

DEVELOPMENT OF STAIR CLIMBING ROBOT FOR GOODS TRANSPORT

Submitted in fulfillment of the requirements for the award of
Bachelor of Engineering degree in Mechatronics

by

S. Karthikeyan (39090015)

Prasanth S (39090705)



**DEPARTMENT OF MECHATRONICS
SCHOOL OF MECHANICAL ENGINEERING**

SATHYABAMA

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

**Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

MAY - 2023



SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with “A” grade by NAAC | 12B Status by UGC | Approved by AICTE

Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119

www.sathyabama.ac.in

DEPARTMENT OF MECHATRONICS

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of S. Karthikeyan (39090015) and Prasanth S (39090705) who have done the project work entitled “Development of Stair Climbing Robot For Goods Transport” under our supervision from June 2022 to May 2023

Internal Guide

Mr. K. BALACHANDAR, M. Tech., (Ph.D).,

Head of the Department

Dr. S. Prakash M.E., Ph.D.

Submitted for Viva Voce examination held on _____ May 2023

Internal Examiner

External Examiner

DECLARATION

We, **S. Karthikeyan (39090015) and Prasanth S (39090705)**, hereby declare that the Project Report entitled “**Development of Stair climbing robot for goods transport**” done by us under the guidance of **Mr. K. BALACHANDAR, M. Tech., (Ph.D)**., is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechatronics Engineering.

1. 

2. 

DATE: _____ **May 2023**

PLACE: Chennai, Tamil Nadu

SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of SATHYABAMA for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my thanks to Dr. S. Prakash M.E., Ph.D., Dean and Head of Department of Mechatronics, School of Mechanical Engineering for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide Mr. K. BALACHANDAR, M. Tech., (Ph.D.), Assistant Professor, Department of Mechatronics, School of Mechanical Engineering for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I wish to express my thanks to all Teaching and Non-teaching staff members of the Department of Mechatronics who were helpful in many ways for the completion of the project.

I would also wish to thank my parents for all the tireless efforts they made for making me able to do what I do today.

ABSTRACT

In today's life, robots are employed to function in dangerous and urban situations, for security, and in operations, robot technology is crucial in many areas of modern life. While some robots are made to function only on natural surfaces, others can also navigate obstacles like stairs and rocky terrain. load. The design, mechanism, and analysis are discussed in depth. Rocker bogies are crucial for doing in-situ scientific investigation of objects that are distant by many meters to tens of kilometers.

A six-wheeled rover with a highly effective suspension system that can move through uneven terrain the simplicity of the drive train, achieved by using just two motors for mobility, is the main mechanical aspect of the rocker bogie design. This article discusses the creation of a vehicle that can climb stairs and move across extremely rough terrain. The stability and speed of the vehicle when climbing stairs are the technological challenges in the design of this vehicle. However, this study's main issue also centers on how steep the steps are. The frequent lifting of items like books for libraries, medications for hospitals, regular mail for any institutes, or transportation of any toxic material for industries are all uses for this particular vehicle. It also allows people who are retarded or paralyzed to move freely over flat surfaces and stairs. To maintain its weight when travelling over level ground, the vehicle features six sets of wheels to make a robot that can climb stairs using a six-wheeled system.

TABLE OF CONTENTS

SI NO	CONTENTS	PAGE NO
1	INTRODUCTION	1
	1.1STAIR CLIMBING ROBOT	4
	1.2TYPES OF STAIR CLIMBING ROBOT	7
	1.3COMPONENTS OF STAIR CLIMBING ROBOT	12
	1.4COMPARISION BETWEEN WHEELED AND LEGGED ROBOTS	20
2	LITERATURE SURVEY	21
	AIM AND SCOPE OF PRESENT STUDY	26
3	3.1 AIM	26
	3.2 SCOPE OF CURRENT INVESTIGATION	27
	EXPERIMENTAL OR MATERIALS AND METHODS	28
4	4.1 MATERIAL SPECIFICATIONS	28
	4.2 WORK PROCESS	29
	4.3 CONCEPTUAL DESIGN	30
5	RESULTS AND DISCUSSIONS	34
	5.1 DESIGN CALCULATION	34
	5.2.FABRICATION MODEL	37
6	SUMMARY AND CONCLUSIONS	39

LIST OF TABLES

TABLE NO	TITLE	PAGE NO
Table 1.4	COMPARISION BETWEEN WHEELED AND LEGGED ROBOTS	20
Table 1.5	MATERIAL SPECIFICATIONS	28

LIST OF FIGURES

FIG NO	TITLE	PAGE NO
4.3a	A Stair Climbing Robot Seen From Above	32
4.3b	A Robot seen from Front	32
4.3c	Side View Of A Robot That Climbs Stairs	33
5.1a.	Drawing for First Triangle	34
5.1b	Drawing for Second Triangle.	34
5.1c.	Dimensions of both up and down of a stair climbing robot.	35
5.2a.	Response of the rocker-bogie suspension when bearing a weight against the height of an obstruction	35
5.2b.	Response of improved rocker-bogie suspension while carrying weight to obstacle height.	36
5.2c.	Comparison of each suspension's performance when bearing a weight versus the height of an obstruction	36
5.3a	Top View	37
5.3b	Front View	37
5.3c	Side View	38

CHAPTER 1

INTRODUCTION

One of the most alluring performances of robot in legged and wheeled is adjustable stair climbing robot. A variety of stair climbers have undergone developments in order to increase their capacity for ascent as well as make their mechanical complexity acceptable and usable. Realising that bargaining is a significant step in research Reduced calorie intake and body weight are also crucial components of development.

We present a few ways to implement the stair climbing devices we invented. Each of them performs well in an area of their own, such as the numerous wheeled shape categories. A machine is a group of mechanisms that transfer force from a power source to a load that needs to be overcome in order to carry out productive mechanical work. The field of automation known as robotics. In the early days, so many researchers have developed a legged robot that can easily pass the obstacle and go on rough terrain comfortably. But it's a fact that the energy required in a legged robot for locomotion was much more than a wheeled robot. There are certain limitations with a wheeled robot that they can pass obstacles only half of the wheel diameter.

Tracked locomotion may produce better outcomes, although manoeuvrability is significantly reduced. A revolutionary design is created to enhance the wheeled robots' ability to climb obstacles while in motion. The suggested design can climb stairs with a height equal to the robot's wheel diameter.

Researchers' interest in creating mobile robots that can traverse difficult terrain has grown during the past ten years. Due of the need for excellent mobility and manoeuvrability when moving across difficult terrain. The robot can then do difficult jobs remotely in hazardous environments.

The wheel has always been the easiest way to implement mobility in a vehicle, and also the fastest method of travel. The Rocker-Bogie design, which has no springs and stub axles for each wheel, enables the rover to climb over objects, such as

boulders, that are up to twice the size of the wheel's diameter while maintaining contact with the ground with all six wheels.

How stable the tilt is is determined by the height of the centre of gravity, like with any suspension system. Systems using springs have a propensity to tilt more readily when the loaded side yields. The technology is meant to be used at slow speeds of around 10 cm/s to lessen dynamic shocks and any associated damage to the vehicle when traversing major obstacles.

The larger links on either side of the suspension system are referred to as "rockers" because they rock as the vehicle is moving. These rockers are connected to the car's chassis and to one another by a differential. In respect to the chassis, as one rocker goes up, the other rocker moves down. The chassis maintains the same average pitch angles for both rockers. A driving wheel and a bogie are mounted to the ends of a rocker, respectively.

Robots that use a rocker bogie mechanism employ a suspension system made up of a number of rigid components joined together at joints with a set number of degrees of freedom (DoF), resulting in a structure with a single system DoF.

They can now move over uneven ground without losing their footing thanks to this. The following table shows three such potential joints. The suspension is made up of six wheels and has symmetrical supports on either side. Each side has three wheels connected by two links, three wheels total. The main linkage, the rocker, is made up of two joints. While the first joint was attached to the front wheel, the second joint was assembled to a linkage known as a "bogie," which is akin to the suspension member on a train wagonette stairclimbing mechanism project uses a variety of parts, including wheels, a PLC, a motor, a battery, pipes, wiring, a remote controller, and more. This 12-volt battery is powered by a 12-volt, 30-rpm DC side shaft motor. It can traverse terrain with heights far larger than the rover itself because to the spider legs. The wheels are actuator powered, which enables the rover to alter the slope so that it

travels over uneven and highly raised terrains without stumbling for greater inclination. Because it can navigate its own way and travel over difficult terrain, it can be useful in vital space missions. It is now utilized in the Mars rover due to the fact that this technique takes into consideration on un-evenness of surface. The most crucial component of a mobile robot is its locomotion system, which governs stability.

Robotic locomotion differs from conventional forms in that it must be more dependable in the absence of human engagement. The terrain specifications, such as stability standards, obstacle heights, and surface friction, must have been chosen by the robot's designer before construction began.

When comparing mobility systems, there is no single, precise answer. To be employed at slow speeds, the Rocker-Bogie Mobility system was created. It can move past obstructions that are roughly the size of a wheel.

However, upon overcoming a significant impediment, the front wheel effectively stops moving while the car moves no further. When this happens, dynamic shocks are lessened when operating at low speed.

Future planetary expeditions will need rovers moving at human-like rates. Shocks from the front wheel hitting an obstacle might cause damage to the payload or the vehicle. A Rocker-Bogie automobile can step over the majority of obstacles using the driving strategy outlined in this paper rather of slamming into them.

1.1 STAIR CLIMBING ROBOT:

A stair climbing robot is a particular style of tram having revolving wheels or rails that may be dragged or pushed up stairs or up steps. Stair climbers come in wheel, track,

push arm, and walker variations and can be manually or electrically propelled. The tracked style of stair climber is often electrically propelled and is capable of moving loads of up to 1,000 kg (2,205 lb) up and down steps manually. The downsides of this mode of transportation are its size and weight. Like continuous track vehicles with independent track control, they can rotate on the spot by operating the individual tracks in opposite directions. This mode of transportation is very robust and can navigate steep stairs and other awkward terrain.

A robot that can climb stairs or other uneven surfaces is called a stair climbing robot. It may be used for a number of tasks, such as transportation, investigation, and search and rescue, thanks to specific mechanics that enable it to go over stairs and barriers.

There are several different types of stair climbing robots, each with its unique features and capabilities. Some are designed to climb stairs using legs or wheels, while others use a combination of both. Many robots use sensors and cameras to detect obstacles and adjust their movements accordingly.

One common design for a stair climbing robot uses a tracked platform that can adjust its height to navigate stairs. The robot is equipped with two tracks, one on each side, which can be raised or lowered to accommodate the height of the stairs. As the tracks climb up and down the stairs, the robot's body remains level, allowing it to maintain stability.

Another type of stair climbing robot uses a combination of wheels and legs to navigate stairs. The robot has a set of wheels that can adjust to the height of the stairs, while also using legs to stabilize itself and maintain balance. This design allows the robot to climb stairs quickly and efficiently while also maintaining stability on uneven surfaces.

Robots that can climb stairs have several uses, including transportation and logistics

as well as search and rescue operations. They can be used to move objects up and down staircases in warehouses or through rubble and debris in disaster zones. Stair climbing robots are anticipated to become progressively more adaptable and effective in a range of different contexts as technology advances.

They may spin on the spot by controlling the various tracks in the opposite directions, much like continuous track vehicles with independent track control.

A robot that can climb stairs or other uneven surfaces is called a stair climbing robot. It may be used for a number of tasks, such as transportation, investigation, and search and rescue, thanks to specific mechanics that enable it to go over stairs and barriers.

There are several different types of stair climbing robots, each with its unique features and capabilities. Some are designed to climb stairs using legs or wheels, while others use a combination of both. Many robots use sensors and cameras to detect obstacles and adjust their movements accordingly.

Depending on the nature and design of the robot, several methods are used to climb stairs. Here are a few illustrations of how various kinds of stair-climbing robots operate:

Robots with legs ascend stairs by stepping up each stair one at a time. These robots can have a variety of leg designs, including stiff legs that move in a more mechanical way or articulated legs that can bend and move like a human leg. Robots with legs also utilise sensors to recognise the stairs and other barriers in their way and modify their stride to effectively climb such obstacles.

Robots with tracks may ascend stairs by rolling over the rungs. The tracks can adapt to the contour of the steps since they are made to be flexible. The robot may need to change the angle of the tracks and its location on the steps in order to climb them.

Robots on wheels can ascend stairs by employing specialised attachments or lifting systems. Some wheeled robots walk up stairs using a set of wheels on either side of the robot that revolve and grab the edge of each step. Other wheeled robots employ a lift mechanism, such as a set of retractable legs or a lifting platform, to help the robot ascend stairs.

In order to give flexible mobility capabilities, hybrid robots combine several forms of

locomotion, such as legs and wheels or legs and tracks. For instance, a robot may travel on flat terrain using wheels and up stairs with legs.

Overall, to effectively and securely ascend stairs, stair-climbing robots employ a combination of mechanical parts and sensors. The creation of increasingly proficient and adaptable stair-climbing robots that can operate in a range of conditions and carry out difficult jobs is being fueled by advancements in robotics technology.

One common design for a stair climbing robot uses a tracked platform that can adjust its height to navigate stairs. The robot is equipped with two tracks, one on each side, which can be raised or lowered to accommodate the height of the stairs. As the tracks climb up and down the stairs, the robot's body remains level, allowing it to maintain stability.

Another type of stair climbing robot uses a combination of wheels and legs to navigate stairs. The robot has a set of wheels that can adjust to the height of the stairs, while also using legs to stabilize itself and maintain balance. This design allows the robot to climb stairs quickly and efficiently while also maintaining stability on uneven surfaces.

Robots that can climb stairs have several uses, including transportation and logistics as well as search and rescue operations. They can be used to move objects up and down staircases in warehouses or through rubble and debris in disaster zones. Stair climbing robots are anticipated to become progressively more adaptable and effective in a range of different contexts as technology advances.

The requirements for a robot that can climb stairs may vary depending on the application and area it will be used in. However, the following are some general requirements for a stair-climbing robot:

The robot should be able to climb stairs with ease, whether on stair-climbing legs, tracks, or wheels. Depending on the application, the robot should also be able to traverse flat ground and various sorts of terrain.

Depending on the intended function, the robot should be able to carry a particular amount of weight. For instance, a stair-climbing robot intended for cargo delivery may require a larger payload capacity than a robot intended for surveillance or inspection.

1.2 TYPES OF STAIR CLIMBING ROBOT:

1.2.1 Legged Based Robot

The SPOT design by Boston Dynamics served as inspiration for the design. We passed on this design since it would be extremely challenging to maintain given the constraints of our budget. A robot with legs, commonly referred to as a quadruped or biped robot, is one that is built to move around on its legs rather than on wheels or tracks. These robots are made to walk and navigate through situations similarly to their biological counterparts and are modelled after animals with legs, such as dogs, cats, and people.

Robots with four legs are known as quadrupeds, whereas biped robots have two legs. Both types of robots move and keep their equilibrium using a mix of sensors, actuators, and control systems. Robots with legs are capable of traversing obstacles, ascending stairs, and even performing acrobatic actions. The capacity of legged robots to travel through uneven or tough terrain, which could be difficult or impossible for wheeled robots, is one of their main benefits. They are therefore advantageous for uses including military operations, exploration, and search-and-rescue missions.

The Spot robot from Boston Dynamics is one example of a four-legged robot that can move through a range of surfaces, including stairs, rocky terrain, and even ice. Another illustration is the Honda ASIMO robot, which can carry goods and open doors and is made to walk on two legs like a person.

Legged robots are still in their infancy, and both their appearance and functionality are constantly changing. Legged robots are anticipated to become much more prevalent as technology advances.

A legged-based robot is a type of robot that moves and explores its surroundings using its legs. Depending on its intended use and the surface it will work on, this sort of robot can be made to travel on two, four, or more legs. Uneven and tough terrain may be

difficult or impossible for wheeled or tracked robots to navigate, but legged robots can. They can also carry out activities like climbing stairs or negotiating crowded spaces that need for agility and movement.

Legged robots come in a variety of shapes and sizes, such as bipedal robots with two legs, quadruped robots with four legs, and hexapod robots with six legs. There are benefits and drawbacks to each form of legged robot, depending on

1.2.2 Wheel Robot

Wheel robots are a type of mobile robot that use wheels or tracks to move over surfaces, including stairs or other uneven terrain. They typically have two or more wheels that are driven by electric motors or other propulsion systems, allowing the robot to move forward, backward, or turn in place.

One of the advantages of wheel robots is their simplicity. They are relatively easy to design and build, and their basic design has been used in a variety of applications, from cleaning robots to exploration rovers.

Another advantage of wheel robots is their speed and agility. Because they rely on wheels, they can move quickly over flat surfaces, and can also navigate turns and obstacles with ease. This makes them ideal for applications such as delivery robots or mobile platforms for scientific experiments.

However, one disadvantage of wheel robots is their limited ability to navigate stairs or other uneven terrain. While some wheel robots can use special attachments or modifications to climb stairs, they are typically not as effective at navigating uneven surfaces as other types of mobile robots, such as legged or tracked robots.

Wheel robots are an efficient and adaptable class of mobile robot that may be employed in a number of tasks. On level grounds, they are perfect for activities requiring speed and agility, but they may struggle on stairways or other uneven ground.

1.2.3 Track Based Robot

A mobile robot that employs continuous tracks to move around is referred to as a track-based robot. Electric motors often power the tracks, which are typically composed of rubber or metal. The robot can traverse uneven terrain with ease, ascend steep inclines, and transport big cargo thanks to this design.

Robots with tracks are frequently employed in a variety of settings, such as military operations, mining, construction, and agriculture. They can be employed for activities including transportation, surveillance, and excavation.

Robots with tracks can navigate uneven or difficult terrain more easily than wheeled robots, which can sometimes struggle or become stuck. They are also less prone to harm the ground or become stuck in soft soil or other obstacles since they have a lower ground pressure than wheeled robots

Robots with tracks can navigate uneven or difficult terrain more easily than wheeled robots, which can sometimes struggle or become stuck.

They are also less prone to harm the ground or become stuck in soft soil or mud since they have a lower ground pressure than wheeled robots.

The steadiness of track-based robots is another benefit. Robots with tracks are less likely to topple over or lose their balance because the tracks disperse the robot's weight across a wider area than do wheels.

They are therefore perfect for transporting large loads or moving up and down hills. They are consequently ideal for travelling up and down slopes or carrying heavy objects.

Track-based mobile robots are a versatile and effective kind that can handle challenging terrain and heavy loads.

1.2.4 Belt crawling robots

Robots that use a network of belts or tracks to move across uneven terrain, such as stairs, are referred to as belt crawling robots. Due to the fact that it often has two or more belts that move in opposite directions

The belts are often constructed of a high-friction material, like rubber, that adheres to uneven surfaces like steps. Electric motors that can be regulated may propel the robot up and down the stairs by powering the belts. Usually, a battery powers the robot, giving the motors and other parts of it the required energy. The ability of belt crawling robots to traverse stairs and other rocky terrain is another benefit. They can go over barriers like curbs and steps as well as ascend stairs at a variety of angles. They are therefore perfect for jobs like search and rescue missions or inspection work.

Belt crawling robots can be sluggish and need a lot of power to climb stairs or go over obstacles, which is a drawback. The belts may also deteriorate over time, necessitating routine upkeep and replacement.

Overall, belt crawling robots are a flexible and efficient class of mobile robot that can move across uneven ground and climb stairs. They are perfect for uses that need stability and the capacity to move or climb stairs

1.2.5 cable driven robots

Robots that are powered by cables, often known as cable robots or wire-driven robots, are a form of mobile robot that traverses surfaces, such as stairs or other uneven terrain, using a network of cables or wires. Usually, the robot has two or more cables that are fastened to the stairwell's treads or other anchors in the surrounding area.

The cables are often composed of high-strength materials like steel or Kevlar, and the tension and movement of the cables are controlled by motors. The robot can navigate stairs or other obstacles by varying the tension of the cords.

Highly adaptable, cable-driven robots may be utilised for a wide range of tasks, including maintenance, inspection, and rescue missions.

They are especially helpful in places where robots on wheels or legs cannot be deployed, like confined areas or incline slopes. The high degree of precision and accuracy that cable-driven robots possess is one of their advantages. The robot can move accurately and make little adjustments as needed because the cables are under stress.

They are therefore perfect for jobs that require precise movement, including inspection or maintenance. The capacity of cable-driven robots to haul high loads is another benefit. The robot can carry a load without touching the ground or placing undue strain on its motors because it is suspended from the cables. They are therefore perfect for tasks like lifting heavy goods or moving machinery.

The intricacy of cable-driven robots is a drawback, too. They might be more challenging to design and construct than other kind of mobile robots since they depend on a network of connections and motors. They also need a lot of cooperation and control in order to work well.

1.2.6 vacuum suction robots

Robotic vacuum cleaners, commonly referred to as suction robots or vacuum suction robots, are a form of mobile robot used for cleaning carpets, floors, and other surfaces. In addition to having a brush or other agitator to assist move dirt and debris around, they generally include suction to remove dirt, dust, and other debris from surfaces.

Robots that use hoover suction are frequently fitted with sensors that let them manoeuvre around objects like furniture and other obstructions in a space. Additionally, they may be programmed to clean specified spaces or adhere to a

predetermined cleaning routine.

Vacuum suction robots' ease is one of its benefits. They may be set up to clean regularly, freeing up your time for other things. The low cleaning power of Hoover suction robots is one drawback, though. They might not be as good at getting rid of stubborn stains or heavy dirt as conventional vacuum cleaners, and they might need to clean an area thoroughly several times.

In general, mobile robots that use Hoover suction are practical and efficient for cleaning floors and other surfaces. They can keep a house or business clean and organised with little effort since they are perfect for normal cleaning duties.

1.3 COMPONENTS OF STAIR CLIMBING ROBOT:

1.3.1 *Pvc Pipes*

It is the standard white plastic pipe used for drainage and plumbing. Because PVC is a low-carbon plastic, producing PVC pipes uses less resources and energy. They are easy to move because of their small weight. PVC pipes are robust, long-lasting, easy to install, and reasonably priced. They are easily recyclable and require little upkeep. One, two, five, ten, eleven, and six centimetres.

Polyvinyl chloride (PVC) resin is used to make PVC pipes, which are plastic pipes. They are a preferred option for many plumbing, drainage, and irrigation applications since they are lightweight, strong, and reasonably priced. Schedule 40, schedule 80, and flexible PVC pipes are just a few of the several sizes and varieties of PVC pipes available.

The most popular PVC pipe used in plumbing and irrigation systems is schedule 40 PVC pipe. They are appropriate for uses like water supply lines and sprinkler systems because they are sturdy, stiff, and can resist high pressures. Due to its thickness and durability, schedule 80 PVC pipes are better suited for applications requiring greater pressure or temperature resistance than schedule 40 pipes.

1.3.2 Side Shaft Motor

It is made of a robust material, and the gear box is designed to withstand the maximum torque the engine produces. While running for a long time, this motor will be somewhat noisy. Side Shaft at 30 RPM Small robots and automation systems are ideal for the 37mmDiameter Compact DC Gear Motor. Metal bushes are used to hold the drive shaft on bothsides. From 4V to 12V, the motor operates smoothly and produces 30 RPM. Drive shaft is D-shaped and 22mm long with a 6mm diameter motor for good connection. An internal combustion engine known as a side shaft motor has the crankshaft and camshaft mounted on the same side of the engine block. Small engines like those seen in lawn mowers, generators, and other portable power equipment frequently employ this design.

The crankshaft and camshaft are situated on the side of the engine block in a side shaft motor, allowing for a more straightforward and compact construction. The engine's valves are opened and closed by the camshaft, which is operated by a timing belt or chain.

The side shaft motor is renowned for its dependability, toughness, and simplicity of maintenance. The engine's straightforward construction makes it possible to reach its parts with ease. The side shaft motor does have certain drawbacks, though. The engine's size and power output limitations make it unsuitable for use in bigger vehicles or heavy-duty equipment, which is one of its primary downsides. Furthermore, compared to other engine designs, the camshaft's location might make it more challenging to attain ideal valve timing and performance.

The side shaft motor is an all-around dependable and effective engine type that works well for small power equipment and applications where simplicity and ease of maintenance are key considerations.

1.3.3 Mobility

To go over the obstacle, the rear wheels push it in front of the front wheels. Then, when the front wheels rotate, the front of the automobile is elevated and propelled over the obstacle. The centre wheel is then forced against the back wheel until it is hauled

up and over by the impediment. The forward speed of the vehicle is slowed or stopped when each wheel crosses the obstruction before the rear wheels are ultimately propelled over the obstruction by the front two wheels. These rovers move slowly and may climb over obstacles since the suspension is raised by the wheels one portion at a time. Robotic mobility is the term used to describe a robot's capacity to move about and find its way around. Robots may move in a variety of ways, from completely motionless stationary robots to wheeled or tracked robots that move on flat surfaces to legged robots that can navigate more difficult terrain.

A robot's mode of movement is determined by the environment and application for which it is designed. Legged robots, on the other hand, are better adapted to uneven or crowded areas where wheeled or tracked robots would find it difficult to travel.

For instance, wheeled or tracked robots are well-suited for flat surfaces, such as factory floors or outdoor locations with paved roads. Advanced sensors, algorithms, and control systems have been developed for robot mobility systems in recent years as a result of advancements in robotics technology.

These innovations enable a greater range of jobs and more complicated environment navigation for robots.

Aerial mobility, or the capacity for robots to fly or hover, is a developing field of robotics mobility. Drones and quadcopters are aerial robots that are increasingly employed for tasks including delivery, inspection, and surveillance.

In general, robot performance and design heavily depend on their ability to move, and improvements in mobility technology are spurring the creation of more powerful and adaptable robots for a variety of applications.

1.3.4 Frames And Base Plate:

The model consists of four vertically fastened frames and a bottom plate that serves as the base. Acrylic is used to make the base plate and other parts of the frames. The appearance of mild steel can range from silvery to drab grey depending on the degree

of surface roughness. It is a malleable, lightweight metal. It is not readily ignited and is not magnetic. The reflectivity of a freshly applied mild steel layer is good for visible light (around 92%) and outstanding for medium and far infrared radiation (up to 98%). Important parts of a robot that give stability and structural support are the base plate and frame.

The structure that houses the robot's internal parts and offers a sturdy framework for attaching and fastening additional parts is referred to as the frame. Depending on the use and design specifications, the frame may be composed of a variety of materials, including aluminium, steel, or carbon fibre. A well-designed frame needs to be compact, durable, and capable of withstanding the loads and pressures that the robot would experience while in use.

While acrylic alloys have yield values ranging from 200 to 600 MPa, low-carbon steel has a yield strength of 7 to 11 MPa. On the other hand, the base plate is the flat area that holds the robot in place and serves as a basis for mounting other parts. The base plate is frequently constructed from a strong material, such as steel or aluminium, and it can be mounted on wheels or tracks to enable movement. Additionally, the base plate may feature slots or mounting holes for securing other parts, such as actuators, sensors, or motors.

Together, the robot's frame and base plate serve as its framework, giving the robot's internal parts and exterior attachments the support and stability they require. For the robot to operate reliably, durably, and effectively, a well-designed base plate and frame are necessary.

1.3.5 Gears:

For a gearbox, gears are crucial. Gears are important for reducing speed as well. It takes two sets of gears to effectively transmit energy. A smaller gear and two larger gears make up each set. A speed reduction ratio of 1.68 results from a smaller gear having 36 teeth and a larger gear having 60 teeth. The gears are nylon plastic gears and are spur gears. There are only two types of gears: spur gears and straight-cut

gears.

Robots frequently employ gears to transmit motion and power between various sections, including motors, wheels, and other mechanical elements. A robot's motions may be made faster or slower, with more or less torque, and in either direction by using gears.

Spur gears, which have straight teeth that mesh together to impart rotational motion, are the most popular gear types used in robotics. High-performance robots frequently employ helical gears as well because of its angled teeth's ability to transmit motion more smoothly and with less noise and vibration. In particular situations where special motion transfer properties are required, other gear types such bevel gears, worm gears, and planetary gears are employed.

To decrease wear and friction, gears can be mounted on shafts and axles using bushings or bearings. Gears can be built of a variety of materials, including metal, plastic, or composite materials. The strength, durability, weight, working environment, and temperature are only a few examples of the elements that affect the choice of gear material.

In general, gears are crucial to the construction and functioning of robots because they transmit motion and power between various parts. Robots are becoming more adept and effective because to developments in gear technology, including the use of lightweight, durable materials and sophisticated manufacturing techniques.

1.3.6 Batteries:

Any charged battery, accumulator, or accumulator can be used as an electrical battery. It has one or more electrochemical cells and might serve as a form of energy accumulator. It is referred to as a storage cell since its electrochemical reactions are electrically reversible. Rechargeable batteries exist in a broad variety of sizes and

designs, ranging from button cells to megawatt systems connected to stabilise an electrical distribution network.

Batteries are a critical component of robots as they provide the energy required to power the robot's motors, sensors, and other electronic components. The choice of battery for a robot depends on various factors, such as the power requirements of the robot, the weight and size of the battery, and the environment in which the robot operates.

Here are some of the types of batteries commonly used in robots:

Lithium-ion batteries: Lithium-ion batteries are a popular choice for robots as they are lightweight and have a high energy density, which means they can provide a lot of power relative to their size. They are also rechargeable, which makes them more cost-effective and environmentally friendly than disposable batteries.

Nickel-metal hydride batteries: Nickel-metal hydride batteries are also used in robots as they have a higher capacity than lithium-ion batteries and can operate at a wider range of temperatures. However, they are heavier and have a lower energy density than lithium-ion batteries.

Lead-acid batteries: Lead-acid batteries are an older type of battery that are still used in some robots as they are relatively inexpensive and can provide a lot of power. However, they are heavy and have a low energy density, which limits their use in certain applications.

Solid-state batteries: Solid-state batteries are a newer type of battery that are being developed for use in robots. They have a high energy density, are safer than lithium-ion batteries, and can operate at a wider range of temperatures. However, they are still in the early stages of development and are not yet widely available.

Overall, the choice of battery for a robot depends on the specific requirements of the robot and the environment in which it operates. Advances in battery technology are driving the development of more efficient and cost-effective batteries, which will continue to improve the capabilities and performance of robots in various applications.

1.3.7 Wheels:

A mechanical linkage is a group of bodies linked to regulate forces and motion. Since geometry is used to study a body's motion, or link, the link is taken to be stiff.

Robots frequently include wheels as a component that gives them movement and makes it simple for them to travel on flat or smooth surfaces. Depending on the application and environment, many wheel types can be employed by robots. Several instances of robots with wheels include:

Solid wheels: such as those constructed of rubber or plastic, are the most basic sort of wheel. They are sturdy and have high traction, but they can be hefty and may not offer a comfortable ride.

Pneumatic wheels: These wheels contain an air-filled tyre that can absorb stress and gives a comfortable ride. They are frequently utilised in rovers and other outdoor robots that must navigate difficult terrain.

The robot can travel in any direction without changing its orientation thanks to omni wheels, which feature little rollers positioned at an angle to the main wheel. They are frequently employed in robots like mobile manipulators that must be able to move in all directions.

The robot can travel in any direction and revolve around its own axis thanks to mecanum wheels, which are similar to omni wheels but have rollers attached at an angle in a precise pattern. They are frequently employed in robots that need to be able to manoeuvre precisely.

Caster wheels: These wheels are frequently employed in robotics, such as mobile robots and carts, that need to be very manoeuvrable. The robot can travel in any direction thanks to a single swivelling wheel that is mounted on a fork.

The type of wheel used will depend on the particular application and operating conditions for the robot. For instance, pneumatic wheels could be the ideal option if the robot needs to go over uneven terrain, while omni or mecanum wheels might be a better option if the robot needs to move in any direction. In general, wheels play a significant role in the design and movement of robots, and advancements in wheel technology are helping to create more powerful and adaptable robots.

1.3.8Esp-32 Cam:

A series of inexpensive, low-power system on a chip microcontrollers called ESP-32 has built-in wifi and dual-mode bluetooth. With built-in antenna switches, power amplifiers, low-noise receive amplifiers, filters, and power-management modules, the ESP32 series uses either an Xtensa LX6 microprocessor in dual-core and single-core varieties, an Xtensa LX7 microprocessor in dual-core or single-core variations, or an Xtensa LX8 microprocessor.

A compact camera module called the ESP32-CAM is built around the ESP32 microcontroller and OV2640 sensor. It has a camera with a 2MP (1600x1200) resolution that can record both still photos and movies. The module has WiFi and Bluetooth that enable wireless communication with other devices as well as internet connectivity.

The Arduino IDE may be used to code the ESP32-CAM, which is designed to be simple to use. It is simple to connect to a computer or other devices since it supports Micro-USB and has a typical UART serial interface. Additionally, the module contains GPIO pins that may be used to connect sensors, displays, and other components from outside the module.

The suggested wheel-step rover in this study has modified active rocker-bogie suspension. A new angle-adjustment system connects the three segments of the differential shaft that connects to the rocker and the rocker itself. To create a wheel-step movement, the mechanism, which is driven by a single motor, alternately expands and narrows the angle between the two rocker components.

It also modifies the angle between a differential shaft component and a rocker portion in order to maintain the bottom side of the rover body horizontal to the ground. The suspension horizontally lowers the bottom side of the lander platform when it is completely extended. To elevate each rocker part, the mechanism works in tandem with a brake that has been installed between them.

1.4 COMPARISON BETWEEN WHEELED AND LEGGED ROBOTS:

Table1.4 Comparison Between Wheeled and Legged Robots

WHEELED ROBOTS	LEGGED ROBOTS
Your robot will move more quickly and more easily if it has wheels.	Robots with legs, however, are unable to move more quickly.
Robots with wheels, on the other hand, struggle on rocky terrain and uneven ground.	Robots with legs, on the other hand, are far better at navigating rocky terrain and uneven surfaces.
Depending on how many wheels a robot has, it may move in a variety of ways.	Legged robots, however, are unable to change their mode of mobility based on the number of wheels they have.
Wheels are straightforward devices that help to lessen the force of friction.	However, there will be a lot of friction with legged robots.
Wheels, which enable the thing to roll along, greatly simplify the situation.	As opposed as in legged, which cannot significantly ease the situation by enabling the object to roll.
Wheels can also be used to assist something turn more quickly or with more power.	It cannot be utilised to assist anything turn more quickly or with more force.

CHAPTER 2

LITERATURE SURVEY

Pinhas Ben-Tzvi, Andrew A. Goldenberg, and Jean W. Zu. University of Toronto, Department of Mechanical and Industrial Engineering, 5 King's College Road, Toronto, ON M5S 3G8, Canada. Articulated hybrid mobile robot mechanism with compounded mobility and manipulation. In this essay, we've gathered some information about mobile robots, which are described as autonomous mechanical devices that carry out automated duties either automatically according to a predetermined programme or with the aid of remote controls operated by humans. Due to the lack of a reliable locomotion system, the employment of mobile robots is restricted. Mobile robots employ a few different types of locomotion mechanisms, including wheels, tracks, and legs. To finish the work in the diverse terrains, such as mountains, is a significant unsolved problem for most industrial and other applications.

Heeseung Hong, Dongmok Kim, Hwa Soo Kim, Seokwoo Lee, and Jongwon Kim, School of Mechanical and Aerospace Engineering, Seoul National University, 599 Gwanak-ro, Gwanak-gu, Seoul 151-742, Republic of Korea. Contact angle estimate and composite locomotive strategy. According to the aforementioned paper's definition of seamless transformation, a new switchover module called a track tensioner unit was created and integrated into the system to make it easier to engage and disengage track mechanisms. The robot would be able to move on a level path at a fairly high velocity and manoeuvrability thanks to the three wheels utilised in this arrangement.

Roland Siegwart, Pierre Lamon, Thomas Estier, Michel Lauria, and Ralph Piguet created a novel design for wheeled movement in difficult terrain. Federal Institute of Technology of Switzerland.

From the paper stated above's literature reviews Robot movement on difficult terrain is particularly dependable because to the track system. To make sure the structure is sound, several selected parts of model were analyzed to ascertain their mechanical behavior under static load condition by using Solidworks simulation tool.

A. Gonzalez, E. Ottaviano, and M. Ceccarelli on the kinematic functioning of a four-bar based system for directing wheels in climbing steps and obstacles. University of Castilla-La Mancha, Av. Camilo José Cela s/n, 13071 Ciudad Real, Spain. School of Industrial Engineering. In this work, a mechanism's design that directs a wheel over slopes, steps, or other impediments is described. The suggested four-bar linkage can be mounted on each wheel of a vehicle, enabling it to climb stairs with the necessary comfort.

Siegwart, R., Lauria, M., Mausli, P., Winnendael, M., 1998, "Design and Implementation of an Innovative Micro-Rover," Proceedings of Robotics 98, the 3rd Conference and Exposition on Robotics in Challenging Environments, April 26-30, Albuquerque, New Mexico. This paper mentions the key issues for robust locomotion the present paper will focus on the design and control of the more innovative solution. It consists of 6 independently driven wheels arranged in two triangles. It therefore allows not only for efficient rolling on flat surfaces but also to step on obstacles

To begin, the Articulated Traction System (referred henceforth as ATS) offers a unique three-cab type chassis. Each cab or bus is able to articulate itself relative to the other allowing for an effective climb solution on virtually any terrain. It operates similarly to the segmentation as found commonly on arthropods, as seems to be the case with most robots. This has been accounted for as a more efficient means while providing some form of compensation in the event of some form of failure in one aspect of the articulation (Ranganathan, 2004) to maintain reasonable traction when driving in difficult off-road conditions. Wheel slipping is prevented by differential locks in the autos. The driver may choose between two operating modes by engaging or disengaging the locks; the closed mode provides superior off-road handling, while the

open mode provides greater freedom.

A hybrid mobile robot mechanism with compounded locomotion and manipulation capabilities was created and studied by Pinhas Ben-Tzvi, an Andrew A. Goldenberg Fellow ASME. At the ORT Braude College in Karmiel, Israel, Avi Weiss, Elifadida, and Uri Ben Hanan optimised step climbing using a two-wheeled, connected inverted pendulum model (2161002). This research presents experimental and analytical findings of a hybrid mechanism mobile robot (HMMR) created for field and military applications based on literature surveys. The second generation mobile robot (HMMR) described in this study combines locomotion and manipulation on a symmetric invertible platform. The outcomes of the experiment demonstrate the robot's capacity to function in an unstructured environment and navigate challenges that are considerably taller than its folded form. The analytical outcomes, on the other hand, demonstrate the robot's capacity to modify the posture of its arm during manipulation in order to counteract tip-over instability.

The work by Park et al presents the design of a bipedal stair-climbing robot with the ability to detect and avoid obstacles using a depth sensor. The robot has a six-legged mechanism with four legs for walking and two legs for climbing stairs. The robot is equipped with a Kinect sensor for obstacle detection and a Raspberry Pi for control. The work by Takeda et al proposes a stair climbing robot with dynamic stair scanning and The robot is equipped with a camera and laser range finder for obstacle detection and uses an adaptive gait control algorithm to climb stairs. The proposed system is demonstrated to be effective in navigating complex staircases with varying heights and shapes.

Similar work by Kwon et al presents a design of a wheeled stair climbing robot equipped with a 3D imaging system for obstacle detection. The robot is capable of traversing staircases with varying heights and shapes and is equipped with a sliding mechanism for smooth transition between steps. Only when the robots are being used

can the effectiveness be seen. Araujo et al.'s research suggests a robot for industrial inspection that can climb ladders and other similar tracks. The robot has a camera system for obstacle recognition and a modular climbing mechanism.

Yet another work by K H Lee et al proposes a stair climbing robot with an active suspension system for stability control. The robot is equipped with a sonar sensor and a camera system for obstacle detection and uses a feedback control algorithm to adjust its suspension system for stability control.

The work done by K S Lee et al presents the design and development of a stair climbing robot for firefighting applications. The robot is equipped with a bipedal mechanism and a camera system for obstacle detection. The proposed system is demonstrated to be effective in navigating through smoke-filled environments and climbing stairs in a firefighting scenario.

The design and development of a stair climbing robot with omnidirectional wheels are shown in the work of Park et al. The robot employs a motion planning algorithm to negotiate difficult staircases and is outfitted with a laser range finder and camera system for obstacle identification.

In their research, Kim et al. offered the idea for a robot that can climb stairs to examine dam gates. The robot has a wheeled mechanism and an obstacle detection camera system. It has been shown that the suggested technique works well for examining dam gates of different heights and forms.

A Mars rover using active suspension was designed and analysed using terramechanics by Junqiang Zheng, Haibo Gao, Baofeng Yuan, Zhen Liu, Haitao Yu, Liang Ding, and Zongquan Deng. Harbin Institute of Technology's State Key Laboratory of Robotics and Systems is located in Harbin, China, 150001.

This essay depicts about The active rocker-bogie suspension of the recommended wheel-step rover in this study has been modified.

CHAPTER 3

AIM AND SCOPE OF THE CURRENT INVESTIGATION

3.1 Aim:

The stair climbing robot we are making with more efficient for example existing model payload capacity will come around 0.5-0.75 KG only. In our stair climbing robot payload capacity is 2.25-2.5KG.

This item is intended to help people go to inaccessible locations. The primary goal of this device is to autonomously ascend any set of stairs to the top, but it is easily adaptable to become an all-terrain robot.

Existing models degrees of freedom is 1 for our stair climbing robot degree of freedom is 180 with more efficient Speed is very important when its come to military application existing models will move around 5-6 KMPH our stair climbing robot will move 10KMPH we will keep on adding features to increase its benefits.

This system may be made more elastic by using varying link lengths for the front, middle, and rear legs. It is feasible to integrate sensors and vision into this robot in the future to expand its utility. Because they allow for posture and insect motions that are similar to walking, variety of motion and the length of time available at each linked point are of the highest significance.

This method may be made more adaptable by using varying link lengths for the front, middle, and hind legs. Future improvements to this robot's effectiveness can be made by generating intelligence with the addition of sensors and vision. The range of motion and moments at each joint should be given the utmost importance since they are essential for developing a posture and walking like an insect.

The types of motors, materials, and mechanical components used to construct the robot, such as chains, wheels, and gears, will also be covered in this project Last but not least, there is previous research that related to this project done by other provided and discussed

3.2 SCOPE OF THE INVESTIGATION:

The rocker-bogie design's most important mechanical feature is how simple the drive train is due to the employment of only two motion motors. Because natural terrain rarely offers obstacles that need the rover's front wheels to climb at the same time, six wheels are used.

There is a need for a mobile, user-friendly material handling equipment since commodities must be carried over various terrain types. A material handling device with a mechanism (rocker bogie mechanism) that enables the device to move on any surface, such as rough construction areas, stairs, etc.

Our research also intends to create a system that makes it easy to collect goods at the household level to ensure best space use and to make the trolley portable, a further modification that makes it totally folding can also be added. Using DC motors and a power supply, a unique alteration was made to the trolley to make it power-driven, reducing human effort and increasing operational flexibility. Therefore, "Stair Climbing Material Handling Equipment" was designed to be made following static and dynamic testing, analysis, and calculations on SOLIDWORKS and ANSYS.

We are still accustomed to the age-old production practices despite the rapid changes in how products are made. There are several explanations, including lethargy, rejecting new technology, a lack of engineering aptitude, a lack of competency and technical understanding, and—most importantly—fear of losing career opportunities. The creation of a technique for effortlessly moving heavy goods up and down stairs is the aim of this project. The requirement for such a system is driven by daily necessities in contemporary society. When standing on level ground, the strain of lifting is lessened by using hand trolleys and other equipment

CHAPTER 4

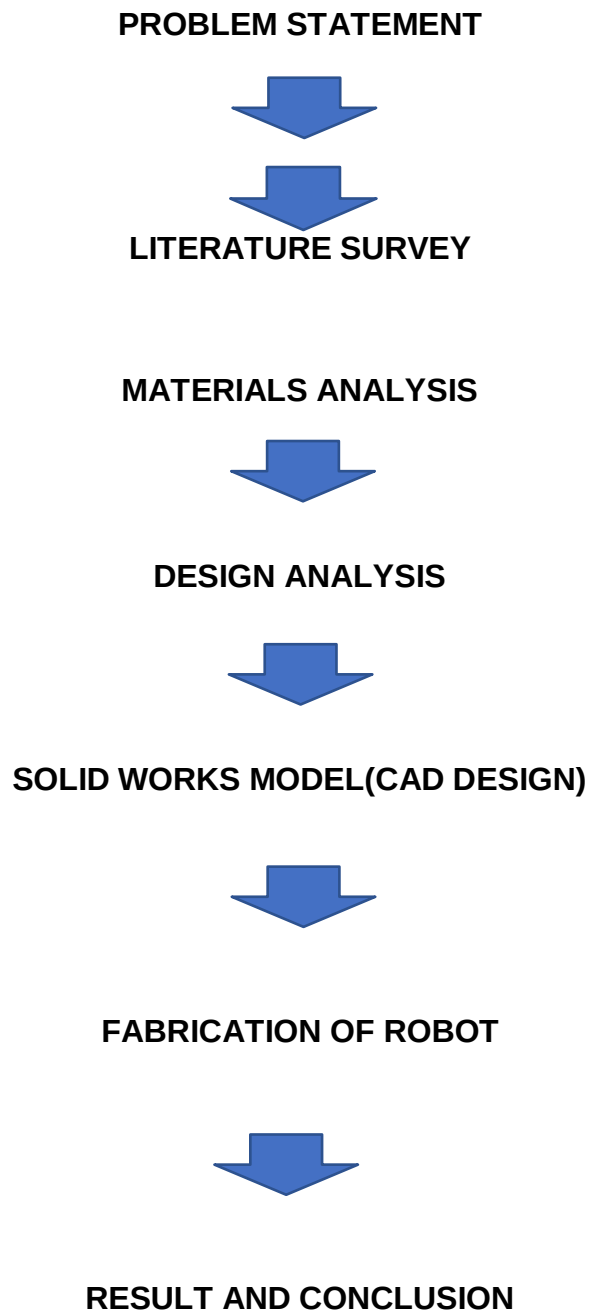
EXPERIMENTAL OR MATERIALS AND METHODS

4.1 MATERIAL SPECIFICATION:

Table 4.1 Material Specification

Name	Photo	Material	Length	Diameter	Thickness	Quantity
Tube Pimtaş		U-PVC	3 m	32 mm	3,6 mm	1 piece
ZonderPim tas 120° Elbow Tube		U-PVC	-	32 mm	3,6 mm	4 pieces
Wheel		Silicone and Plastic	-	125 mm	58mm	6 pieces
3D printing		PLA (Polylactic Acid)	-	-	-	1 piece
For tank pallet Esp- 32 cam		Camera with Bluetooth connected	-	-	-	1piece

4.2 WORK PROCESS:



4.3 CONCEPTUAL DESIGN:

Conceptual design of a robot is done to overcome limitation of wheeled locomotion that it can climb the step height half than that of its wheel diameter. The proposed design is capable of climbing steps of the height same as its wheel diameter with satisfactory locomotion. Figure 1 shows the design of a wheeled stair climbing robot. Certain salient features of the design are as follows. Separate bogie is to be provided for each pair of wheels to avoid restriction of the bogie movement. Complete rotation of bogie around its axis won't result in climbing up the obstacle as it is free. Apply stoppers to avoid rotation. Design such a way that the elastic property of material itself acts as suspension system. Frame is to be designed to accommodate control circuit. Middle link is to be designed to keep enough ground clearance. The conceptual design of stair climbing robots involves several key considerations, including the type of locomotion, the size and shape of the robot, and the materials used in its construction. Here are some of the key elements that are typically considered in the conceptual design of stair climbing robots:

There are several different types of locomotion that can be used in stair climbing robots, including wheeled, tracked, legged, and hybrid systems. Each of these systems has its own advantages and disadvantages, and the choice depends on the specific requirements of the robot and the environment in which it will operate.

The size and shape of the robot will depend on the application and the specific requirements of the robot. For example, if the robot is designed for search and rescue operations, it may need to be small and agile to navigate through tight spaces, whereas if the robot is designed for transportation, it may need to be larger and more robust.

The materials used in the construction of the robot will depend on the specific requirements of the robot and the environment in which it will operate. For example, if the robot is designed for use in hazardous environments, it may need to be constructed from materials that are resistant to heat, chemicals, or radiation.

Stair climbing robots typically require a range of sensors and control systems to navigate stairs and other types of uneven terrain. These may include cameras, LiDAR,

GPS, and other types of sensors, as well as sophisticated algorithms for processing and interpreting data.

The power source for the robot will depend on the specific requirements of the robot and the type of locomotion used. Some robots may be battery-powered, while others may be tethered to a power source.

Overall, the conceptual design of stair climbing robots involves a range of considerations, including the type of locomotion, the size and shape of the robot, the materials used in its construction, and the sensors and control systems required for navigation. By carefully considering these factors, designers can create robots that are capable of safely and efficiently navigating stairs and other types of uneven terrain, opening up new possibilities for applications in search and rescue, inspection, transportation, and more. The wheels must not touch each other. It is a crucial point to design. According to manufacturing limitations the cover is to be designed to bare loads without affecting function. After the CAD model has grown, the proportions of the quadruped robot's hardware components and overall dimensions have been fixed. The torso structure and legs of the robot are built of PVC foam sheet (Sun board) material. A stair climbing robot may be built in a variety of ways, and the ideal design for your robot will depend on what it will be used for. If you want your stair climbing robot to be able to move quickly and efficiently, then you will need to pay special attention to its leg design. If you want your stair climbing robot to be able to climb walls or ceilings, then you will need to give special consideration to its claw design. And if you want your stair climbing robot to be able to carry a heavy load, then you will need to focus on its body design. No matter what your specific goals are for your stair climbing robot There are some basic design principles that you will need to follow in order to create a successful design.

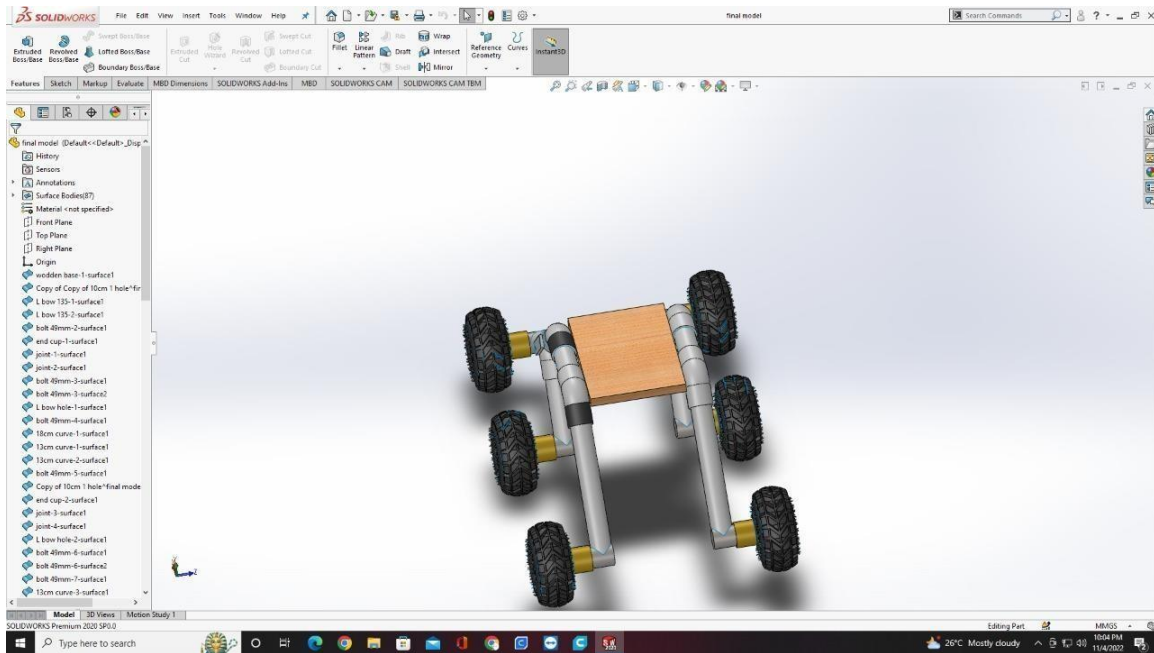


Fig : 4.3a : A Stair Climbing Robot Seen From Above

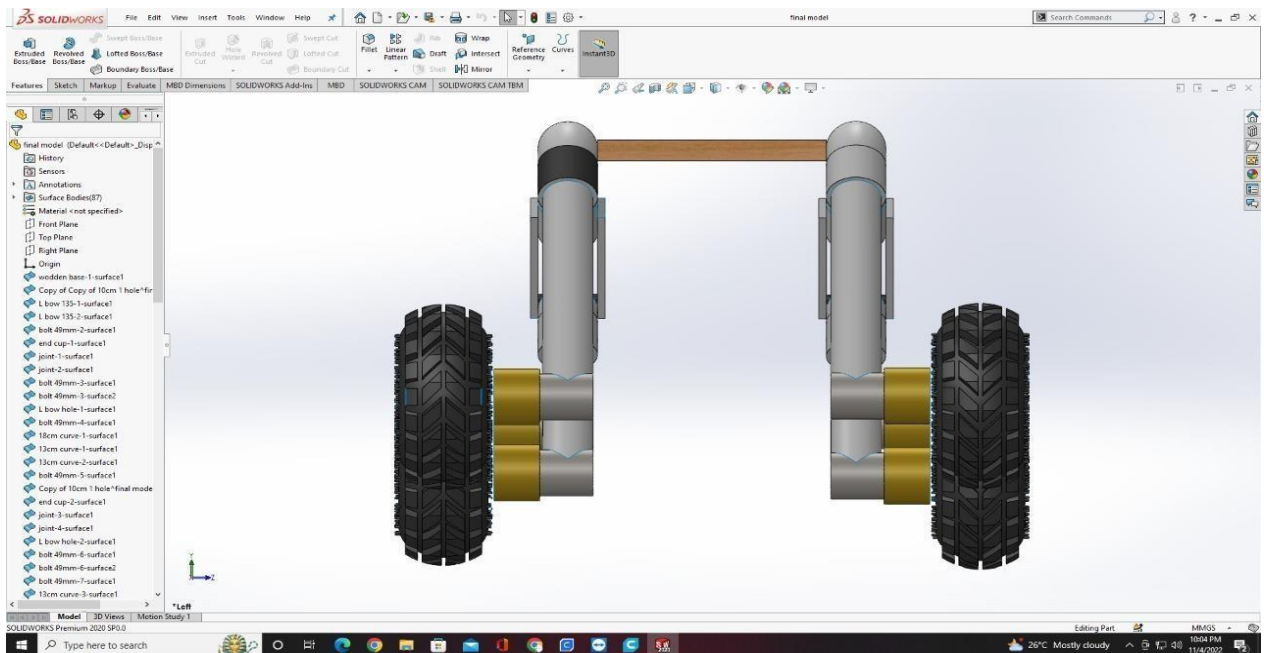


Fig 4.3b A Robot seen from Front

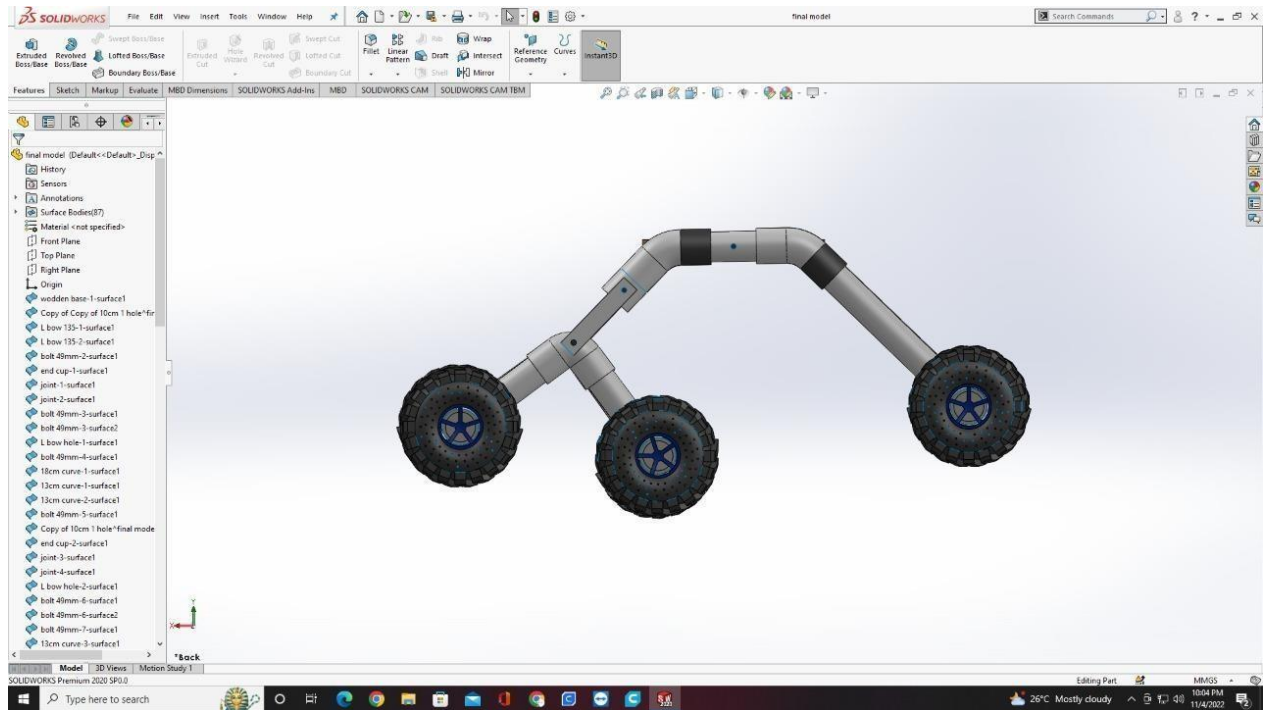


Fig 4.3c Side View Of A Robot That Climbs Stairs

CHAPTER 5

RESULT AND DISCUSSIONS

5.1 DESIGN CALCULATION:

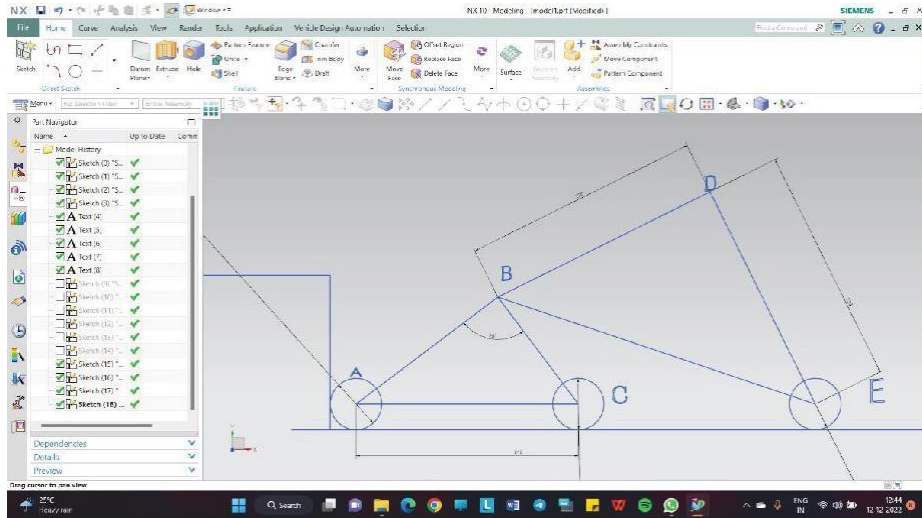


Fig 5.1a. Drawing for First Triangle

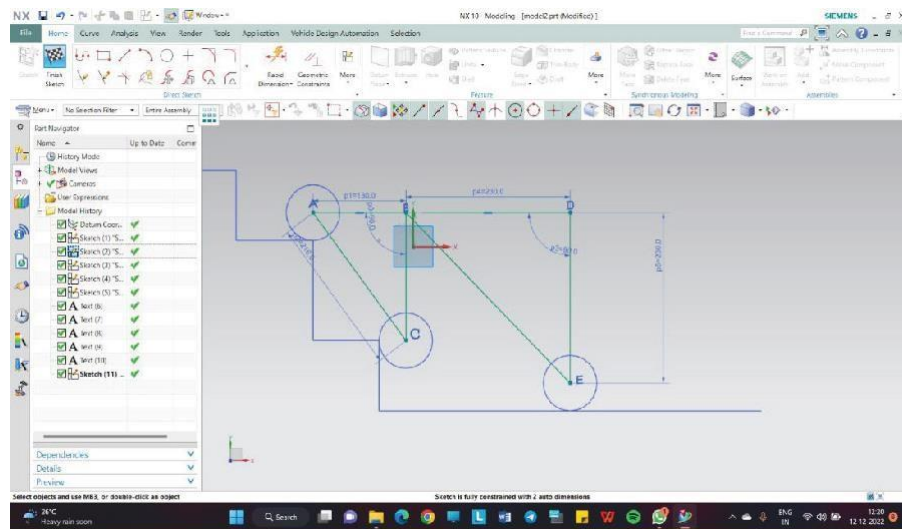


Fig 5.1b. Drawing for Second Triangle.

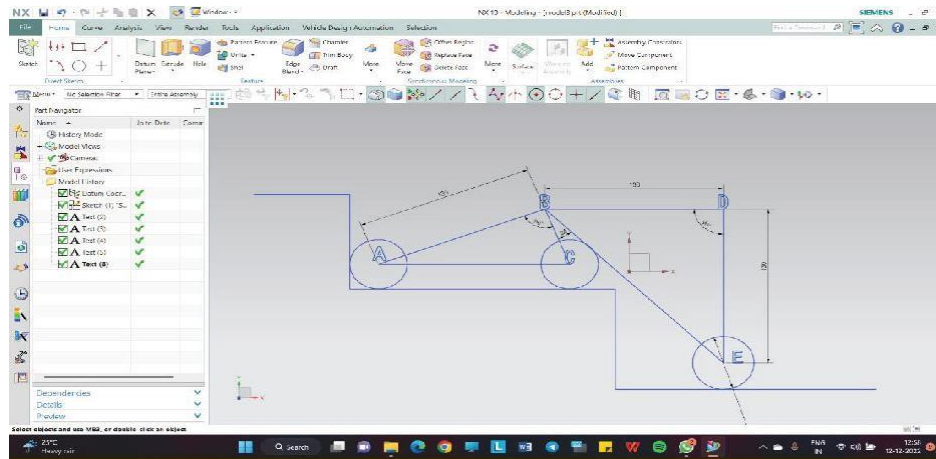


Fig 5.1c. Dimensions of both up and down of a stair climbing robot.

Through the use of Negative Moment vs. Obstacle Height, several tests were carried out to compare the improved geosurvey rover's performance to that of its predecessor designs when carrying weight. We collected the findings, drew their graphs, and made comparisons.

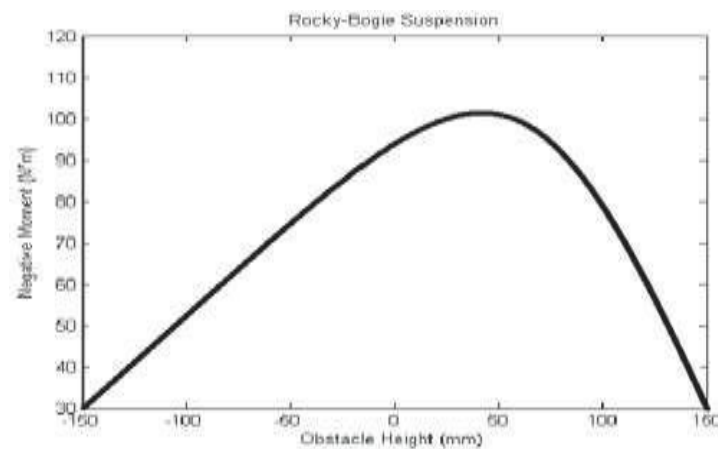


Fig 5.2a. Response of the rocker-bogie suspension when bearing a weight against the height of an obstruction

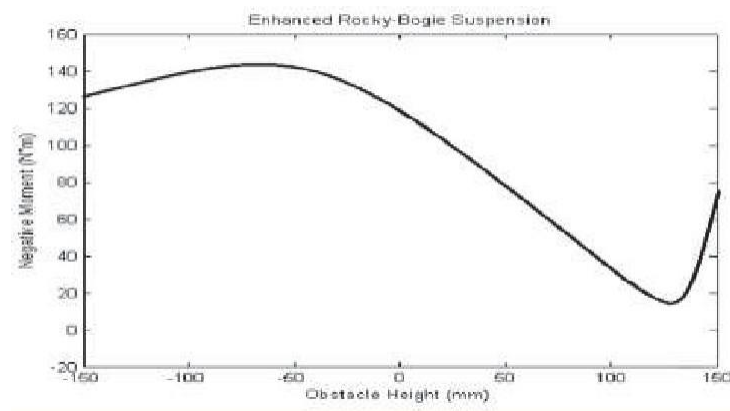


Fig 5.2b. Response of improved rocker-bogie suspension while carrying weight to obstacle height.

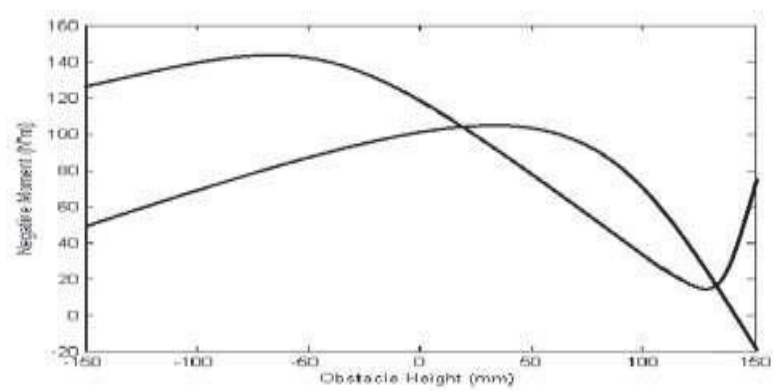


Fig 5.2c. Comparison of each suspension's performance when bearing a weight versus the height of an obstruction

5.3 FABRICATION MODEL



Fig 5.3a Top View



Fig 5.3b Front View

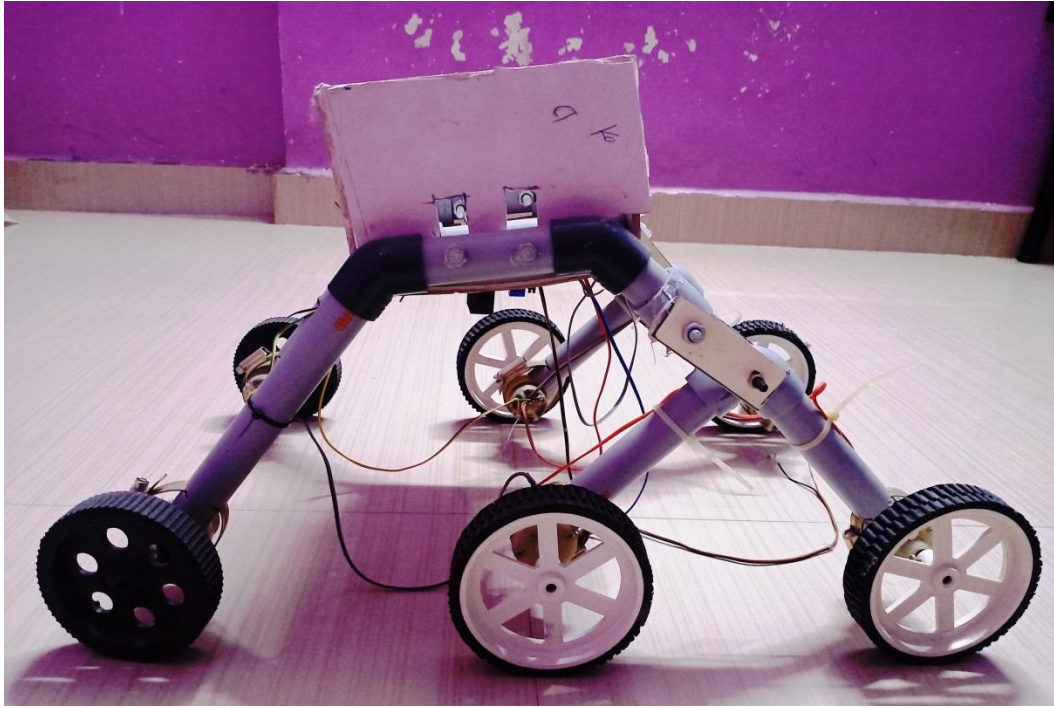


Fig 5.3c Side View

HAPTER 6

SUMMARY AND CONCLUSION

The recommended study suggests a ground-breaking concept to improve the rocker-bogie mobility system in traditional heavy loading vehicles and to extend the rover's battery life and operational duration when high-speed traversal is necessary. This was made feasible by a separate directional control system that depends on a limited number of drive modules and is influenced by the speed and operating circumstances of the vehicle. It is feasible to predict the rover's attitude and configuration as well as whether it would slide, topple over, or keep its balance using sensors and equipment given its position and the terrain's attributes. The near zero tilt approach lowers the percentage and enables self-balancing of the rover by using the power supply, which is attached to the main body of the rover.

Develop sensing and control techniques that let the hybrid mobile robot system operate on its own in various unstructured environments. To minimise the system's overall weight without compromising cargo capacity, redesign the system. Future studies could involve equipping the robot frame with sensors, cameras, and manipulators. The robot can thus carry out challenging tasks remotely in dangerous settings. The complicated pattern is based on how the robot's legs interact geometrically with the step.

The effect of the robot's proper dimensions on the algorithm is demonstrated. A quick examination of the robot's quasi-static stability also demonstrates that by adopting the stable four-leg supporting stance, stability is often maintained and possible unstable postures may be avoided. The developed method is then put to the test through simulation and experimentation, proving its usefulness. We are now developing an algorithmic feedback system that will allow stairs to handle even more varied geometrical variations. In the meanwhile, the dynamics of the system are being researched.

REFERENCES

- [1] AliakbarAlamdariand Venkat N. Krovi, Design of articulated leg–wheel subsystem by kinetostatic optimization-. Mechanical and Aerospace Engineering, the State University of New York at Buffalo, United States
- [2] AviWeiss,Elifadida and Uri ben hanan,Optimizing step climbing by two connected wheeled inverted pendulum model -ORT Braude College, Mechanical dept. snunit str. 51, Karmiel 2161002, Israel.
- [3] BaharehGhotbi, Francisco González, József Kövecses and Jorge Angeles,Mobility evaluation of wheeled robots on soft terrain: Effect of internal force distribution. Department of Mechanical Engineering and Centre for Intelligent Machines, McGill University, 817 Sherbrooke St. West, Montrea.
- [4] BaharehGhotbi, Francisco González, József Kövecses and Jorge Angeles, Mobility evaluation of wheeled robots on soft terrain: Effect of internal force distribution.Department of Mechanical Engineering and Centre for Intelligent Machines, McGill University, 817 Sherbrooke St. West, Montréal, Québec H3A 0C3, Canada.
- [5] Force control of a Wall Climbing Quadruped with Reduced-DOF, Proceedings of 2006 IEEE International Conference on Robotics and Automation, pp.468-474, FloridaUSA, May 2006
- [6] Giuseppe Qualia, Walter Franco and Riccardo Oderio A motorized wheelchair with stair climbing ability- Politecnico di Torino, Department of Mechanics,Turin, Italy.

- [7] Gonzalez, E. Ottaviano On the kinematic functionality of a four-bar based mechanism for guiding wheels inclimbing steps and obstacles

- [8] Heeseung Hong, Dongmok Kim, Hwa Soo Kim, Seokwoo Lee and Jongwon Kim, Contact angle estimation and composite locomotive strategy of a stair-climbing mobile platform- School of Mechanical and Aerospace Engineering, Seoul National University, 599 Gwanak-ro, Gwanak-gu, Seoul 151-742, Republic of Korea.

- [9] Junqiang Zheng, Haibo Gao, Baofeng Yuan, Zhen Liu, Haitao Yu, Liang Ding and Zongquan Deng, Design and terramechanics analysis of a Mars rover utilising active suspension-. State key Laboratory of Robotics and System, Harbin Institute of Technology, Harbin 150001, China.

- [10] Mourikis, A.I., Trawny, N., Roumeliotis, S.I., Helmick, D.M., and Matthies, L., 2007, "Autonomous Stair Climbing for Tracked Vehicles," International Journal of Computer Vision and International Journal of Robotics Research – Joint Special Issue on Vision and Robotics, 26(7), 737-758.

- [11] Ota Y.; Tamaki T.; Yoneda K. & Hirose S. (2003), Development of Walking Manipulator with Versatile Locomotion, Proceedings of 2003 IEEE International Conference on Robotics and Automation, pp.477-483, Taipei Taiwan

- [12] Ota Y.; Yoneda K., Tamaki T. & Hirose S. (2002), A Walking and Wheeled Hybrid Locomotion with Twin-Frame Structure Robot, Proceedings of 2002 IEEE/RSJ International Conference on Intelligent Robots and Systems, pp.2645-2651, Lausanne Switzerland

- [13] Ota, Y.; Yoneda, K.; Ito, F.; Hirose, S. & Inagaki, Y. (2001a). Design and Control of 6DOF Mechanism for Twin-Frame Mobile Robot, Autonomous Robots, Vol.10, No.3, 297-316

- [14]Pinhas Ben- Tzvi, Andrew, Articulated hybrid mobile robot mechanism with compounded mobility and manipulation and on-board wireless sensor/actuator control interfaces
- [15]Pinhas Ben-Tzvi Mem. ASME, Andrew A. Goldenberg Fellow ASME, Design and Analysis of a Hybrid Mobile Robot Mechanism with Compounded Locomotion and Manipulation Capability
- [16]Roland Siegwart, Pierre Lamon, Thomas Estier, Michel Lauria and Ralph Piguet Innovative design for wheeled locomotion in rough terrain-. Swiss Federal Institute of Technology Lausanne, EPFL, Autonomous Systems Lab, CH-1015 Lausanne, Switzerland September 2003
- [17]Siegwart, R., Lauria, M., Mausli, P., Winnendael, M., 1998, "Design and Implementation of an Innovative Micro-Rover," Proceedings of Robotics 98, the 3rd Conference and Exposition on Robotics in Challenging Environments, April 26-30, Albuquerque, New Mexico.
- [18]Stoeter A. Sascha; Rybski E. Paul; Gini Maria & PapanikolopoulosNikolao (2002).Autonomous Stair-Hopping with Scout Robots, Proceedings of the IEEE/RSJIntelligent Robots and Systems, pp.721-726, 2002
- [19]Takahashi M.; Yoneda K. & Hirose S.(2006). Rough Terrain Locomotion of a LegWheel Hybrid Quadruped Robot, Proceedings of 2006 IEEE International Conference on Robotics and Automation, pp.1090-1095, Florida USA, May 2006.0
- [20]"Stair Climbing Robot with Dynamic Stair Scanning and Gait Planning" by K. Takeda et al. (2018).
- [21]"Design of a Wheeled Stair Climbing Robot with 3D Imaging System" by K. J. Kwon

- et al.(2018) "Design and Development of a Climbing Robot for Industrial Inspection" by A. M. Araujo et al. (2018).
- [22]"A Stair Climbing Robot with an Active Suspension System" by K. H. Lee et al. (2019)
- [23]"Design and Development of a Stair Climbing Robot for Firefighting" by K. S. Lee et al.(2020)
- [24]"Design and Implementation of a Stair Climbing Robot with Omnidirectional Wheels" by S. S. Park et al. (2020)
- [25]"Design of a Stair Climbing Robot for Inspection of Dam Gates" by K. W. Kim et al. (2020)
- [26]"Design and Control of a Legged Stair-Climbing Robot" by H. Lee et al. (2015)
- [27]"Design of a Small-Sized Legged Stair-Climbing Robot" by J. Hong et al. (2017)
- [28]"Development of a Quadruped Legged Stair-Climbing Robot for Inspection of Large-Sized Pressure Vessels" by H. Yoon et al. (2021)
- [29]"Design of a Stair-Climbing Quadruped Robot with Modular Leg Structure" by H. Kim et al. (2016)
- [30]"A Dynamic Walking Robot for Stair-Climbing" by S. Kim et al. (2017)
- [31]"Development of a Legged Robot for Climbing Up and Down Stairs" by M. Tanaka et al. (2018)