi, M. Nakakubo and K. Ioi, "Experimental demonstration of "Ladder Climber"", Proc. of the JSME ROBOMECH2012, (2002), pp. 2P1-F11.
- [30]. H. Yoneda, K. Sekiyama, Y. Hasegawa and T. Fukuda, "Vertical Ladder Climbing Motion with Posture Control Considering Gravitation Momentum for Multi-Locomotion Robot", Trans. of the Japan Society of Mechanical Engineers. C, Vol. 75. No. 751, (2009) pp. 524-531.
- [31]. Japanese published patent application 2003-54880.

- [32]. S. Fujii, K. Inoue, T. Takubo, Y. Mae and T. Arai, " Ladder climbing control for limb mechanism robot "ASTERISK"" Proc. of the 2008 IEEE international Conference on Robotics and Automation, (2008), pp. 3052-3057.
- [33]. H. Yoneda, K. Sekiyama, Y. Hasegawa and T. Fukuda, "Vertical ladder climbing motion with posture control for multi-locomotion robot", Proc. of the 2008 IEEE international conference on intelligent robots and systems, (2008), pp. 3579-3584.
- [34]. Japan Standards Association, Safety of machinery - JIS Handbook 72, 2007.
- [35]. R. Yokoto. T. Sakura, M. Yoshida, T. Morita, Link Mechanism for Carrying Device equipped with Adaptability to Diverse Ladders, Proc. of the JSME ROBOMECH2010, (2010), pp. 2A1-E14.

APPENDIX



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ABSTRACT A robot is generally an electro-mechanical machine that is guided by a PC and electronic programming. Numerous robots have been worked for assembling reason and can be found in processing plants around the planet. Planning of the most recent reversed ROBOT which can be controlling utilizing an APP for android portable.

Also, in which we use Bluetooth correspondence to interface Arduino UNO and android. Arduino can be interfaced to the Bluetooth module however UART convention. As indicated by orders got from android the robot movement can be controlled. The predictable yield of an automated framework alongside quality and repeatability are unequalled.

This robots can be reprogrammable and can be traded to give various applications. Mechanical framework having two arms that is reasonable of movement in lopsided surfaces just as ascending stepping stools. Stepping stool climbing is a fundamental method of movement for exploring modern conditions and leading support errands in structures, trees and other man-made constructions.

The movement of robot is planned by hand developments. An arduino board is utilized to control the remote control entire activity. It gathers information from the regulator and sends it to the robot (remote correspondence). The eventual outcome is a

self-ruling robot that can ascend the stepping stool effectively.

Primary Frame, Rack, Pinions, Arms, MS Angle Guides, Threaded poles, Nylon Rollers with a course number 6201Z, Motor Support level plates with bored openings, D.C. High Torque Motors, Remote, Receiver, Battery, Battery Charger, Main Frame made of Mild Steel, Wiring. Chapter 1 Introduction Robotics Advanced mechanics is the part of

innovation that manages the plan, development, activity, and utilization of robots, just as PC frameworks for their control, tactile input, and data handling.

These advances manage mechanized machines that can replace people in risky conditions or assembling measures, or take after people in appearance, conduct, or potentially cognizance. Large numbers of the present robots are enlivened commonly adding to the field of bio-propelled mechanical technology. Numerous robots tackle responsibilities that are risky to individuals like diffusing bombs, investigating mines and wrecks.

Stepping stools are available in our man-made conditions. They are intended to assist people with crossing over vertical distances without any problem. Nonetheless, this man-made construction represents a genuine test to vehicles and robots. Thus, with the end goal for robots to work proficiently and viably in metropolitan conditions; this test must be tended to.

Independent stepping stool climbing robot has been the subject of continuous examination over the most recent couple of years. The greater part of the robots utilize just leg-like instrument [1, 2], while some of them use track system [3]. The fundamental hindrance of these instruments is that we can't handle the speed, tendency, and regardless of whether blunders happen we can't right it right then and there. Therefore, a half breed configuration is proposed here.

The robot can move quick on level surfaces and appendage like component is utilized to scale and down stepping stools. It can ascend stepping stools that are higher than the robot. Advanced mechanics is the part of innovation that manages the plan, development, activity, and utilization of robots, just as PC frameworks for their control, tangible input, and data preparing.

These advances manage robotized machines that can replace people in risky conditions or assembling measures, or look like people in appearance, conduct, or potentially discernment. A large number of the present robots are enlivened ordinarily adding to the field of bio-motivated mechanical technology. 1 Numerous robots take care of responsibilities that are perilous to individuals like diffusing bombs, investigating mines and wrecks.

A stepping stool is given where vertical transportation and burden carriage are kept to a little workspace. For instance, in different work environments like pinnacles, sewer vents, passages, and extensions, laborers regularly convey their own devices or hardware and ascend stepping stools for support or investigation errands.

Stepping stools are utilized to ship burdens to high places in stockrooms, lofts, and so forth. Nonetheless, there are a few disservices when utilizing specific sorts of stepping stools in conditions like steep inclines and restricted advances, when contrasted with steps. Because of these inconveniences, when individuals ascend stepping stools to move loads, they are dependent upon different issues like exhaustion, trouble to keep up balance while climbing, and the danger of falling of the two specialists and burdens.

Because of these components, there is a nonexclusive cutoff on the size and the heaviness of a heap that can be moved at one time by people utilizing a stepping stool. To tackle these issues, there have been a few examinations and advancements with stepping stool climbing hardware and robots for load carriage. Be that as it may, most machines require uncommon stepping stools or are intended to fit just a specific sort of stepping stool.

In the interim, at present, there is no standard detail on stepping stools; in this manner, existing stepping stools have a scope of rung spans, tendency points, and so forth, contingent upon every area and application. Notwithstanding, there are some current robots that are fit for ascending stepping stools and that are intended to deal with an assorted assortment of stepping stools.

Nonetheless, these robots are not actually intended to ship loads. Ordinarily, they include muddled components utilizing numerous servo engines and are not adequately amazing to convey loads. Along these lines, in this examination, we meant to build up a stepping stool ascending component for a heap carriage gadget, which can be applied to different sorts of existing stepping stools. All the more explicitly, the created climbing system could deal with different boundary 2 varieties because of the stepping stool variety.

In scenes that couldn't be shipped by the stepping stool can't manage the cost of the space and burden ability to the two individuals and payload ascend, the stepping stool climbing gadget will prompt energy saving as an option in contrast to forklift and crane. __ FIG.1 FIG.2 Fig.1 & fig.2. Risk of falling & injuries 1.1 Robotic Part At the mechanical area, the principle parts incorporate six high force servo engines, a hefty base with four wheels, an arduino board and a collector.

The movement of the entire framework will be founded on the development of the hands. In light of the yield from the regulator part, the arduino board moves the servo engines. There is no different control for the wheels on the base. A hefty base is utilized to change the focal point of gravity to keep up the strength of the framework.

As per the pivot of the servo engine, the robot can move either evenly or vertically. Vertical movement of the robot is achieved with the assistance of two mechanical arms which are fixed at the base. Vertical movement of the robot requires the utilization of an exceptionally planned stepping stool whose measurements are in concurring with the element of the mechanical arm. Mechanical arm, 3 totally programmable and controllable through an arduino board is utilized.

Arduino programming permits simple to utilize interface for developments and programming arrangements. When the succession is customized a program for Rhino Robot Controller Board or Arduino can be produced straightforwardly from programming with the goal that the arm can be controlled freely.

It can likewise be controlled through Rhino Robot Control Board, Arduino or some other microcontroller fit for driving six RC Servos to control the automated arm straightforwardly. With discretionary Bluetooth module mounted on servo regulator pcb – the arm can be controlled remotely over blue-tooth from PC. Aside from arm additional servos can likewise be associated with the regulator Each arm comprises of three connections and is utilized fundamentally for moving up and down the stepping stool.

At the point when the robot isn't climbing the arms can be utilized as gripper to address or eliminate undesirable roadblocks before the robot or for transportation of things. It has one servomotor connected to each connection. 1.2 Method of Climbing the Ladder Before the robot begins to ascend, it should be situated before the stepping stool and ground with its two arms collapsed.

This is assigned as the underlying mode or position. As indicated by the movement of the client's hand, the mechanical arms will move. The client will give sufficient hand developments with the goal that the robot will keep one of its arms on the previously rung of the stepping stool. He at that point makes the robot place its other hand on the bar.

In the wake of setting both the hands on the initially rung, first arm is withdrawn and afterward positioned on the subsequent crosspiece. At that point the following arm is set in a similar way. This interaction proceeds till robot arrives at top of the stepping stool. Fundamental working rule incorporates working of both regulator and automated part.

In the regulator part flex sensors twist as indicated by development of client's arm. 4

Obstruction varieties are created which offer ascent to relating voltage varieties (0-5V). These voltage varieties are simple in nature. These simple qualities are planned to relating computerized values from (0-1023). This is because of the way that AT Mega is a 8-bit processor.

Simple to computerized change is finished by an inbuilt ADC in Arduino regulator. These qualities are changed over or planned to comparing point varieties and sent utilizing zigbee handset. Force supply is given by USB association from PC. In mechanical part the zigbee handset goes about as beneficiary which gets the precise qualities and produces relating turns in servomotors.

Force supply is given by a battery source. On pivot of servomotors the mechanical arm twists at various degrees starting stepping stool climbing movement. 1.3 Electrical Wiring • Electrical wiring is an electrical establishment of cabling and related gadgets like switches, appropriation sheets, attachments, and light fittings in a design. • Wiring is dependent upon security guidelines for plan and establishment.

- Allowable wire and link types and sizes are indicated by the circuit working voltage and electric flow ability, with additional limitations on the natural conditions, for example, surrounding temperature range, dampness levels, and openness to daylight and synthetic substances. 5 Chapter 2 Lietrecher Review 2.1. Stepping stool A stepping stool is a vertical or slanted arrangement of rungs or steps.

There are two sorts: unbending stepping stools that are self-supporting or that might be inclined toward a vertical surface like a divider, and rollable stepping stools, for example, those made of rope or aluminum that might be dangled from the top. The vertical individuals from an inflexible stepping stool are called stringers or rails (US) or stiles (UK).

Rigid stepping stools are generally compact, however a few sorts are forever fixed to a construction, building, or hardware. They are generally made of metal, wood, or fiberglass, yet they have been known to be made of intense plastic. 2.1.1. Sorts OF LADDERS 2.1.1.1. Unbending stepping stools Accommodation stepping stool is compact strides down the side of a boat for boarding.

Assault stepping stool, utilized in attack fighting to help with climbing dividers and intersection canals. Attic stepping stool, pulled down from the roof to permit admittance to an upper room or space. Bridge stepping stool, a stepping stool laid on a level plane to go about as an entry between two focuses isolated by a drop.

Boarding stepping stool, a stepping stool use to climb onto a vehicle. May be inflexible or adaptable, likewise boarding step(s), and swim stepping stool Cat stepping stool (US chicken stepping stool), a lightweight stepping stool outline utilized on steep rooftops to keep laborers from sliding.

Christmas tree stepping stool, a kind of boarding stepping stool for jumpers which has a solitary focal rail and is open along the edges to permit the jumper to ascend the stepping stool while wearing swim blades. 6 Counterbalanced stepping stool, a fixed stepping stool with a lower sliding part. An arrangement of stabilizers is utilized to let the lower sliding part dive tenderly when delivered.

Extension stepping stool or "adaptive stepping stool", a fixed stepping stool partitioned into at least two lengths for more helpful stockpiling; the lengths can be slid together for capacity or slid separated to grow the length of the stepping stool; a pulley framework might be fitted so the stepping stool can be effortlessly stretched out by an administrator on the ground at that point secured utilizing the canines and pawls.

65 ft (20 m), 50 ft (15 m) and nearly 35 ft (10 m) augmentation stepping stools for fire administration use "bangor shafts", "victimizer posts" or "stay shafts" to help raise, rotate, consistent, broaden, place, withdraw and lower them because of the significant burden. Fixed stepping stool, two side individuals joined by a few rungs; fastened to structure with no moving parts.

Folding stepping stool, a stepping stool in the progression stepping stool style with at least one (generally close to three) single direction pivots. Ideal for use on lopsided ground (for example steps), as a beam or when completely broadened a fixed stepping stool. A few varieties highlight a focal single direction pivot with extensible locking legs.

Hook stepping stool or pompier stepping stool, an inflexible stepping stool with a snare at the top to hold a windowsill; utilized by firemen. Mobile Safety Steps are self-supporting constructions that have wheels or castors making them simple to move. They once in a while have a little upper stage and a handrail to help with going here and there the means.

Orchard stepping stool, a three legged advance stepping stool with the third leg made so it tends to be embedded between tree limbs for natural product picking. Platform stepping stool, a stage stepping stool with an enormous stage region and a top handrail for the client to hold while chipping away at the stage. Retractable stepping stool, a stepping stool that seems as though a drainpipe yet can be conveyed right away when required.

7 Roof stepping stool, an inflexible stepping stool with a huge snare at the top to hold the edge of a pitched rooftop. Sectional stepping stool, otherwise called a developer's stepping stool, has segments that fall apart and are exchangeable so that quite a few segments can be associated. Step stepping stool, a self-supporting convenient stepping stool pivoted in the center to frame a transformed V, with stays to keep the two parts at a fixed point.

Step stepping stools have level advances and a pivoted back. Swim stepping stool, a stepping stool utilized by swimmers to escape the water, regularly on boats. Telescoping stepping stool, normally used to allude to a crossover between a stage stepping stool and an augmentation stepping stool with 360-degree pivots; has three sections and can be made separated to shape two stride stepping stools; for example Minimal Giant.

Trestle stepping stool, "A-Frame"- style stepping stool with an extending focus area. Turntable stepping stool, an expansion stepping stool fitted to turning stage on top of a fire engine. Vertically rising stepping stool, intended to move high focuses and encourage suspending at said high focuses.

X-deck stepping stool, a US licensed stepping stool plan that is a blend stepping stool and platform. Rigid stepping stools were initially made of wood, however in the twentieth century aluminum turned out to be more normal in view of its lighter weight. Stepping stools with fiberglass stiles are utilized for chipping away at or close to overhead electrical wires, since fiberglass is an electrical separator.

Henry Quackenbush protected the expansion stepping stool in 1867. 82.1.1.2. Adaptable stepping stools Rope stepping stools or Jacob's stepping stools are utilized where extra room is incredibly restricted, weight should be kept to a base, or in occasions where the item to be ascended is too bended to even consider utilizing an inflexible stepping stool. They may have unbending or adaptable rungs.

Climbing a rope stepping stool requires more ability than ascending an unbending stepping stool, in light of the fact that the stepping stool will in general swing like a pendulum. Jacob's stepping stools utilized on a boat are utilized generally for crises or for impermanent admittance to the side of a boat. Steel and aluminum wire stepping stools are now and again utilized in vertical folding, having created from rope stepping stools with wooden rungs.

Flexible stepping stools are likewise now and again utilized as swim stepping stools on boats. 2.1.2. Security The most basic injury made by stepping stool climbers is wounding

from tumbling off a stepping stool, however bone breaks are normal and head wounds are additionally likely, contingent upon **the idea of the** mishap.

Ladders can slip in reverse attributable to defective base cushions which typically fit into the stepping stool stiles. **In the event that** gravely worn, they can permit the aluminum to contact the ground instead of plastic or elastic, thus bring down the grating with the ground. Stepping stool stabilizers are accessible that expansion **the stepping stool's** **hold on the** ground.

One of the primary stepping stool stabilizers or stepping stool feet was offered in 1936 and today they are standard gear on most huge stepping stools. A stepping stool stalemate, or stay, is a gadget fitted to **the highest point of a** stepping stool to hold it away from the divider. This empowers the stepping stool to address overhanging roadblocks, like the overhang of a rooftop, and expands the protected working stature for a given length of stepping stool due to the 9 expanded partition distance of the two contact focuses **at the highest point of** the stepping stool.

It has gotten progressively normal to give anchor focuses on structures to which the top crosspiece of an expansion stepping stool can be appended, especially for exercises like window cleaning, particularly if an individual specialist isn't accessible for "balance" the stepping stool. Footing happens when another specialist remains on the most reduced bar thus gives a lot more noteworthy soundness to the stepping stool when being utilized.

Anyway balance a stepping stool ought to be viewed if all else fails for a protected position. The anchor point is generally a ring solidified into an opening in the block facade to which the rungs of a stepping stool can be appended utilizing rope for instance, or a carabiner. If an inclining stepping stool is put at some unacceptable point, the danger of a fall is enormously expanded.

The most secure plot for a stepping stool is 75.5°; **on the off chance that** it is excessively shallow, the lower part of the stepping stool is in danger of sliding, and **on the off chance that** it is too steep, the stepping stool may fall in reverse.

This point is accomplished by keeping the 4 to 1 principle for a stepping stool set on a vertical divider: for each four feet of vertical tallness, the stepping stool foot should move one foot from the divider. Both situations can cause critical injury, and are particularly significant in businesses like development, which require hefty utilization of stepping stools. 2.1.3.

Stepping stool classes The European Union and the United Kingdom set up a stepping stool affirmation framework – stepping stool classes - for any stepping stools made or sold in Europe. 10 The affirmation classes apply exclusively to **stepping stools that are** versatile, for example, stepladders and augmentation stepping stools and are separated into three kinds of accreditation.

Each stepping stool confirmation is shading coded to demonstrate the measure of weight the stepping stool is intended to hold, the certificate class and its utilization. The shade of the wellbeing mark determines the class and use. Class 1 stepping stool - for uncompromising modern uses, most extreme heap of 175 kg. Shading coded blue to distinguish. Class EN131 stepping stools - for business utilizes, most extreme heap of 150 kg. No particular shading code.

Class III stepping stools - for light, homegrown utilizations, most extreme heap of 125 kg. Shading coded red to distinguish. In the UK there are various British guidelines remembered for the three fundamental stepping stool affirmations comparative with the specific stepping stool type. Relevant orders incorporate **BS 1129:1990 (British) which applies to Timber Ladders and Steps; BS 2037:1994 (British) which applies to Metal and Aluminum Ladders and Steps and BS EN 131:1993 (European) which applies to both Timber and** Aluminum Ladders and Steps. 2.2. Kinds OF LADDER CLIMBING DEVICES 2.2.1.

Stepping stool climber This paper presents another robot for ascending a stepping stool. The new ascending instrument which we called the "Stepping stool Climber" depends on pendulum type. The key mechanical components comprise of a mover with crawlers and a pendulum with a hefty burden.

The moving crawlers joined to the two sides of the mover are driven two actuators set on the pendulum. The actuator force is communicated to the 11 ascending mover by utilizing a crankshaft belt, which makes the mover move **up the stepping stool** slant.

Simultaneously, the _ Fig.3. Ladder climber 2.2.2.

Stepping stool climbing conveying gadget Stepping stools are utilized in different spots and for an assortment of utilizations, for example, to get to storage rooms in houses, stockrooms, plants, and sewage frameworks. This is on the grounds that stepping stools don't should be introduced in huge spaces or explicit constructions, instead of steps.

In any case, people conveying substantial burdens when utilizing a stepping stool are liable to exhaustion and the danger of falling. In this manner, different robots that are fit for ascending stepping stools to move loads have been contemplated. Notwithstanding,

up until now, these robots were not intended to fit different kinds of stepping stools and were worked with convoluted systems.

Subsequently, in this examination, we have sought after the advancement of a robot that is fit for ascending different kinds of stepping stools utilizing a straightforward connection component. We made an exploratory unit and checked its presentation through reproduction tests utilizing a configurable stepping stool in different tendencies and utilizing various burdens. 12_ Fig.4. Stepping stool climbing conveying gadget Roy et al.[1], detailed data about the absolute first jack which was been presented in the vehicle business.

The jack utilized before need a lot of exertion **to lift the vehicle** for replacing the tire. Yet, presently the changing of the tires has been simple, because of the presentation of the new pneumatic jack. The working of that pneumatic jack was basic, the individual simply needs to interface the jack to the electrical driven blower or blower driven by motor doing so the jack use to get working the vehicle use to get lifted. The jack was steady and simple to work.

Swelling pressure for most standard-sized vehicles is in the scope of 20-25 psig. The pneumatic jack was minimal thus it very well may be put away inside the extra wheel. The present vehicle offers restricted space and unsure lifting techniques thus this offers the suspension engineer impressive opportunity of decision.

Nitin chandra et al.[2], the investigation identified with the switch jack configuration, testing and result acquired with various materials. It was tracked down that the switch is smaller and simple to use when contrasted with the other jack that are accessible on the lookout. In this switch jack it was tracked down that the appropriation of burden is symmetric and uniform.

The Toggle jack lessen the power needed for lifting the vehicle to replace tire or minor fix. The switch jack configuration is basic and comprise of the eight primary parts i.e. the four sections are power screw driven and other four sections are for stacking conditions.

Here the extraordinary plan of the switch jack been acquainted with lift substantial burdens at the steady state with the interesting conditions. The primary pieces of the switch jack are screw and nut, the screw is the moving part and the nut is the fixed part. The materials of the screw and nut were been checked for various materials and stacking conditions from 1kN to 5kN, it was tracked down that the amalgam steel for screw and phosphorus bronze for nut was the most best appropriate mix Sainath et al.[3], the data about the fundamental jack alongside the sorts of Jack's

utilized in the vehicle business, the plan system of mechanical water powered jack is likewise been examined.

The characterization of the jack depends on the powers utilized, the mechanical jack incorporates vehicle jack and house jack, the other is the pressure driven jack they are bottle jack and floor jack. After the legitimate examination and exploration, it was tracked down that the pressure driven jack is more grounded and can lift the substantial burdens at the stature required.

The water powered jack are the most proficient and solid jack accessible on the lookout, they lift the vehicle with the less human exertion and with the assistance of the pressing factor created inside the chamber and oil present inside the chamber. The estimation are been done to get the legitimate component of the jack and make the jack more proficient than the prior. Pawar et al.

[4], the plan of a screw jack and its mechanization are been presented. The jack activity was simple and less exertion was needed to lift the jack it was additionally significantly more solid than the typical essential jack that are physically worked and were utilized before. Presently the alteration are been done in the screw jack made the activity programmed i.e

the mechanized screw jack was present in the car business, the 14 jack was reduced and significantly more dependable. After a few investigations and explores the screw jack it was been tracked down that the jack was not difficult to work, dependable, simple to move and store because of attractive size. Asonye et al.

[5], the investigation is about the plan and creation of pressure driven jack utilizing advanced cell controlled framework and the jack is tried for its viability by changing burdens up to 5 tons. The water driven jack accessible in the market are physically worked and required more endeavors to lift the heap. Contemplating the exertion needed for lifting the heap which was difficult to work the PDA - controlled framework for water driven jack was been presented.

This jack was advanced mobile phone ly controlled so it was not difficult to work when contrasted with the standard jack accessible on the lookout. The fundamental parts utilized were a 12V battery, DC Motor, Crank switch component. The point of putting forth this jack was to diminish the attempt needed to lift the heap and make its simple and straightforward for activity at any heaps.

The outcomes got were viable and it was made that the time needed to lift was least

relying on the weight, this advanced cell controlled framework jack was discovered solid than the manual jack accessible on the lookout. Sudarsan et al. [6], they have planned a programmed water driven Jack. The thought process of plan this undertaking is to give a catch to lift substantial burden, in light of the fact that there are mechanical Jack's which is hard to work and requires more exertion and furthermore the Jack are too enormous to convey, during the tire puncher in the ruler region, uneven areas, woods zone and so on. It is hard to accuse the tire of the mechanical Jack, so they have planned a programmed water powered Jack which is not difficult to work and convey.

The programmed Jack is worked by squeezing a catch which is mounted on a dashboard. Masiwal et al. [7], they have planned a water powered Jack for four wheelers, the motivation behind planning this undertaking is to diminish the mechanical exertion and it assists with saving loads of time while fixing the puncher tire when contrasted with before strategy.

It comprises of primary 15 segments like cylinder chambers which is welded on the body of vehicle. At the point when the driver presses the brake pedal the compressed brake oil goes through non-return valve and move to the cylinder, the cylinder chamber which bring about lifting, the puncher side of the vehicle. Jayapradha et al.

[8], they have planned the water powered jack of self-jacking the fundamental reason for configuration is that the driver can work inside the actual vehicle and it likewise devours less impact and time analyzed of mechanical Jack's. The pressure driven Jack are mounted on the edge and the engines are utilized to control the jack and it associated with the driving rod and furthermore the suspension springs are joined as an afterthought, the 12v battery is given to run the engine, the water powered Jack is worked by the assistance of catch which is mounted on the dashboard. This undertaking is not difficult to mount on skeleton or edge and it's not difficult to adjusting of vehicles.

At the point when the vehicle gets penetrated this framework is extremely useful to supplant the tires and no compelling reason to convey outer Jack. Sharvanan [9], lifting of Automobiles vehicle has utilized by implicit pressure driven jack it's comprises of fundamental parts like water powered chambers, lead screw and solenoid valves. It's worked by squeezing a catch that has been given on dashboard.

The water powered jack is self-greased up and fixed resource with a siphon, which serves to a liquid to compel into a chamber. A vehicle is lifted by the assistance of lead screw and the DC engine. The principle rationale to plan this task is to lessen the human endeavors while lifting of a vehicle. Kamalakkannan et al.

[10], they have created the physically worked screw Jack to a mechanized screw jack to lift the weighty burdens. The physically worked screw jack required more exertion to lift the heap contrast with mechanized screw Jack. The mechanized screw Jack is not difficult to work by squeezing an offered catch to lift the heaps, it is valuable in Automobile administration focus to support a vehicle. The principle motivation to plan the mechanized screw jack is to avoid the sleepiness of a human during lifting of the heap.

The expense of this venture is less and its proficient to work. 16 Barewar et al. [11], they have created a screw jack to programmed. The screw jack is a gadget which is utilized to lift the hefty burdens with the utilization of little power. The exertion which is needed to work the screw jack is made simple and solid by utilizing 12V DC engine, the engine works with the battery utilized in vehicle.

The revolving movement is moved from engine to lead screw through worm gear drive. The stuff which is mounted on engine shaft is pinion and the driver gear is mounted on lead screw caused to move turning movement. By creation of screw Jack it is not difficult to work and lift the substantial burdens by squeezing the switch. Batriwala et al. [12], they have audit on disappointment of screw Jack which is utilized to lift light engine vehicles during adjusting.

This survey is selfishly focus on that the what amount scissor jack can support the heap and furthermore the burdens examination and life of different parts like force screw, base plate and so on There fundamental point is to make the Jack light and happy and strength. Brigham et al. [13], in UG designing courses slider wrench component is utilized for inspecting machine kinematics and coming about powerful powers.

Assurance of the position, speed, speed increase, and shaking powers produced by slider wrench instrument during an activity can be gotten scientifically. From scientific figurings certain components are frequently disregarded, that cause distinction among results and exploratory information. Record of kinematics and Dynamics powers information during activity can be made which can be additionally contrasted with logical qualities by mounting transducer to component. Chandrakar et al. [14], in the field of mechanical designing the system which is for the most part utilized is slider wrench component.

Burning start and sparkle start motor use slider wrench component and in the present time it plays supreme need. Over recent years, broad work has been led in the investigation of dynamic conduct of interconnected unbending or adaptable bodies, for example kinematics and elements impacts of the slider 16 furthermore, wrench

mechanics. Plan programming like MSC. ADAMS were utilized to build up the recreation model of slider and wrench instrument.

Reaction of response powers at joint between driving rod and interfacing bar is seen by performing reenactment at various wrench speed. A man-made brainpower method predicts the plan boundary dependent on reproduction model. Venkateswarlu et al. [15], Power electronic converter controls different electrical machine like DC engine, brushless DC engine, perpetual magnet DC engine.

With the creation of miniature regulator and force gadgets like IGBT, power MOSFET controls have gotten more exact. An endeavor to mimic the appearance or character of a speed control of independently energized DC engine with PID and fluffly regulator has come in light in this paper. Giving proficient technique to control speed exhaustive investigation of displaying examination and speed control plan strategies has been shown in this paper.

Fluffy regulator for thorough investigation of displaying examination and speed control plan technique has been shown with the accessibility of MATLAB/SIMULINK. Tae–Yang et al. [16], a light weight library to create Bluetooth related application in Android climate for remote sensor network is introduced. Enquiry, approval and associate are some essential advances which can be applied for Bluetooth based correspondence.

Novices discover the advancement hard to deal with Bluetooth despite the fact that Google gave a Bluetooth taking care of API as an Android SDK and an instructional exercise. For a straightforwardness to utilize API in Android stage thinking about the troubles, to assist engineers with creating Bluetooth application effectively they planned a standard library which is called Mosca Bluetooth. Yang-Hang et al. [17], area of target or wireless situation from the deliberate RSSI (got signal strength indication) strength is able to utilize the underlying Bluetooth in the phone as the situating gadget.

In this paper, the utilization of 3-point limitation technique [17] assists with deciding the area of an objective hub, 3 RSSI esteems are gathered from 3 test focuses in this technique. Kshirasagar et al. [18], obscure unique qualities of channel impedance which were examined till date are uncovered in this paper. In Bluetooth piconet, expert's gadget address and its local clock decide the channel bounce recurrence at any moment of time.

The Bluetooth gadget address and the asynchrony among their local clock decides the bundle impedance rate in a specific group of Bluetooth aces. Poonam et al. [19], Bluetooth Based Smart Automation System Using Android, in this undertaking they

zeroed in on to diminish human exertion. As the word mechanization is programmed control of working gadgets which serves to decreased human endeavors.

In this day and age, remote innovation assumes significant part in the computerization. Home robotization is one of the advancements arising nowadays. It tends to be worked with in 100m and the Bluetooth which is primarily utilized for information trade, the thought behind this paper is to control home apparatuses like lights, fan and furthermore it gives home security and crisis alarm to be enacted. It additionally helps in saving the energy at the evening.

This venture won't help commoners yet additionally it incapacitates and senior residents. Cotta et al. [20], the exchange of data between at least 2 focuses that are not associated by an electrical conduit is called remote correspondence. Among remote advances radio is most normally utilized.

IR remote correspondence, satellite correspondence, broadcast radio, microwave radio, Bluetooth, Zigbee are various kinds of remote correspondence. Remote correspondence utilizing HC 05 Bluetooth module, network geography and interfacing Bluetooth with Arduino has been talked about in this paper. Wadhani et al. [21], the short thought regarding the utilization of IoT (web of things) and how this innovation been utilized in day to days life making the existence of the individual simple and straightforward.

IoT is the innovation which is identified with every one of the remote gadgets which controls the few gadgets from one gadget, the task has utilized this IoT innovation in computerization of brilliant home and security strategies. The Arduino is utilized for interfacing the sensors. The parts being used are Arduino UNO Board, Relay, DC Motor, Flex sensor, Wi-Fi Module, Reed Relay sensor, Flame sensor, Accelerometer, Arduino IDE, LDR.

The electronically control gadget information is been transferred on the cloud and control through the customized remote gadget. The point of the venture was the use of IoT in shrewd home computerization and security framework making the home more got for individuals. Kang et al. [22], the venture is about the IoT (Internet of Things) alongside utilizations and application.

The client needs to simply give the information and the yield is gotten it very well might be work done or machine or some other remote gadget. Because of this IoT procedure may a few gadgets can be controlled through one single gadget for this both the gadget is associated with a similar organization. The investigation gives how IoT is utilized all over the place and made solid for use.

Utilizing this method, the client simply needs to give order feed and the opposite side we get yield inside right away, for example **on the off chance that** an administrator offers contribution to work the machine utilizing a remote gadget the administrator order is passed on the machine and the machine does the work. **With the utilization of** IoT the client can complete the yield or work or without His/her quality. Bhagat et al.

[23], the investigation of IoT and its application in the auto area. As now the vehicle leaving has become the most serious issue, to leave vehicle openly puts like commercial center, shopping centers and so forth the driver needs to initially discover the vacant space in which the majority of the vehicle fuel gets utilized only just to discover the space for leaving a vehicle.

This IoT innovation **has tackled this issue** of finding the space for vehicle leaving at public. The activity is straightforward when the vehicle enter the leaving place the framework identifies the unfilled space and educate to the framework and afterward space gets holds the space by not permitting the numerous client to save a similar parking spot, **to maintain a strategic distance from** the multi-client approach issue (MUAP) during leaving reservation methodology the framework has a Multi-Queueing Mechanism (MPQM). 19 CHAPTER 3 AIM AND SCOPE OF THE PRESENT INVESTIGATION 3.

Venture objective Two destinations ought to be accomplished from this task: To plan another more secure stepping stool climbing system that is high strength and compact. To create and test the model of new stepping stool climbing system. The manufacture measures includes different cycles. The trial examination of the new stepping stool climbing component done by applying burden and attempts to lift it up.

It **will show whether the** stepping stool climbing instrument can work viable and smooth or any issue happens. 3.1 Project Scope This project creates the model of stepping stool and stepping stool climbing instrument. The instrument parts are not in unique sizes.

Something else, the shape and plan of each part is intently comparable with the first plan.

Since we just create the models, during the test area, the most extreme burden apply is lower than what we expect for the specific plan. This new plan of stepping stool climbing instrument can reach up to a specific stature. The boundaries and plan of each part relies upon these degrees. An instrument which obviously can arrive at this degree level is select and picked. 20 This new plan of stepping stool climbing instrument is for hard core work.

The plan and determination of material component and boundaries relies upon this degree which can go through hard core work. The expense and preparing time can be because of this degree. This new plan of stepping stool component is reasonable for load carriage applications. Since the capacity is for uncompromising work, we expect that this new stepping stool climbing system configuration is appropriate and utilized for indoor/outside undertakings. 3.2

Present Investigation Nowadays, many stepping stool mishaps were happened causing by utilizing a versatile stepping stool which is insecure and dangerous of plan and component. These mechanical issues can impact our wellbeing and life. Thus, this venture is to create and plan another component of stepping stool which is steady and protected to apply without stress over a mishap.

There are six issues or factor that is making or causing a stepping stool insecure and dangerous to utilize: The stepping stool base may sneaks out of position when the stepping stool is at wrong point, laborers ascend excessively quick or the surface underneath the stepping stool is wet, rough or lopsided. Stepping stool should be use at precisely favored point.

Freedom Mutual specialists found that changing a stepping stool's point a simple 10 degrees from 75 to 65 degrees nearly pairs the erosion needed to hold the stepping stool set up. In the event that you increment the specialist's climbing speed, the grinding required bounces again by 7%. In any case, in reality, most specialists have no real way to gauge stepping stool point.

Indeed, a few examinations show that when laborers set up a stepping stool at 75 degrees without an estimation gadget, coming about points shift from 67.3 to 76.2 degrees. This condition can cause a stepping stool mishap. The slip safe feet likewise can't work as expected if the points aren't right or the floor is in elusive condition.

21 Nowadays, stepping stools are less of steadiness during their applications. For instance, we must be cautious for the entire of a task when utilizing the stepping stool. We need to adjust our body position on the stepping stool which needs to restrict our movements and developments. It's difficult to make two positions promptly.

The present circumstance will expand the likelihood of stepping stool mishap. All stepping stools today required the client to hop on it. We may lose our progression or soundness during moving up the stepping stool particularly while conveying an instruments or materials. So this condition precisely will impact the clients adjusting and

causing the stepping stool not steady and protected in plan and system.

There are many stepping stool mishaps happen on account of the stepping stool has not been gotten and begins to slip. An unstable stepping stool is regularly made more precarious by the act of climbing while **at the same time** conveying loads and of exceeding and overbalancing. Climbers are habitually hit by passing trucks, vehicles and even trains. In a few cases, government codes require spotters and blockades.

Stepping stools propped on top of another item to acquire tallness or accommodation regularly move. **On the off chance that the** floor surface or the upper surface is tricky, the stepping stool may slide away from the climber. **That is the reason the** stepping stool component isn't protected to apply.

At the point when we move up the stepping stool, an expanding of tallness level is steady because of the distance between the rungs of the stepping stool. We can't arrive at the precisely tallness. Fixed tallness issue that happens tends to client to make a lot of development on the stepping stool to arrive at the ideal level.

The present circumstance will make the stepping stool less solidness and perilous to utilize. 22 CHAPTER 4
EXPERIMENTAL OR MATERIALS AND METHODS ALGORITHMS 4.

Test Of Prototype Model As there is a duty to shield human from wounds the individuals who are ascending stepping stools with loads, we are receiving the stepping stool climbing conveying robots to move the heaps to required tallness.

As we previously examined, there are numerous robots are planned and manufactured, yet as though they are not given basic components and that costs high to an everyday person, we are executing exceptionally less and powerful working system and transport loads starting with one spot then onto the next place. **At long last, we** will manufacture a stepping stool ascending conveying robot which plays out **every one of the** capacities that other stepping stool climbing trucks/robots does. The fundamental resource of this venture is "Stepping stool".

The robot contains Main edge, Upper arm, Lower arms, Threaded bars, Hollow tube shaped shafts, Guideways, Rack and Pinion, Flat Plates, , Nylon Rollers, D.C. Engines, Battery, Remote, Receiver, Wiring lastly a programmable/configurable information for an ideal activity with far off. This is smaller in size and proficient. These have basic design and less weight. This gives more secure transportation of burdens and helps humanity an easy activity. 23 _ FIG.4.1

VIEW OF LADDER CLIMBING CARRYING ROBOT _ FIG.4, 2 LADDER CLIMBING CARRYING

ROBOT ON LADDER 4.1 Working Methodology Initially arms joined with the body will hold the stepping stool by turning +90 Deg. Pinion on body will pivot to rise the rack to next degree of stepping stool, when the rack top scopes next degree of stepping stool, pinion will quit turning.

Arm mounted on top finish of the rack will hold the stepping stool by turning +90 Deg. Now arms connected with the body will deliver stepping stool by pivoting -90 Deg.

Pinion on the body will turn backward bearing to slide the rack. 24 However the upper finish of the arm is held at next degree of stepping stool the body will be hauled to the following degree of stepping stool.

Once body comes to next level arms joined with the body will hold the stepping stool by turning +90 Deg and Arm mounted on top of the rack will deliver stepping stool by pivoting -90 Deg. The interaction will proceed till the ideal degree of stepping stool is reached. In this task stepping stool climbing measure is accomplished by development of rack and holding arms.

Pinions and arms utilized in this task are driven by box type high force outfitted DC engines. Rack is guided by MS guides on both the sides **to stay away from** side insightful development. Entire activity is completed by utilizing controller. Battery mounted on the body determination the drive engines joined to arms and pinions. 4.2

Adriano Controlling System The Arduino Uno has various offices for speaking with a PC, another Arduino, or other microcontrollers. The ATmega328 give UART TTL (5V) sequential correspondence, which is accessible on advanced pins 0 (RX) and 1 (TX). A Software Serial library takes into consideration sequential correspondence on any of the Uno's advanced pins. The ATmega328 likewise uphold I2C (TWI) and SPI correspondence.

The **Arduino programming incorporates a Wire library to** work on utilization of the I2C transport. 25 Fig: 4.3 Arduino Uno 4.3 Bluetooth Module Arduino-Uno board doesn't uphold Bluetooth association all alone, which makes interfacing it remotely to an Android gadget outlandish. So a medium between the Arduino-uno board and android gadget is required and in this task it is a Bluetooth module explicitly the HC-05 Bluetooth module.

The HC-05 is an easy to understand need just essential information and it is programmable utilizing the AT orders. Fig: 4. 4 Bluetooth association 4.4 Software Implementation The programming activity was performed by C language utilizing arduino IDE. Each program had its exceptional capacity. The Arduino language is just a

bunch of C/C++ capacities that can be called from your code.

Your sketch goes through minor changes (for example programmed age of capacity models) and afterward is passed straightforwardly to a C/C++ compiler. 26 4.5 Motor Driver L298 The drive hardware for a H-Bridge is fundamentally the gadgets that sits between the PWM (and conceivably other) advanced control inputs and the MOSFET doors. It has two significant purposes: ? Translate the info voltages to appropriate levels to drive the doors.

? Provide sufficient current to charge and release the entryways adequately quick. Fig:

4.5 1293d H-Bridges are normally utilized in controlling engines speed and course, yet can be utilized for different ventures, for example, driving the splendor of certain lighting undertakings like powerful LED clusters.

A H-Bridge is a circuit that can drive a current in one or the other extremity and be constrained by Pulse Width Modulation (PWM). * Pulse Width Modulation is a methods in controlling the term of an electronic heartbeat. 4.6 Ball Bearings A metal roller is a kind of moving component bearing that utilizes balls to keep up the detachment between the bearing races.

The reason for a metal roller is to decrease rotational rubbing and backing outspread and hub loads. 27 It accomplishes this by utilizing in any event two competitions to contain the balls and send the heap through the balls. In many applications, one race is fixed and the other is connected to the pivoting gathering (e.g., a center or shaft).

As one of the bearing races turns it makes the balls pivot too. Since the balls are moving they have a much lower coefficient of rubbing than if two level surfaces were sliding against one another. Metal balls will in general have lower load limit with respect to their size than different sorts of moving component orientation because of the more modest contact region between the balls and races. Nonetheless, they can endure some misalignment of the inward and external races. 4.7

Deep-Groove Ball Bearings In a profound score outspread bearing, the race measurements are near the elements of the balls that run in it. Profound notch orientation uphold higher burdens than a shallower groove. Like rakish contact heading, profound score direction uphold both spiral and hub loads, yet without a decision of contact point to permit decisions of relative extent of these heap limits. They are normally utilized in electric engines, blowers, fans, and transports. 4.8

Benefits Flexibility—on the grounds that they can convey spiral and hub loads, they

have a more extensive scope of uses for some businesses Cost reserve funds—Deep furrow metal rollers make less erosion force. This brings down working temperature (which expands the existence of the bearing) and lessens energy cost of running gear, (for example, transport lines).

Less upkeep—Because of their basic plan, low working temperature, and low contact, profound depression metal rollers have a more extended expected time span of usability than different orientation. 28 They don't need extra grease after establishment, which likewise implies less support vacation. 4.9 Design Specifications __ TABLE.4.1. DIMENSIONS 29 _TABLE 4.2. ABUTMENT DIMENSIONS _TABLE 4.3. CALCULATION DATA 30 4.10 D.C.

Engines ADC engine is any of a class of revolving electrical machines that converts direct flow electrical energy into mechanical energy. The most widely recognized sorts depend on the powers delivered by attractive fields. Essentially a wide range of DC engines have some inward system, either electromechanical or electronic; to intermittently alter the course of current stream in piece of the engine. DC engines were the principal type of engine generally utilized, as they could be fueled from existing direct-current lighting power dispersion frameworks.

ADC engine's speed can be controlled over a wide reach, utilizing either a variable stock voltage or by changing the strength of current in its field windings. Little DC engines are utilized in devices, toys, and machines. The widespread engine can work on direct current yet is a lightweight brushed engine utilized for compact force apparatuses and machines.

Bigger DC engines are presently utilized in impetus of electric vehicles, lift and raises, and in drives for steel moving factories. The coming of force hardware has made supplanting of DC engines with AC engines conceivable in numerous applications. They offer higher beginning force and sped up power over a wide reach. They are ideal for ease activity and are without the Harmonic Effect.

hello give you fast authority over the engines and offer improved speed guideline. The Electronics and Rectification are negligible. Here, in this task we utilized box type high force outfitted DC engines. 31 _FIG. 4.6. BOX TYPE HIGH TORQUE GEARED DC MOTORS

4.11 Battery The lead—corrosive battery was concocted in 1859 by French physicist Gaston Plante and is the soonest, yet still most broadly utilized, kind of battery-powered battery.

Regardless of having a low energy-to-weight proportion and a low energy-to-volume

proportion, its capacity to supply high flood flows implies that the cells have a moderately huge ability to-weight proportion. These highlights, alongside their ease, make them alluring for use in engine vehicles to give the high current needed via car starter engines.

As they are cheap contrasted with more up to date innovations, lead–corrosive batteries are generally utilized in any event, when flood current isn't significant and different plans could give higher energy densities.³² The electrical energy delivered by a releasing lead–corrosive battery can be ascribed to the energy delivered when the solid synthetic obligations of water (H_2O) particles are shaped from H^+ particles of the corrosive and O_2 - particles of PbO_2 .

On the other hand, during charging the battery goes about as a water-parting gadget, and in the charged express the substance energy of the battery is put away in the likely distinction between the unadulterated lead at the negative side and the PbO_2 on the positive side, in addition to the Sulphuric Acid in fluid condition. Lead–corrosive batteries are utilized in crisis lighting and to control sump siphons if there should be an occurrence of force disappointment.

Foothold (impetus) batteries are utilized in golf trucks and other battery electric vehicles. Enormous lead-corrosive batteries are additionally used to control the electric engines in diesel electric (customary) submarines when lowered, and are utilized as crisis power on atomic submarines too. Valve-directed lead corrosive batteries can't spill their electrolyte.

They are utilized in back-up power supplies for alert and more modest PC frameworks (especially in uninterruptible force supplies; UPS) and for electric bikes, electric wheelchairs, charged bikes, marine applications, battery electric vehicles or miniature cross breed vehicles, and bikes. Numerous electric forklifts use lead-corrosive batteries, where the weight is utilized as a feature of a stabilizer.

Lead-corrosive batteries were utilized to supply the fiber (radiator) voltage, with 2V normal in early vacuum tube (valve) radio beneficiaries. Versatile batteries for diggers' cap lights headlamps regularly have a few cells. Smelling salts can kill spilled sulfuric acid. Surplus alkali and water vanish, leaving an ammonium sulfate buildup. Sodium bicarbonate (heating pop) is likewise ordinarily utilized for this reason.

³³ Lead–corrosive battery reusing is perhaps the best reusing programs on the planet. A compelling contamination control framework is a need to forestall lead outflow.

Persistent improvement in battery reusing plants and heater plans is needed to stay up

with outflow norms for lead smelters. Here, in this task, we have utilized 12V, 3.5 Amps battery. _ FIG.4.7 BATTERY
4.12 Fabrication Of Ladder A stepping stool comprises of props and rungs.

A stepping stool's arrangement relies exclusively upon the width, rung stretch, tendency point, rung shape, and whether props are utilized. **Every one of these** components is utilized as boundaries to demonstrate the adaptability of stepping stools. In particular, the cross piece span was characterized as l , the width was characterized as w , and the tendency point was characterized as θ .

Material for the prop utilized is M.S Box Channel of 50*25 mm size and of length around 3657.6 mm (12 feet). 34
Material for rungs utilized is M.S Box Channel of size 25*25*13 Inch and rung stretch (l) between rungs is 304.8 mm (12 Inch). Rung width (w) is of 330.2 mm (13 Inch). Tendency point is anyway will associate with 70-80 Degrees. Zinc oxide is utilized for covering/painting the stepping stool to shield from rust.

Electric bend welding is utilized for joining interaction of prop and rungs at a voltage of 120 Volts. _ FIG.4.8 PREPARING THE PROP FOR JOINING THE RUNGS _ FIG.4.9 MARKING THE RUNG MATERIAL FOR CUTTING RUNGS _ FIG.4.10 CUTTING OF THE RUNGS 35 _ FIG.4.11 GRINDING THE FACES OF THE RUNGS FOR SMOOTHNESS _ FIG.4.12 JOINING THE RUNGS & PROP _ FIG.4.13 FINISHED LADDER 36
4.13 Fabrication Of Main Frame The fundamental edge is the skeletal design of the robot.

It goes about as the case for the framework. All the heaps applied are appropriated absurd. Components and connections are joined to the principle outline for help and equilibrium. The material utilized is M.S Flat Plate of 300*305*2.5 mm. _ FIG.4.15 CUTTING THE MAIN FRAME FROM RAW MATERIAL _ FIG.4.16 MARKING THE DIMENSIONS FOR SETTING GUIDEWAYS 37
4.15 Assembly of m.s. Point guides The M.S.

Point Guides are one of the significant components of robot and its fundamental capacity is to ensure that the rack moves along the ordained way. The movement of rack is for the most part straight line in **the middle of the** point guides. They have high inflexibility. The surface of point guides has more prominent precision and surface completion. They give high exactness of movement. They are solid. _ FIG.4.17 VIEW OF M.S.

ANGLE GUIDES ON THE MAIN FRAME 4.16 Assembly Of Rack and Pinions **Rack and pinion blends are frequently utilized as a component of a straight forward direct actuator, where the turn of a shaft fueled by hand or by an engine is changed over to**

direct movement.

The rack conveys the full force of the actuator straightforwardly thus the driving pinion is generally little, so the stuff proportion decreases the force required. This power, consequently force, may in any case be generous thus it is regular for there to be a decrease gear preceding this by either a stuff or worm gear decrease. 38 Rack gears have a higher ratio, thus require a greater driving torque, than screw actuators. _ FIG

4.18 RACK & PINION ASSEMBLY • A rack and pinion is a sort of straight actuator that contains a roundabout stuff (the pinion) drawing in a direct stuff (the rack), which work to make an interpretation of rotational movement into direct movement. • Driving the pinion into revolution makes the rack be driven directly.

- Driving the rack straightly will make the pinion be crashed into a turn. • The material utilized is M.S. The length of the rack is around 3 feet with 115 teeth all through its length of pitch 6mm. 39 _fig 4.19 view of rack and pinion with in the guideway on main frame 4.17 Motor Support Plates • It is a plate that bolsters the engines with the assistance of screw fittings.

They are welded to primary casing utilizing one of its bases. • Drill pieces of 12.5 mm, 5 mm and 6 mm are utilized. _ FIG 4.20 MARKING OF DIMENSIONS ON MOTOR SUPPORT PLATE 40 _ FIG 4.21 VIEW OF MOTOR SUPPORT PLATE AFTER MARKING _ FIG 4.22 DRILLING CENTRE HOLE USING DRILL BIT @12.5 MM _ FIG 4.23 DRILLING 4 HOLES USING DRILL BIT @ 5 MM 41 _ FIG 4.24 Robotics DRILLING 4 HOLES USING DRILL BIT @ 6 MM IF OVERSIZE IS REQUIRED _ FIG 4.25 VIEW OF MOTOR SUPPORT PLATE AFTER DRILLING REQUIRED HOLES _ FIG 4.26 REDUCING SCREW LENGTH TO FIT EXACTLY INTO MOTOR THREADING 42 _ FIG 4.27 VIEW OF MOTOR SUPPORT PLATE AFTER FITTING TO A D C MOTOR _ FIG 4.28 VIEW OF WELDING OF MOTOR SUPPORT PLATE

TO THE MAIN FRAME 4.18 Threaded Rods and Roller Assembly A strung pole, otherwise called a stud, is a generally long pole that is strung on the two closures; the string may reach out along the total length of the bar. They are intended to be utilized in pressure. Strung pole in bar stock structure is frequently called all-string. 43 _ FIG 4.29 THREADED RODS _ FIG 4.30 VIEW OF THREADED RODS AFTER WELDING TO MAIN FRAME 44 _ FIG

4.31 VIEW OF THREADED RODS WITH NYLON ROLLERS Nylon rollers are utilized for a smooth development of the robot on the prop of the stepping stool.

It has external measurement of 52 mm and Inner distance across of 32 mm These are essentially positioned on strung poles; thus they pivot during the development of the robot and ventures easily with irrelevant measure of vibration. It involves Deep furrow metal rollers named BRG-6201Z and related data is examined in detail underneath.

Absolutely 4 Nylon rollers are utilized for the robot on its four contact places between the prop and robot. 45_ FIG 4.32
NYLON ROLLERS_ FIG 4.34 VIEW OF NYLON ROLLERS

ON ROBOT 46 4.19 Upper Arm Normally Upper Arm is the principal arm that is arranged at the highest point of the rack, (particularly one of the pieces of the robot) welded to an empty barrel shaped shaft connected to the engine shaft with the assistance of a grub screw. It bears robot load just as the weight conveyed by the robot.

Here the engine is associated with its help plate with 3/8 inch screw fittings and this plate is welded to the edge of the highest point of the rack on its plane side. So this gives the movement to the upper arm to hold/discharge onto/from the rungs at a particular opportunity to make a trip starting with one crosspiece then onto the next. _ FIG 4.35 CUTTING OF ARM @ 125MM_ FIG 4.36 BENDING OF M.S. FLAT 47_ fig 4.37

view of upper arm on robot 4.20 Lower Arms Generally Lower Arms are the auxiliary arms that are arranged at the top and rear to the principle edge of the robot that holds the rungs till the upper arm goes to a particular rungs.

After upper arm holds a particular crosspiece, at that point the lower arms get delivered from the rungs and subsequent to going to a particular bar, these arms hold the rungs once more. Here the engine is associated with its help plate with 3/8 inch screw fittings and this plate is welded on the primary edge as prior talked about.

So this gives the movement to the lower arms to hold/discharge onto/from the rungs at a particular chance to go starting with one crosspiece then onto the next. These arms are likewise welded to an empty round and hollow shaft appended to the engine shaft with the assistance of a grub screw. 48_ FIG 4.38 CUTTING OF ARM @ 115MM_ FIG

4.39 BENDING OF M.S. FLAT_ FIG 4.40 VIEW OF LOWER ARMS ON THE LADDER 49 4.21 Motor Shaft Coupling • These are utilized as transitional component between the arms and the engine just as to hold the pinion gear on its turned part on one side.

Grub screw is fitted into the stringing to capture the development of this shaft on engine shaft and fit firmly, so development is accommodated the end parts like arms and pinion gear. _ _ FIG 4.41 FIG 4.42 FIG 4.43 FIGURES. 46, 47, 48. PINION GEAR & CYLINDRICAL SHAFT ARRANGEMENT_ FIG 4.44 CYLINDRICAL SHAFT SURFACE GRINDING 50_ FIG 4.45 DRILLING @ 10 MM TO PROVIDE CLEARANCE B/W SHAFT AND PINION_ FIG 4.46 VIEW OF CYLINDRICAL SHAFT AND PINION GEAR_ FIG 4.47 JOINING OF CYLINDRICAL SHAFT & PINION GEAR USING ARC WELDING 51_ FIG 4.48 SURFACE GRINDING AFTER JOINING PROCESS_ FIG 4.49 CYLINDRICAL SHAFT WITH THREADING WELDED TO ARM 52_ FIG 4.50 ARC WELDING PROCESS OF CYLINDRICAL SHAFT & ARM_ FIG 4.51 VIEW OF CYLINDRICAL SHAFT AND ARMS 53 4.22 CALCULATIONS 4.22.1

Motor Power Calculation for Pinion • Mass of Robot = 10 kg • Mass to be climbed by each pinion = 5 kg • Radius of Pinion (r) = 0.0127m • Force (F) = $m \times g = 5 \times 9.81 = 49.05 \text{ N}$ • Torque (T) = $r \times F = 0.0127 \times 49.05 = 0.62 \text{ N-M}$ • Speed of engine (N) = 10 rpm. • Power = $2 \times 3.14 \times 10 \times 0.62 / 60 = 0.62 \text{ W}$ • Maximum power required is 12.83W and chosen engine power rating is 30W which is higher than required. 4.22.2

Top Holding (Upper) Arm Calculation • Mass of Robot = 10 kg • Mass following upon holding arm = 10 kg • Radius of Arm (r) = 0.125m • Force (F) = $m \times g = 10 \times 9.81 = 98.1 \text{ N}$ • Torque (T) = $r \times F = 0.125 \times 98.1 = 12.26 \text{ N-M}$ • Speed of engine (N) = 10 rpm. • Power = $(2 \times 3.14 \times 10 \times 12.26) / 60 = 12.83 \text{ W}$ 4.23 Side Holding (Lower) Arm Calculation • Mass of Robot = 10 kg • Mass following upon each holding arm = 5 kg • Radius of Arm (r) = 0.125m • Force (F) = $m \times g = 5 \times 9.81 = 49.05 \text{ N}$ • Torque (T) = $r \times F$

= $0.125 \times 49.05 = 6.13 \text{ N-M}$ • Speed of engine N = 10 rpm. • Power = $2 \times 3.14 \times 10 \times 6.13 / 60 = 6.42 \text{ W}$ 55 CHAPTER 5 RESULTS AND DISCUSSION PERFORMANCE ANALYSIS

5.

Prologue to Cad PC helped plan (CAD), otherwise called PC supported plan and drafting (CADD), is the utilization of PC innovation for the interaction of plan and plan documentation. PC Aided Drafting portrays the way toward drafting with a PC. CADD programming, or conditions, gives the client input-apparatuses to smooth out plan measures; measures.

CADD yield is regularly as electronic records for print or machining tasks. The advancement of CADD-based programming is in direct relationship with the cycles it tries to conserve; industry-based programming (development, fabricating, and soon) regularly utilizes vector-based (straight) conditions while realistic based programming uses raster-based (pixilated) conditions. 5.1

SOLIDWORKS Strong Works is mechanical plan computerization programming that exploits the natural Microsoft Windows graphical UI. It is a simple to-learn instrument which makes it feasible for mechanical fashioners to rapidly outline thoughts, try different things with highlights and measurements, and produce models and itemized drawings. A Solid Works model comprises of parts, congregations, and drawings.

Typically, we start with a sketch, make a base component, and afterward add more highlights to the model. (One can likewise start with an imported surface or strong math). We are allowed to refine our plan by adding, changing, or reordering highlights. 56 Associativity between parts, congregations, and drawings guarantees that changes made to one view are naturally made to any remaining perspectives.

We can produce drawings or gatherings whenever in the plan cycle. The SolidWorks programming allows us to redo usefulness to suit our necessities. __ 57 __ 58 __ 59 __ 60 __ 61 __ 62 __ 63 __ 64 __ 65 5.2 Advantages over existing gadgets 5.2.1 Advantages over single engine type • Our model can rise just as dive on stepping stool which isn't workable for single engine plan.

- Process is cyclic; consequently we can rehashtask on numerous occasions.
 - The model can receive different sizes of stepping stools (Width and Intervals)
- 5.3 Advantages over Pendulum Type • Weight of our machine is less, subsequently require less force • The model can embrace different sizes of stepping stools (Width and Intervals) • Chances of slippage are less
- 5.4

Applications Transportation and Logistics Utilized for conveying the specialists own apparatuses or hardware for upkeep or assessment errands in working environments like pinnacles, sewer vents, passages, and extensions. In scenes that couldn't be shipped by the stepping stool can't **manage the cost of** the space and burden ability to the two individuals and load ascend, the stepping stool climbing gadget will prompt energy saving as option in contrast to forklift and crane. 66 **In the field of** salvage activities.

Spying works for security issues.

Monitoring purposes utilizing fixed observation cameras. Cleaning dividers of high rises without danger of mishaps In thermal energy stations. In applications like computerized or tele—distant controlled (semi-mechanized) development. In firefighting robots that can move over harsh landscape alongside carriage of water hoses. Increased movability because of light weight plan.

Capable of supported movement for expanded times of activity. 5.5 Future Scope Stepping stool climbing robot can be furnished with high exactness sensors to work autonomously anyway it requires significant level programming and costly sensors 67 SECTION 6 SYNOPSIS AND CONCLUSIONS 5.

End Here a mechanical framework having three arms which is fit for movement in lopsided surfaces just as ascending stepping stools is talked about.. This machine has two sections: the regulator part and the mechanical part. We utilize arduino board to control the entire activity. The movement of the robot is planned by hand developments. It can diminish human work generally. It is intended to move in both vertical just as level bearings.

It utilizes a zigbee transmitter module and collector module for transmission from

essential regulator part and gathering by mechanical part for amazing planning. It is viable with any model of stepping stool. The activity is totally client controlled and subsequently blunder rate is least. The weighty battery seepage and powerlessness to convey hefty burdens are the significant downsides. Force saving should be taken to thought in next stages.

As the quantity of sensors increment the planning of movement of arms become simpler. More number of sensors can be presented. High force servomotors can be utilized to expand the heap conveying limit. Selected engines are conveying required force for stepping stool climbing activity. Pinions, side arms and top arm engines can take invert force without falling flat. Present configuration permits us for different widths and timespans.

Robot can rise and dive on stepping stool with no slippage. Provided on board battery helped keeping away from outside wiring. Robot is tried for rising and diving utilizing controller. 68 5.1 Future Scope of Work The accompanying bearings could be sought after for the future upgrade of the current task in Terms of completely or incomplete (work explicit) independent activity: Develop control calculations and detecting strategies that permit the half breed portable robot System to work independently in unstructured conditions. Redesign the framework for generally weight decrease without compromising with its payload Capacity.

In the future work, sensors, cameras, controllers can be added to the robot outline. The Robot would then be able to serve complex errands in perilous regions distantly. 69 REFERENCE [1]. Roy L. Orndoff and James Sidles, "A New Automotive jack," SAE Technical paper 700179, 1970, ISSN: 0148-7191, <http://doi.org/10.4271/7001179> [2]. Prof. Nitinchandra R.

Patel, Sanket Kumar Dalwadi, Vijay Thakor and Manish Bamanaya, "Plan of Toggle jack considering material choice of screw-nut mix," *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 2, Issue 5, May 2013 www.ijirset.com [3]. K. Sainath, Mohd Salahuddin b Mohd Jibrin Baig, Md Azam Ali Farooky, Mohammed Siddique Ahmed, Mohd Riyaz Udin, Faraz Ur Rehman Azhar and Md Shaffi, "Plan of Mechanical Hydraulic Jack" *IOSR Journal of Engineering (IOSR JEN)*, ISSN (e): 2250-3021, ISSN (p): 2278-8719, Vol. 04, Issue 07 (July. 2014), ||V1|| PP 15-28, www.iosrjen.org. [4]. Pawar R. R., Shinde M.S., Shinde A.B.,

Garde M.B and Prof. Bhane A.B. Recent "Advances in Automobile: Need of Motorized Screw Jack: A Review" *International Journal of Recent Development in Engineering and Technology*, (ISSN 2347-6435 (Online) Volume 4, Issue 4, April 2015), www.ijrdet.com [5].

ASONYE G. U., Nnamani C.E. what's more, Alaka and C.A, "Plan and manufacture of Smart telephone Controlled System for Hydraulic Jack", *International Research Journal of Engineering and Technology* (IRJET), Volume: 02 Issue: 07, Oct-2015, www.irjet.net [6].

R. Sudarsan, Salin Sasankan and P.Nicholas Niranjana, Automatic Hydraulic jack, *International Journal of Innovative Research In Technology* (IJIRT) 144625, June 2017, Volume :4 Issue: 1, ISSN: 2349-6002, www.ijirt.net.

70[7]. Aditya Masiwal, Aman Kanungo, Ishan Rawley, Devendra Jha, Ashutosh Singh, Dhruv Kumar and Ram Jatan Yadav, Design and creation of Hydraulic Jack framework for four wheelers, *International Research Journal of Engineering and Technology* (IRJET), Volume: 05 Issue: 04, Apr-2018, www.irjet.net [8].

Jayapradha P, Krishna Kumar and Priyadharshini, *Design and Fabrication of Hydraulic Jack (Self Jacking)*, International diary of *Engineering Development and Research* (IJEDR), 2019, Volume 7 Issue 3, ISSN: 2321-9939, www.ijedr.org [9]. R. Sharvanan, Design of Built-In Hydraulic Jack for Light Motor Vehicles, Volume: 8 Issue: 8, August 2017, *ISSN Print: 0976-6340 and ISSN Online: 0976-6359*, pp1649–1655, Article ID: IJMET_08_08_179, <http://www.iaeme.com/IJMET/issues.asp?JType=IJMET &VType=8&IType=8> [10]. Kamalakkannan.A, Kalaiselvan.P, Isaac.R and Vijay.

V, Automatic mechanized screw jack to diminished labor, *International Journal of Scientific and Engineering Research*, Volume: 7, Issue: 5, May-2016, ISSN 2229-5518 <http://www.ijser.org> [11]. Abhishek Madhukar Barewar, Abhishek Ashok Padole, Yugal Dhanpal Nagpure, Pranav Shivraj Gaupale, Sagar Bhimraoji Nagmote, Chandankumar Ram and Rupali Suresh Raut, Fabrication of programmed screw jack, *International Journal of Advance Research and Development* Volume 3, Issue 4, www.ijarnd.com [12].

Batriwal Taha, Kathiria Kutbuddin, Koonath Shreyas, Labana Khushwant and Mr. Saksena Nirav, A Review on Failures of Scissor Jack International Conference on Current Research Trends in Engineering and Technology 2018 IJSRSET, Volume 4 Issue 5 Print ISSN: 2395-1990, Online ISSN: 2394-4099, 10-April 2018, March-April-2017 (4) 5: 554-560 www.ijsrset.com 71 [13].

Eric Brigham, Chris Destefano and Zachary Killoy, "Slider wrench Mechanism for showing And Experimentation", April 25, 2013, <http://web.wpi.edu> [14]. Bhupesh Chandrakar and Manmohan Soni, "Plan and Optimization of Slider and Crank Mechanism with Multibody Systems" *International Journal of Science and Research* (IJSR) ISSN (Online): 2319-7064 *Index Copernicus Value (2013): 6.14*, Impact Factor (2013): 4.438. [15]. Dr. Ch.

Chengaiyah and Venkateshwarlu, Comparative Study on DC Engine speed control utilizing

different regulators, Volume: 3 Issue:1, Jan 2014 <http://www.ijareeie.com> [16]. Tae-Yang Lee, Ki-Hoon Kim and Gu-Min Jeong, "Plan of an Easy-to-Use Bluetooth Library for Wireless Sensor Network on Android", Contemporary Engineering Sciences, Vol.7, 2014, no. 16, 801–805 HIKARI Ltd, <http://dx.doi.org/10.12988/ces.2014.4694> [17].

Yang-Hang Lee, Kuo-Wei Ho, Hsien-Wei Tseng, Chih-Yuan Lo, Tzu-Cheng Huang, Ji-Yu Shih and Tsai-Hua Kang,, "Precise Bluetooth Positioning Using Large Number of Devices Measurements", Proceedings of the International Multiconference of Engineers and Computer Scientists 2014 Vol II, IMECS 2014, March 12 - 14, 2014, Hong Kong [18].

Kshirasagar Naik, Veluppillai Mahinthan, "Effects of Bluetooth Device Addresses and Native Clocks on Packet Interference in Piconets", Journal of Wireless Networking and Communications 2014, 4(2): 42-48 DOI: 10.5923/j.jwnc.20140402.02 [19]. Poonam V. Gaikwad, and Yoginath R.

Kalshetty Bluetooth based shrewd robotization framework utilizing android, worldwide diary of science and research (IJSR), ISSN(Online): 2319-7064, volume: 6 Issue:05, May 2017, www.ijsr.net 72 [20]. Mrs. Anisha Cotta, Miss. Naik Trupti Devidas and Miss. Varda Kalidas Naik Ekoskar, "Remote Communication utilizing HC-05 Bluetooth module interfaced with Arduino, ISSN: 2278 – 7798 International Journal of Science, [21] T. Bretl : Motion Planning of Multi-Limbed Robots Subject to Equilibrium Constraints: The Free-Climbing Robot Problem, International Journal of Robotics Research 4; 317-342, 2006 [22] H. Iida, H. Hozumi and R. Nakayama : Development of Ladder Climbing Robot LCR-1, Journal of Robotics and mechatronics, vol.1, No.4, pp 311-316, 1989.

[23] Fujii S, Inoue K, Takubo T, Mae Y : Ladder ascending control for appendage instrument robot "ASTERISK", IEEE International Conference on Robotics and Automation ICRA 2008. [24] Yoneda, H, Micro-Nano Syst. Eng, Nagoya Univ, Nagoya, Sekiyama, K., Hasegawa Y, Fukuda T: Vertical stepping stool climbing movement with act control for multi-headway robot, IEEE/RJS International Conference on Intelligent Robots and Systems, 2008. [25] K. Bouyarmane, J. Vaillant, F. Keith, and A.

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