

DESIGN AND FABRICATION OF SPIDER BOT

Submitted in partial fulfillment of the requirement for the award of
Bachelor of Engineering Degree in Mechatronics

By

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SATHYABAMA

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

**Accredited with Grade “A” by NAAC | 12B Status by UGC | Approved by AICTE
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of **SABARI GANESH.S (39090706)** and **LOKESH. M (39090703)** who carried out the project entitled **"DESIGN AND FABRICATION OF SPIDER BOT "** under our supervision from June 2022 to May 2023.

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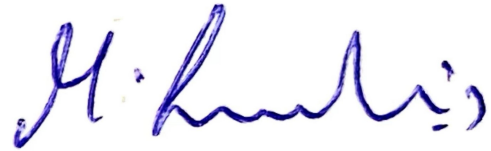
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DECLARATION

I **S. SABARI GANESH (REG.NO.39090706)** , hereby declare that the Project Report entitled “**DESIGN AND FABRICATION OF SPIDER BOT**” done by me. 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.

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ABSTRACT

In this project, involves the construction of the spider bot's body using lightweight and durable materials, such as acrylic and fiber, that provide the necessary strength and flexibility. The legs of the spider bot are designed using joints that allow for the smooth movement of the bot across various terrains. The DC motors, which are controlled using an Arduino board, power the spider bot's movement, allowing it to move in any direction. The battery links provide the necessary power to operate the motors and the Arduino board, ensuring the spider bot has the necessary energy to perform its tasks. The spider bot can be programmed to perform various tasks, such as exploring different environments or providing assistance in difficult-to-reach locations. The spider bot's versatile and adaptable design makes it a valuable tool for numerous applications, including military, rescue operations, and surveillance. The spider robot with Theo Jansen mechanism The Theo Jansen mechanism is a type of walking mechanism that uses a series of interconnected rods and joints to create a natural walking motion. This mechanism is inspired by the movement of creatures such as spiders and crabs and is commonly used in the design of legged robots. To use the Theo Jansen mechanism in the design of a spider bot, the robot's legs would need to be designed using a series of interconnected rods and joints that mimic the movement of a spider's legs. The mechanism would be powered by DC motors and controlled using an Arduino board, which would allow the spider bot to move in any direction. This project focuses on developing a four-legged robot that utilizes the four-bar link mechanism inspired by Theo Jansen. The project is divided into two phases: the design phase, where the robot will be designed and modeled using computer-aided design (CAD) software, and the fabrication phase, where the robot will be built using the specified methods and materials. The authors chose the Jansen mechanism over Joe Klann's mechanism due to its advantages. The primary goal of the project is to create a lightweight and stable robot that can walk like a spider. To achieve this goal, the robot is made using materials such as acrylic and fiber, resulting in a 30% reduction in weight compared to its previous version

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION TO SPIDER BOT

This device functions very similarly to crab legs in terms of construction. This project's primary goal is to evaluate the literature on the different uses of this mechanism that have been discovered since 1990 and are either in development or at an advanced level [1]. This review is anticipated to aid scientists, engineers, and creative in coming up with even better mechanisms, improving current ones, or developing new uses for existing ones. [2] The hybrid mechanism of the robot consists of a mobile robot platform for mobility and a manipulator arm for manipulation. It is composed of both parallel and serially connected links [3].

By multiplying the two, the power required for the motors is created. For various connecting arm lengths, the required power by the front and rear motors in proportion to the climbing angle [4]. Passive wheels, link 2, link 3, end-effectors, and two comparable and parallel base link 1 tracks (left and right) make up the platform. All of the links are nested inside of one another to emphasize the pattern's symmetrical nature [5]. To solve these shortcomings, this work proposes a simple, reliable, and fairly cost contact angle estimate approach based on several tilt sensors. This is based on the fact that when climbing a step or stair, the two tilt degrees of the proposed movable platform are closely connected to one another. [6] This study provides a multi-layered grid map containing important geometric and mechanical characteristics, as well as significant parameters extracted from terrain bearing and shearing models. [7]

Alternative designs of articulated leg-wheel subsystems were investigated in order to manage the motion and force interactions between the ground and the chassis and so enable vehicle systems to travel in difficult circumstances and uneven terrain. [8] The detected motor current pattern is compatible with the kineto-static analysis trend. Furthermore, the kineto-static analysis increases the RHyMo's step-climbing capabilities by decreasing the required motor currents. [9]. The front wheel has a spring suspension to ensure that all four wheels always have the best possible ground contact. Coordination of steering of the front and rear wheels as well as the speed difference of the bogie wheels, the vehicle is turned. [10] Originality This spider robot used to find

hazardous or difficult regions where people can readily get access. For instance, looking for survivors after a horrible nuclear disaster, investigating in conflict areas, or looking at shaky structures after a natural disaster like an earthquake, tsunami, or volcanic eruption.

According to our research, various elliptic circles may be used for walking, ascending, exploring new territory, and returning by leveraging the connection center's cyclic movement. The objective is to put together an eight bar interface system- based new mechanical automated walker. In the future, we'll need to use this robot to carry out a variety of tasks by using sensors. Robotic walking machines are ideal for navigating unstructured environments due to their stability. However, they require complex mechanics and significant control resources [11].

Limited mobility can hinder a robot's ability to achieve its mission goals and, in extreme cases, render it immobile [12]. A proposed four-bar linkage mounted on each wheel of a vehicle would enable it to climb stairs comfortably and effectively [13]. A four-bar linkage is used to move and rotate a wheel chair to prevent tipping and ensure the user's comfort during various procedures [14].

These systems are often referred to as "learning," "developing," and "evolving" as they interact with their environment, solving symbol or representation grounding issues in artificial intelligence research[15]. Although animal-robot interaction is a fascinating topic, our experiment will not involve human participation as they do not exhibit swarm behavior [16].

A modular, self-configurable system called Polycot is being researched to better understand the physicality of robots with replaceable parts. [17] By compiling scattered data on the occupancy of adjacent spaces, individual sensor readings create more precise maps of a robot's surroundings [18].

Finally, the possibility of mechanical bodies with artificial minds capable of independent physical labor seemsto be within reach [19]. A robot is an automated machine that can perform tasks quickly and accurately with little or no human intervention. There are six types of commonly used robots, including Autonomous mobile robots, AGVS, Articulated robots, Humanoids, Robots, and

Hybrids. Our spider robot falls into the category of Autonomous mobile robots, which are designed to perform heavy and light duty tasks, transport items to human employees or for military use, and provide safety and security applications. Our spider robot is intended for remote environmental monitoring. We used the Theo Jansen mechanism, which is a popular linkage mechanism for its superior performance compared to others, such as Klann mechanism,

The Theo Jansen linkage is a planar leg mechanism that offers smooth walking motion, making it an excellent choice for our spider robot. We integrated an ultrasonic sensor to detect obstacles and prevent the robot from sustaining damage. The sensor functions as a proximity sensor, producing a pulse to identify objects or materials in front of the spider robot. Our spider robot was primarily designed for military use, such as transporting bullets, bombs, and medical however it may also be used in commercial situations.

CHAPTER 2

LITERATURE SURVEY

Norton 2004[1,] For legged robots, 2 DOF is the bare minimum for raising and swinging a leg forward. It demonstrates a leg system that is comparable to a spider leg. In comparison to other types, such as the four-bar mechanism, we picked the six-bar mechanism because of its greater force transmission angle and larger oscillation angle. "Swadhin Patnaik [2]" investigated four-legged walking. I discovered some statistics when investigating mining businesses. Roads account for around half of the total cost.

Long-distance travel causes considerable wear and tear on the tyres of vehicles used for transportation, necessitating regular tyre replacement. The weight on haul roads is not distributed equally, resulting in considerable stress difficulties After some investigation, I discovered that the legs performed well on terrain rather than wheels. After examining this process, I discovered that it mimics the movement of insects. "Al Salameh Shamsudin [3]" investigated the movement of walking machines. He demonstrated the robot's configuration, number of degrees of freedom, and leg movement analysis. Walking robots with biologically inspired gaits were discussed. "Richard Edgeworth [4]," In 1770, he attempted to build a wooden horse. That horse had a total of eight legs. It was designed to leap over tall barriers. However, 40 years of effort failed to produce such a system. The first computer-controlled walking machine was created by "Frank and McGhee[5]." Recently, the University of Southern Queensland's Mechatronics Research Group developed pneumatic

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improved bipedal robot gait stability. CLAWAR 2001 - Fourth International Conference on Climbing and Walking Robots - From Biology to Industrial Applications, edited by Berns K and Dillmann, Professional Engineering Publications Ltd, Bury St. Edmunds and London, UK. J. Albiez and K. Berns, Biologically Inspired Walking: How Much Nature Do We Need? Climbing and Walking Robots, edited by Armada MA and de Santos Gonza' lez. Springer-Verlag, Berlin Heidelberg, Germany. Alexander RMcN (1984) Bipedal and quadrupedal animal gaits. International Journal of Robotics Research, Vol. 3(2), pp. 49-59. Three applications of springs in legged movement, Alexander RMcN (1990). The International Journal of Robotics Research, Volume 9(2), Pages 53-61. RMcN Alexander (2005) Scale issues for animals that walk and climb. Climbing and Walking Robots, edited by Armada MA and Gonza' lez de Santos P. Springer-Verlag, Berlin Heidelberg, Germany. J. Ayers (2004). Underwater walking. 347-360 in Arthropod Structure and Development. MG Bekker (1960) Locomotion Off the Beaten Path University of Michigan Press, Ann Arbour, MI. Introduction to Terrain Vehicle Systems, Bekker MG (1969). University of Michigan Press, Ann Arbour, MI. R. Breithaupt, K. Zahedi, J. Hertzberg, F. Pasemann, and J. Dahnke (2002) Robo-Salamander is a method that benefits both robotics and biology. P. Bidaud and F. B. Amar (eds.) Climbing and Walking Robots - Fifth International Conference on Climbing and Walking Robots and Mobile Machine Support Technologies.

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3153–3158. Foot placement and velocity control in smooth bipedal walking, Dunn ER and Howe RD (1996), in Proceedings of the 1996 IEEE International Conference on Robotics and Automation, 22-28 April, Minneapolis, MN, pp.578-583. Endo, K., and T. Maeno (2003) Co-evolution of biped humanoid robot morphology and walking pattern using evolutionary computation - building the real robot, in Proceedings of the 2003 IEEE International Conference on Robotics and Automation, 14-19 September, Taipei, Taiwan, pp. 1362-1367. The research delves into the design and analysis of a Mars rover that use active suspension technology to increase its mobility in tough terrain. Terramechanics and design Junqiang Zheng, Haibo Gao,

Baofeng Yuan, Zhen Liu, Haitao Yu, Liang Ding, and Zongquan Deng examined a Marsrover using active suspension. Harbin Institute of Technology, Harbin 15001, China, Statekey Laboratory of Robotics and Systems. The suggested rover design has six wheels, each powered by its own engine, as well as a rocker-bogie suspension system that allows the rover to navigate uneven terrain with increased stability and agility. The authors undertook a thorough examination of the rover's terran mechanics, taking into consideration Martian surface features such as the presence of rocks, sand, and slopes. Terramechanics investigation comprised simulations of the rover's performance in different conditions, including as ascending steep slopes and passing huge rocks. The authors created an active suspension system that can modify the height of the rover's body relative to the ground in real-time to increase the rover's mobility. This permits the rover to stay in contact with the ground even in uneven terrain, lowering the chance of it becoming trapped or toppling over. The researchers also tested the rover's capabilities on tough terrain using a real replica. The findings of these studies proved the active suspension system's usefulness in boosting the rover's mobility and stability. Overall, the suggested Mars rover design, which incorporates active suspension technology, has considerable potential for future space research missions. because it enables more movement and agility in uneven terrain, which is frequent on Mars. According to the scientists, this technique might be adapted to different types of rovers used for exploration on other planets and moons with comparable surface conditions.

CHAPTER 3

AIM AND SCOPE OF WORK

Spider bots have always been a fascinating topic for scientists, researchers, and engineers. Their unique ability to climb walls and ceilings and navigate through complex terrains makes them an attractive option for search and rescue missions, military applications, and even domestic services. With advancements in technology, spider robots have become more efficient and capable of performing complex tasks.

As part of our research, we identified several existing models of spider bots. While these models are efficient, we believe that there is a need for a more capable and efficient spider bot. Our aim is to develop a spider bot that can carry a larger payload and has a faster speed compared to the existing models. We plan to achieve this by designing a spider bot that carry a payload of 2.25-2.5 kg The increased speed of 10 kmph will make the spider bot ideal for military applications where speed is crucial.

To make the spider bot more flexible and adaptable, we plan to use different link lengths for the front, middle, and rear legs. By doing so, we can achieve better stability and control over the spider bot's movements. We also plan to add sensors and vision to enhance the spider bot's effectiveness. The addition of sensors will allow the spider bot to detect obstacles, navigate through complex terrains, and avoid potential hazards. The use of vision will enable the spider bot to detect and identify objects, improving its overall functionality.

Achieving the desired stance and movement of the spider bot is crucial for its effectiveness. The range of motion and moments at each joint must be considered during the design phase to achieve the desired insect-like walking. Our spider bot will be designed to have 180 degrees of freedom, which will allow for greater control over its movements. We will also focus on achieving the desired range of motion and moments at each joint to ensure that the spider bot can navigate

through complex terrains and perform tasks with ease despite the recent popularity of spider bots, they have been in development since the 1980s. The first spider bot was developed by Japanese engineer Toshio Fukuda in the early 1980s. Since then, spider bots have evolved into sophisticated machines capable of performing various tasks in industrial and commercial settings. In recent years, spider bots have gained popularity in the military and defense sectors, where their ability to navigate through complex terrains and perform tasks in hazardous environments makes them an ideal choice.

In conclusion, our research shows that spider bots have come a long way since their inception in the 1980s. Our aim is to develop a spider Bot that is more efficient and capable of performing complex tasks. We plan to achieve this by designing a spider Bot that has 180 degrees of freedom, can carry a payload of 2.25-2.5KG, and has a speed of 10KMPH. We also plan to make the spider Bot more flexible and adaptable by using different link lengths for the front, middle, and rear legs and incorporating sensors and vision. Achieving the desired range of motion and moments at each joint is crucial for the spider Bot's effectiveness, and we will focus on achieving this during the design phase. With our spider Bot, we hope to revolutionize the field of robotics and pave the way for more advanced and sophisticated machines.

CHAPTER 4

METHODOLOGY

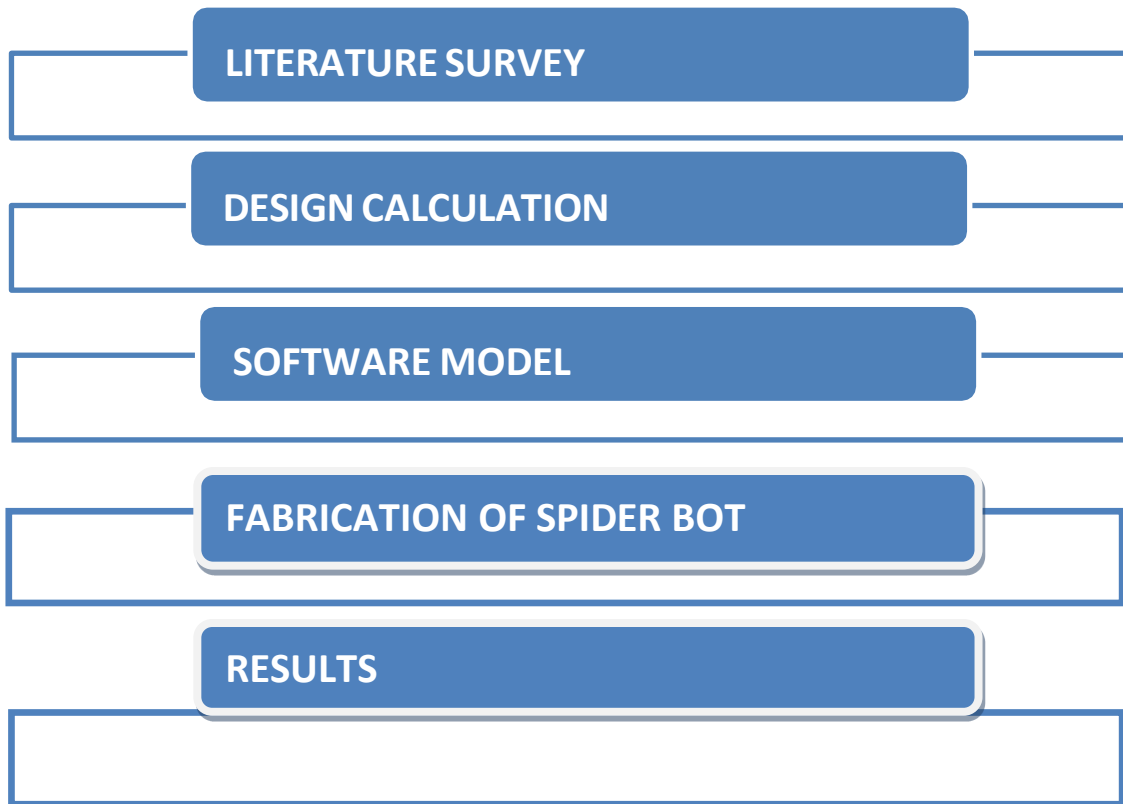


FIG 4.1 Methodology of spider bot

4.2 CONCEPTUAL DESIGN

The conceptual design of a robot is aimed at overcoming the limitations of wheeled locomotion, which can only climb steps that are half the height of its wheel diameter. The proposed design is capable of climbing steps of the same height as its wheel diameter, ensuring satisfactory locomotion. Figure 1 depicts the design of a wheeled stair-climbing robot, and there are certain features of the design that should be taken into consideration. For instance, a separate bogie should be provided for each pair of wheels to avoid restriction of the bogie movement. The complete rotation of the bogie around its axis should not result in climbing the obstacle as it is free, and stoppers should be applied to avoid rotation. The elastic property of the material itself should act as the suspension system, and the frame should be designed to accommodate the control circuit. Additionally, the middle link should be designed to maintain adequate ground clearance, and the wheels must not touch each other, which is a crucial point to consider During the design process. According to manufacturing constraints, the cover should be built to withstand loads without compromising function. Following the creation of the CAD model, the proportions of the robot hardware components and the overall dimensions of the quadruped robot are established. The hardware components of the robot, such as the torso frame and legs, are manufactured of PVC foam sheet (Sun board).

When designing a spider bot, the intended purpose of the robot must be considered to determine the best design. For instance, if the spider bot is expected to move quickly and efficiently, special attention should be paid to its leg design. If the spider bot is expected to climb walls or ceilings, its claw design must be given special consideration. Finally, if the spider bot is expected to carry a heavy load, the body design should be focused on. Regardless of the specific goals for the spider bot, certain design principles must be followed to ensure a successful design. Firstly, the spider bot must be well balanced, meaning that its center of gravity should be evenly distributed to prevent it from tipping over movement.

Secondly, the spider bot must be aerodynamic to move quickly and efficiently. Lastly, the spider bot must be durable, enabling it to withstand being dropped or hit without being damaged. By adhering to these principles, a spider bot can be designed to meet its intended purpose effectively.

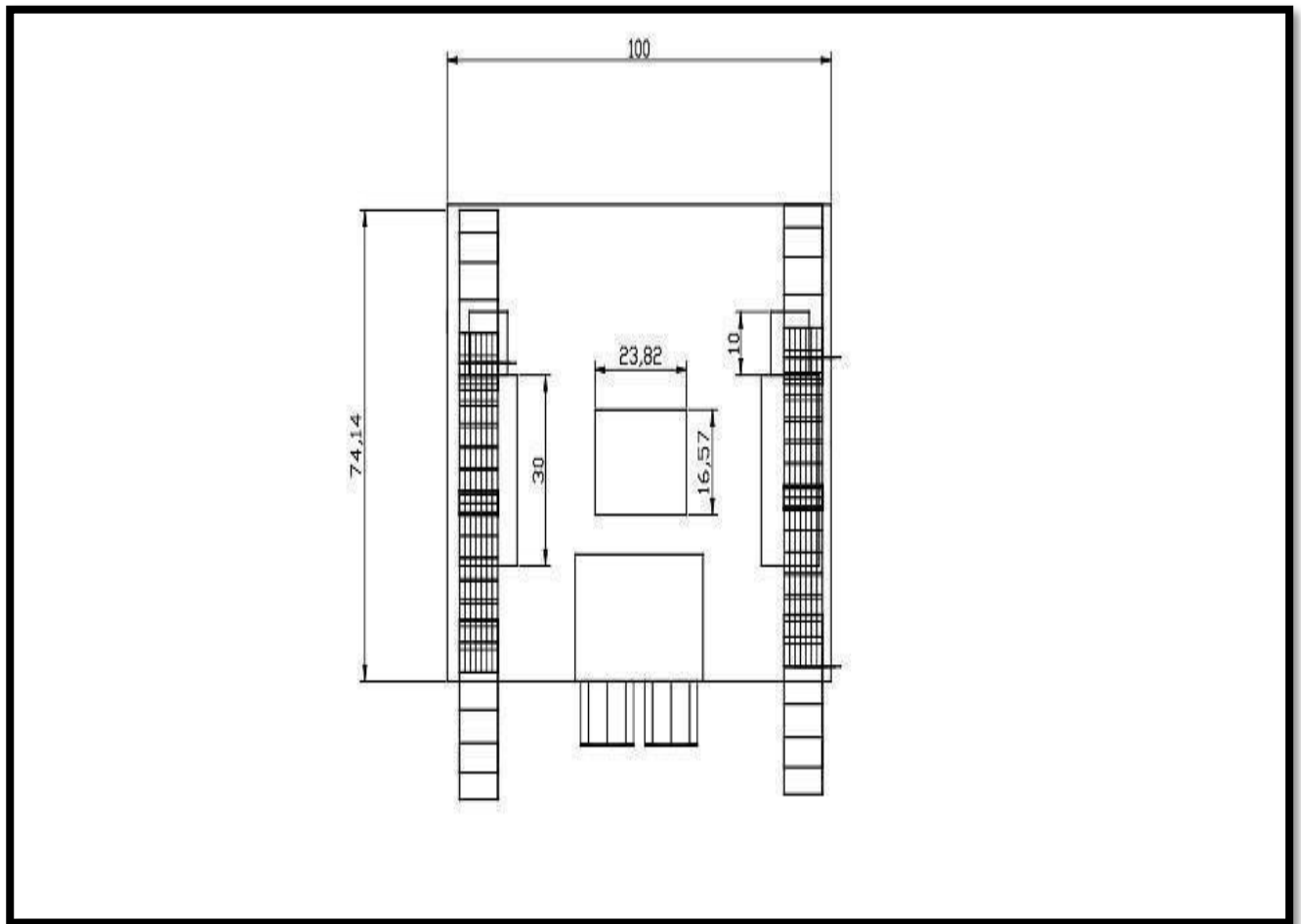
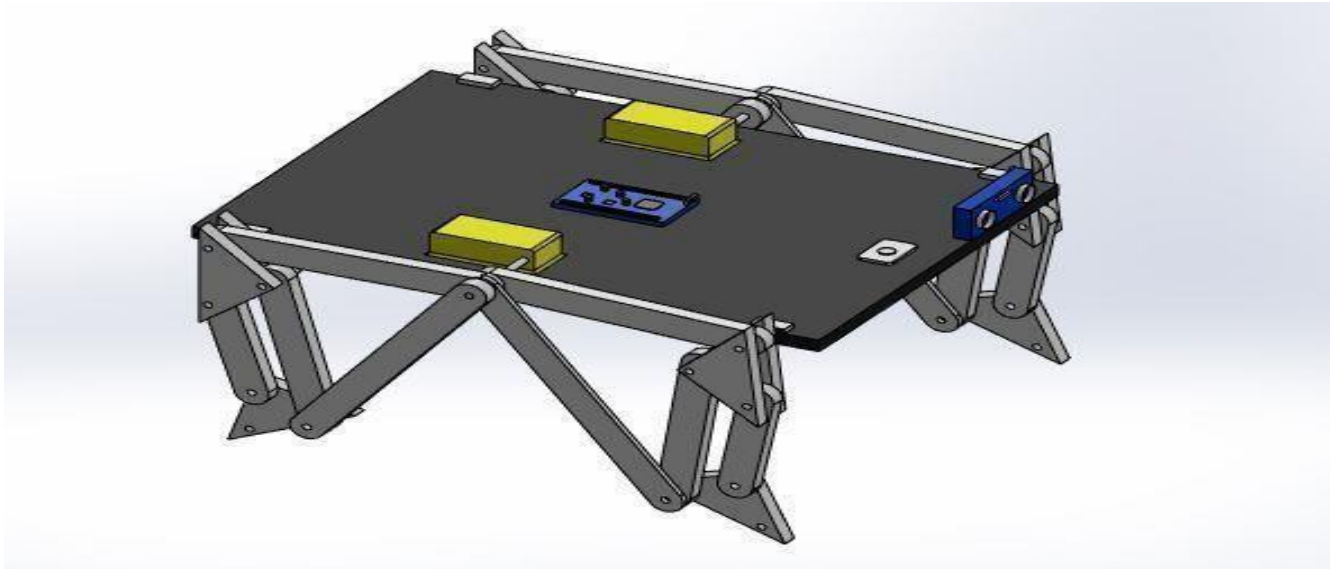
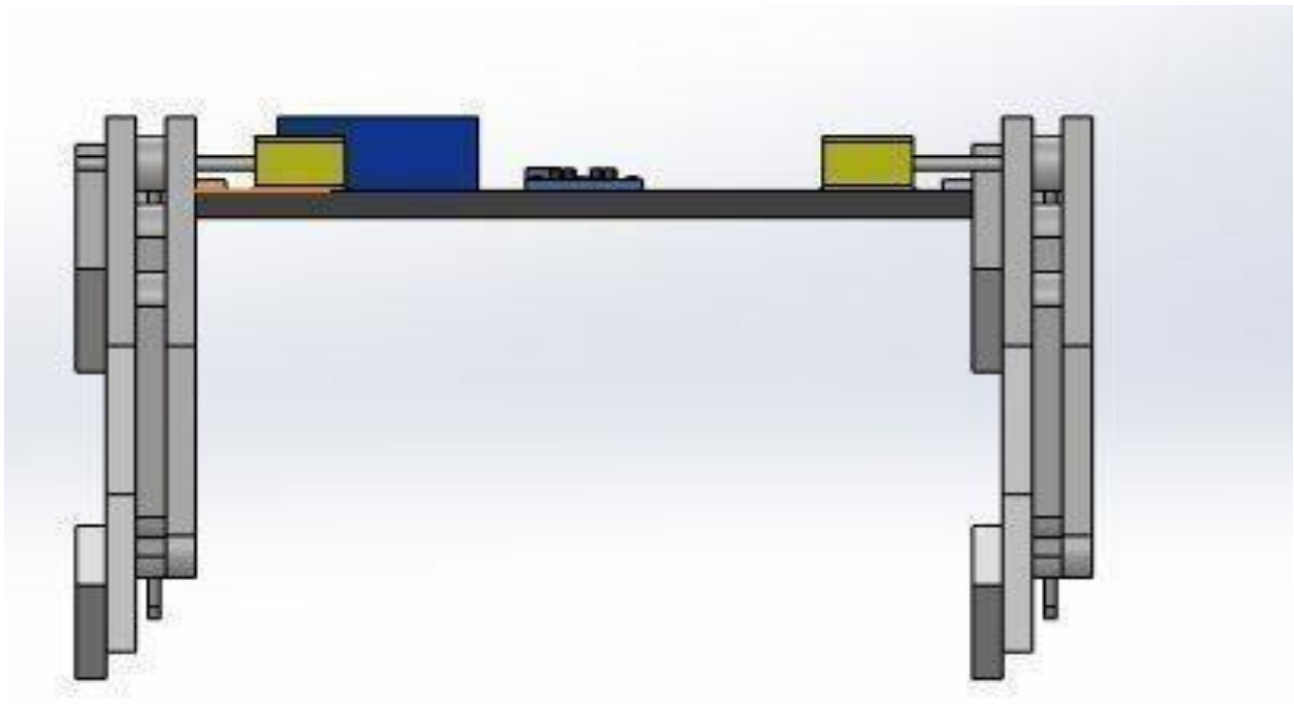


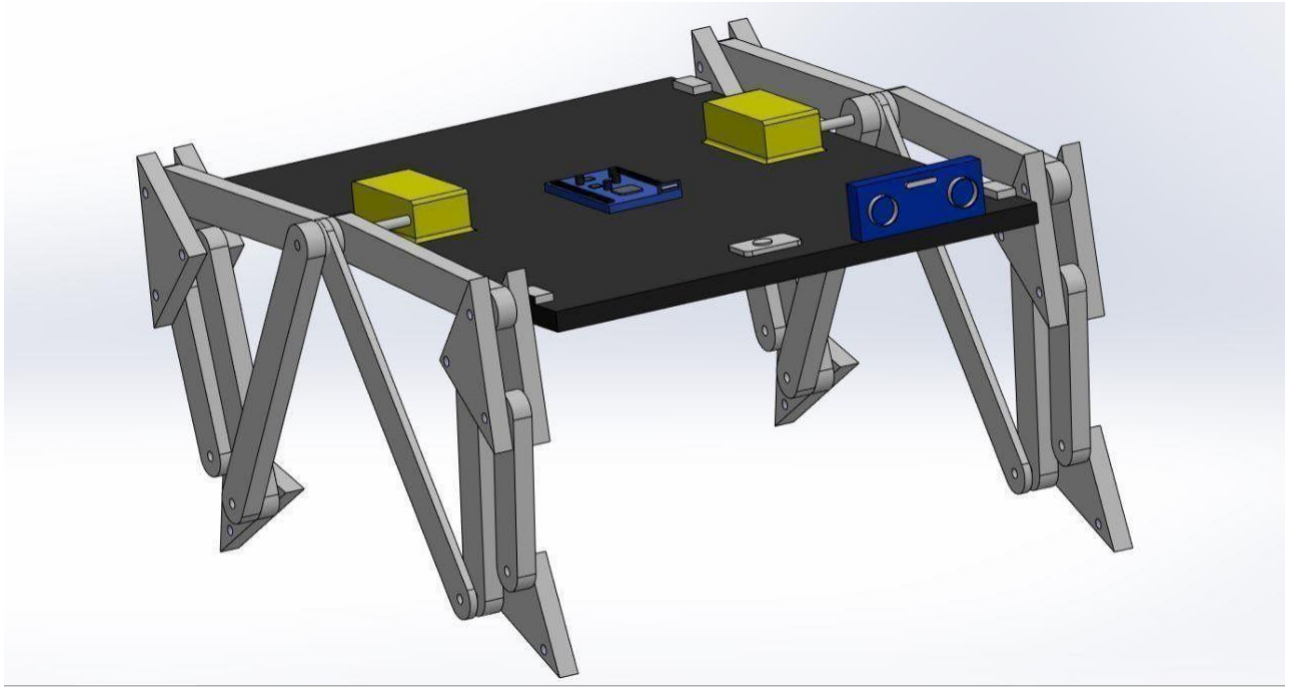
Fig 4.2.1 Auto cad design of spider bot



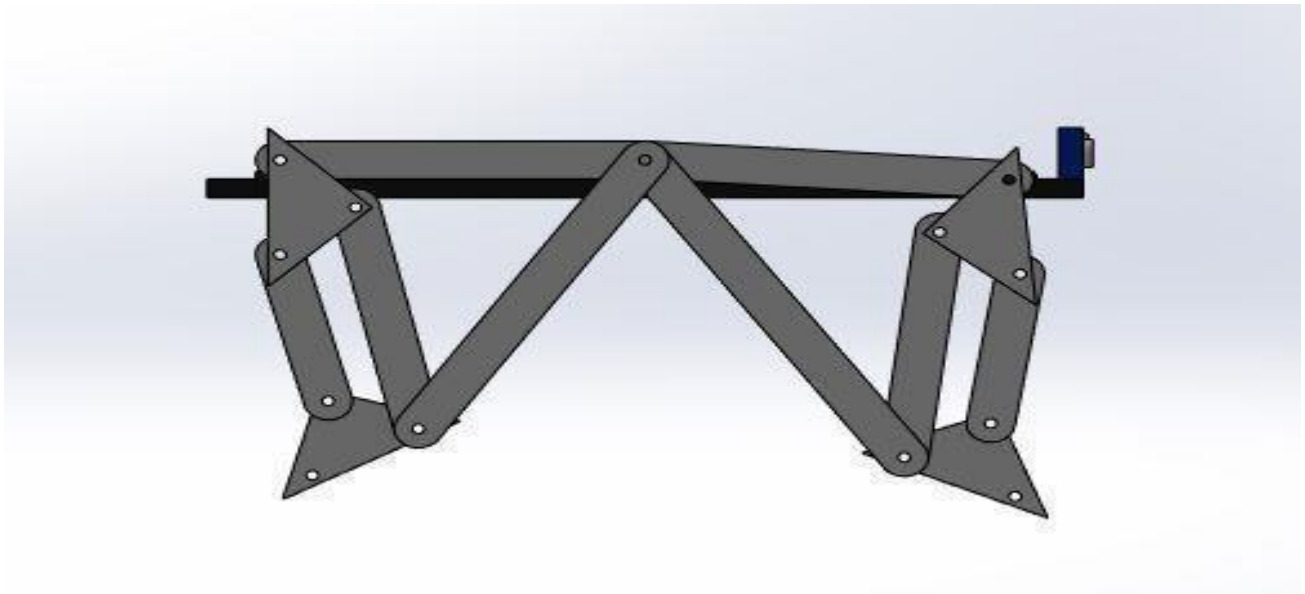
4.2.2 Design of spider bot



4.2.3 Rear view of spider bot



4.2.4 Front view of spider bot



4.2.5 Side view of spider bot

CHAPTER 5

5.1 THE PRINCIPLE OPERATION OF THE SPIDER BOT

The study focuses on the development of a quadruped robot that can navigate flat terrain at a maximum speed of 20 mm/s. The robot's size and weight are determined based on the chosen actuation system, electrical converter, and system weight, with a maximum weight of 0.5 kg for the converter and system. Spider robots are designed to move like spiders and are used for exploration, search and rescue, and military applications. They typically have four or more legs and may be equipped with sensors and cameras. The four bar mechanism is a commonly used mechanical device that converts linear motion into rotary motion and is used in a variety of applications. Spiders have specialized leg muscles that allow them to move in unique ways and stay balanced. The research on spider robots is an exciting field of study that holds great potential for advancing robotics. Spider robots are designed to move like spiders and are built for a variety of purposes, including exploration, search and rescue, and military applications. One of the key components of the spider robot is its ability to receive radio signals via a built-in antenna and use an Arduino receiver or microcontroller to transfer the signal to the servo and speed controller. The controller manages the electric and servo motors by regulating their rotational speed to match the transmitter's signal. This system allows the spider robot to move forward or backward while avoiding obstacles.

Robots with legs have a significant advantage over wheeled robots as they can enter inaccessible spaces. By modeling robots after animals with legs, scientists and engineers can incorporate biological ideas into designs for stable and rapid walking. Leg measurements are inversely correlated with frame measurements, and the quadruped robot's physical and performance requirements are determined before design begins. The spider robot is a great example of the application of these ideas. Its four electric motors, two of which operate in reverse, are all connected in parallel. This is because each end of the research will have two electric motors, and when one pair of the legs is moving forward, the other leg must be moving backward. This effect

is accomplished by connecting the motor such that current flows in the opposite direction. The spider robot's physical characteristics also play an important role in its design. Spider robots typically have four or more legs, and may also have arms and other appendages. They are often equipped with sensors and cameras, and may be controlled remotely or autonomously. Spider robots have been developed by a number of different companies and organizations and are available for purchase commercially. They can also be built by hobbyists and enthusiasts. One of the most interesting aspects of spiders and their movement is their use of specialized leg muscles. When a spider wants to move, it first contracts its leg muscles. This makes the legs bend at the joints. The spider then releases the muscles and the legs straighten out again. This process is repeated over and over again, and it's what gives spiders their characteristic 'walking' motion. The leg position also helps spiders to move quickly. When a spider wants to accelerate, it simply moves its legs closer together. This decreases the spider's base, making it more stable and able to move faster.

Spider robots are also fascinating in terms of their physical characteristics. Leg measurements are inversely correlated with frame measurements. By deciding on an actuation system, system, and electrical converter, the robot's size and weight are fixed. Electrical converter and system weight is considered to be a maximum of 0.5 kg. The quadruped robot's performance and physical requirements are also decided here. Physical standards, which specify the robot's size and weight, and performance specifications, which describe task-related parameters, are both critical aspects of the design process. In conclusion, spider robots are a promising area of research with the potential to revolutionize robotics. By modeling robots after animals with legs, scientists and engineers can incorporate biological ideas into designs for stable and rapid walking. Spider robots are designed to move like spiders and are built for a variety of purposes, including exploration, search and rescue, and military applications. They are often equipped with sensors and cameras and may be controlled remotely or autonomously. The spider robot's physical characteristics, including its leg position and specialized leg muscles, are essential components of its design. By understanding and utilizing these characteristics, researchers can create more advanced and efficient spider robots that are better equipped to navigate complex environments and perform a wide range of tasks.

CHAPTER 6

COMPONENTS

6.1 FRAMES AND BASE PLATE: The model consists of a base bottom plate and four vertically fixed frames made of acrylic. Mild steel is used for the base plate and other components, with its appearance varying from silvery to dull grey depending on surface roughness. Mild steel is a lightweight, flexible metal that is non-magnetic and not easily ignited. It has high reflectivity for visible light (around 92%) and excellent reflectivity for medium and far infrared radiation (up to 98%). Acrylic alloys have yield values ranging from 200 to 600 MPa, while low-carbon steel has a yield strength of 7 to 11 MPa.

6.2 DC MOTOR: It is an electrical rotary device that converts DC electricity into energy. It usually contains an internal mechanism, whether electromechanical or electronic, that enables it to periodically change the direction of the motor's partial current flow.

6.3 GEARS ARE ESSENTIAL COMPONENTS: Gearbox and are also used for speed reduction. Two sets of gears are required for effective energy transmission, each consisting of a smaller gear and two larger gears. A smaller gear with 36 teeth and a larger gear with 60 teeth produce a speed reduction ratio of 1.68. The gears used in this model are nylon plastic spur gears, which are the only two types of gears available: spur gears and straight-cut gears.

6.4 AN ELECTRIC BATTERY: It can be any type of charged battery, accumulator, or storage cell. It can serve as an energy accumulator and is made up of one or more electrochemical cells. Because its electrochemical processes are electrically reversible, it is referred to as a storage cell. Rechargeable batteries are available in a variety of sizes and configurations, from button cells to megawatt systems used to stabilize electrical distribution networks.

6.5 MECHANICAL LINKAGE: The system of interconnected bodies that control forces and movement. The motion of a body, or link, is analyzed using geometry, assuming that the link is rigid.

6.6 SHAFT:

Length: 110 mm Diameter: 12 mm 4.7 CONTROL BOARD STAND: Length: 100 mm Breadth: 120 mm Thickness : 29 mm The velocity of a point on a poignant link relative to the pivot of the link is given by the equation: $V = r\omega$, where ω = angular velocity of the link and r = distance from pivot

$$f1 := x1^2 + (x2+1)^2 + (x3-.5)^2 - R^2;$$

$$f2 := x1 - .5x2 + .5x3;$$

$$f3 := (x1-x4)^2 + (x2-x5)^2 + (x3-x6)^2 - 19;$$

$$f4 := \sin(x4) - x5; f5 := \sin(2x4) - x6;$$

6.6.2 Basic Theoretical Calculations

-Variables

F_k = Traction generated by the motor.

N_k = Ground reaction force f_i = friction forces at step

N_i = Supportive force at step

6.6.3 Properties of robot assembly

1. Total weight of quadruped robot assembly = 1.7 Kg.
2. Overall height = 281 mm , Overall length = 350 mm, Overall width = 260 mm.

CHAPTER 7

ROBOT ASSEMBLY

Batteries, servomotors as actuators in the example Batteries are essential components of the quadruped robot since they provide the necessary power to run the servomotors and other electronic components. The batteries used in this robot are rechargeable and can provide long- lasting power to ensure the robot's smooth operation. The type of batteries used may depend onthe specific requirements of the robot and the application it is being used.

Servomotors are used as actuators in the quadruped robot to provide the necessary motion and movement required to walk and perform other tasks. Servomotors are electrical devices that canprecisely control the movement and position of mechanical systems. They can generate a lot of torque and are capable of making quick and precise movements, making them ideal for use in robotic systems.

The controller board is responsible for processing the signals from the sensors and other input devices, and sending commands to the servomotors to control the robot's movements. The controller board used in the quadruped robot is typically a microcontroller or a single-board computer that can handle the complex computations required for the robot's control.

A servo shield is used in the control system to simplify the wiring and control of the servomotors.The servo shield provides a convenient interface for connecting the servomotors to the controllerboard, allowing for easy control and programming of the robot's movements.

The Jansen linkage is a mechanical linkage that is used in the locomotion of the quadruped robot.This linkage provides the necessary stability and load-bearing capacity required for the robot to move smoothly over uneven terrain and carry heavy loads. The Jansen linkage has been chosen

as the primary mechanism for the robot's locomotion due to its ability to handle heavy loads while maintaining stability.

The quadruped robot has been employed in a number of different industries, including mining, sports pitch marking, gardening and stair climbing. It is an invaluable equipment for a variety of applications because of its capacity to traverse challenging terrain and transport large loads while retaining stability. Due to their capacity to traverse difficult terrain and lift greater weights, quadruped robots are being used more frequently as alternatives to wheeled robots.

The Jansen linkage has been investigated in the mining industry as a long-term substitute for wheels for load-carrying tippers and trucks. The Jansen linkage was selected because of its capacity to support enormous weights while maintaining a stable body. This study intends to address the difficult and time-consuming problems associated with smooth vehicle passing at mining sites. The Jansen linkage is a sophisticated mechanical device made up of a number of interlocking links that may move in unison to create intricate movements.

Parekh et al. proposed a robot without wheels based on Jansen's loco motional mechanism for pitch marking on sports fields. This robot can support heavier loads than its own weight if weight is evenly distributed. The robot can mark the sector using chalk, paint, or water colors and can be adapted for gardening tasks. The Jansen mechanism allows the robot to move smoothly and efficiently, making it a useful tool for sports field marking and gardening.

A prototype created by Liu and colleagues can climb stairs effortlessly and resembles the human ankle. The robot uses the Jansen mechanism for smooth trajectory and balance. The robot's legs are designed to be flexible, allowing it to adapt to uneven terrain. The spider robot offers unique capabilities and features such as flexibility and sensor-equipped cameras for gathering information and performing tasks autonomously, making them valuable for many industries.

Spider robots have mobility based on the concepts of legged locomotion employing pneumatic cylinders for motion. They can climb walls and ceilings and navigate around obstacles with ease. The spider robot's adaptable body design makes it simple to modify it for various uses. Spider robots are employed in a variety of industries, including maintenance, surveillance, and search and rescue. Robots with quadruples have been created to address the drawbacks of wheeled robots, enabling them to travel across rough terrain and carry big loads without losing stability. The Jansen linkage is an effective substitute for wheels for load-carrying tippers and trucks in the mining industry because it is a sophisticated mechanical system that can generate complicated movements. Robots can move smoothly and effectively thanks to the Jansen mechanism, making them great equipment for gardening and marking sports fields.

Because of their special flexibility and sensor-equipped cameras for obtaining data and carrying out tasks on their own, spider robots are useful in a wide range of sectors. The spider robot's adaptable body design makes it simple to modify for various uses, making it an effective tool for maintenance, surveillance, and search and rescue operations.

CHAPTER 8

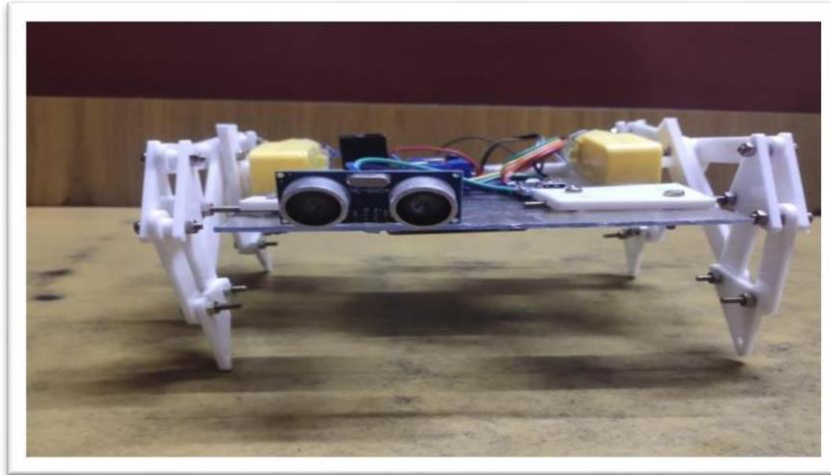
ULTRASONIC SENSOR

Ultrasonic sensors are a popular choice for a wide variety of applications due to their reliability and versatility. One of the main advantages of ultrasonic sensors is their ability to function in a wide range of lighting conditions, whether indoors or outdoors. This makes them a popular choice for applications where lighting conditions may vary or where reliable detection is necessary regardless of the lighting conditions. In addition to their ability to function in a wide range of lighting conditions, ultrasonic sensors are also capable of managing frequent movement and collision avoidance for robots, as long as the robot isn't moving too quickly. This makes them a popular choice for robotics applications where frequent movement and obstacle avoidance are necessary.

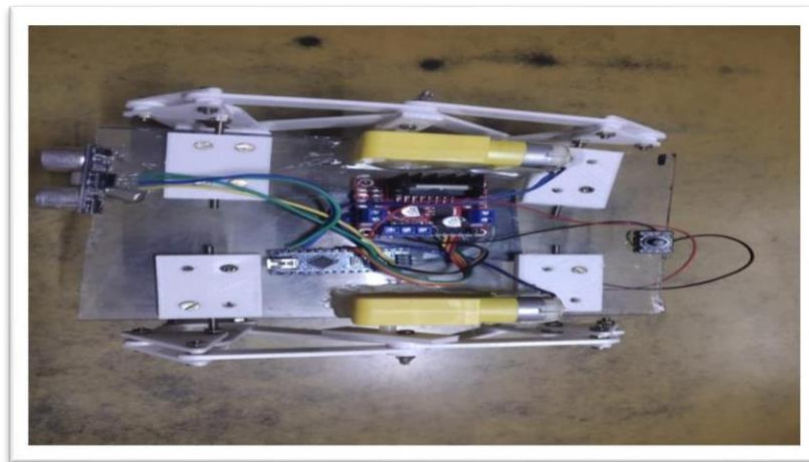
Another advantage of ultrasonic sensors is their versatility. They can be used for a wide range of applications, including drone applications, water level sensing, grain bin sensing, and sensing cars at drive-through restaurants or banks. Ultrasonic rangefinders are also commonly used in collision detection technology, making them an important tool for improving safety in a variety of industries. One of the unique advantages of ultrasonic sensors is their ability to detect distant objects using a variety of surface characteristics. While soft materials like wool may pose a challenge for ultrasonic sensors, they are still preferable to infrared sensors since they are not affected by smoke or dark objects. This makes them a popular choice for applications where detection accuracy is important and environmental factors may interfere with other types of sensors. Despite their versatility and reliability, ultrasonic sensors are not without their limitations. Like any technology, they are not flawless and may occasionally produce false readings or fail to detect certain objects. However, overall, they have proven to be effective and dependable, making them a popular choice for a wide range.

CHAPTER 9

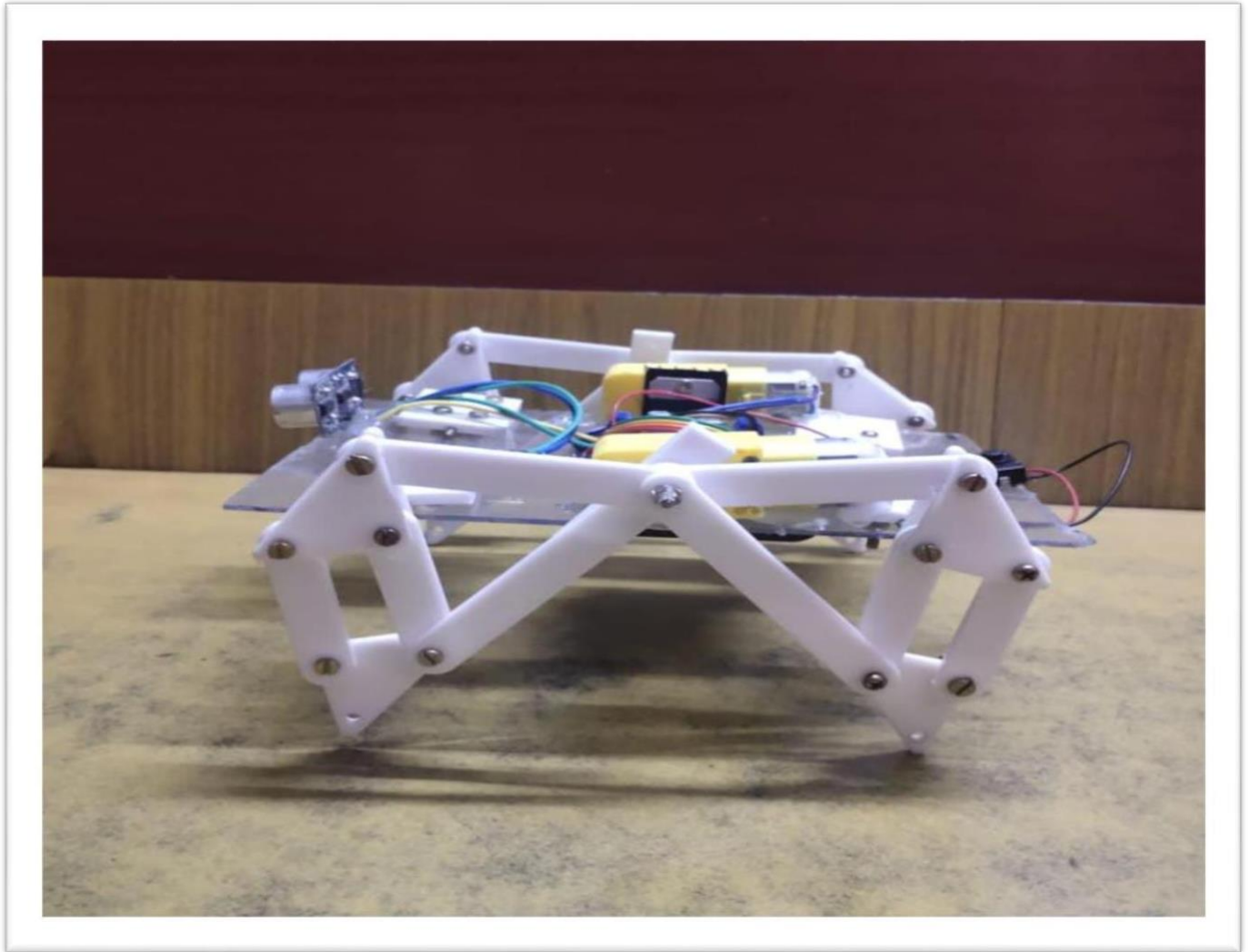
TEST MODEL



9.1 Front view of spider bot



9.2 Top view of spider bot



9.3 Side view of spider bot

CHAPTER 10

STANDARDS AND CONSTRAINTS

A spider robot is a type of robot that is designed to move like a spider. These robots typically have four or more legs, and they can be used for a variety of tasks, including exploration, search and rescue, and entertainment. Spider robots are becoming increasingly popular due to their unique abilities and potential applications.

For example, spider robots can be used to investigate difficult-to-reach places, such as collapsed buildings or caves. They can also be used in search and rescue operations, as they can quickly cover large areas and navigate through tight spaces. Additionally, spider robots are often used for entertainment purposes, as they can perform acrobatic feats and other tricks.

Spider bots are a type of robot that is designed to move like a spider. They typically have eight legs, each of which is driven by a separate motor. This gives them a very versatile range of motion, allowing them to climb over obstacles and navigate through tight spaces.

Spider bots are often used in search and rescue operations, as they can quickly cover a large area and access places that humans and other types of robots cannot. They are also used in research, as they can be equipped with sensors and other devices to collect data about their environment. The robot in question is compliant with IEEE, CE, IEC, and ISO standards, as it is constructed solely of original electrical, electronic, and electromagnetic components, and its cabling is safely constructed to avoid user hazards.

The robot is powered by a 12 Volt DC power supply, which is below the safe limit of 50 Volts. Spider robots are a type of robot that can move like spiders, with four or more legs. They are versatile and can be used in various tasks, including exploration, search and rescue, and entertainment. Spider bots are equipped with sensors and devices to collect data about their surroundings and can be used in search and rescue operation, as they can cover large areas and access hard-to-reach places. They can also be used for research and data collection. Spider bots are innovative machines that move like spiders and can climb walls and ceilings using suction cups.

They are equipped with sensors and can communicate wirelessly, making them useful for various tasks, such as surveillance, search and rescue, and environmental monitoring. Spider bots are versatile machines that can deliver goods to hard-to-reach places, including high-rise buildings, and are perfect for inspecting difficult areas, such as inside a jet engine.

Spider bots are autonomous robots that can crawl and climb surfaces, with sensors and wireless communication capabilities, making them ideal for various tasks, including search and rescue, surveillance, and environmental monitoring.

They are versatile machines that can deliver goods to hard-to-reach places. These robots are designed to move and operate like spiders, using a combination of sensors and leg movements to climb walls, navigate through tight spaces, and avoid obstacles. They typically have multiple legs, often eight, that can move in all directions, allowing them to move in a way that is similar to their arachnid counterparts.

Spider bots have a variety of potential uses, including exploration, search and rescue, surveillance, and entertainment. Due to their ability to climb walls and navigate through tight spaces, they can be used to inspect hard-to-reach areas, such as the inside of a jet engine or the corners of a building.

They can also be used in search and rescue operations, as they can easily navigate through debris and access areas that humans or other types of robots cannot. In addition to their practical uses, spider bots can also be used for entertainment purposes.

Their unique abilities and movements make them popular attractions at science exhibits, trade shows, and other events. Some spider bots are even designed to perform acrobatic feats, such as flipping and spinning. Overall, spider bots are versatile and powerful robots that have a wide range of potential applications.

As technology continues to advance, it's likely that we will see even more innovative uses for these amazing machines in the future.

10.1 LEG MECHANISM

There are many different types of spider bots, but they all have one thing in common: their leg mechanisms. The legs of a spider bot are its most important feature, as they allow the bot to move around and perform various tasks. There are many different designs for spider bot legs, but they all have a few key components. The first is the actuator, which is responsible for moving the leg. The second is the sensor, which helps the spider bot to detect obstacles and navigate its environment. The third is the controller, which tells the spider bot how to move its legs in order to achieve its desired goal. Spider bots use a variety of actuators to move their legs. The most common type is the servomotor, which is a precision-controlled electric motor. Other types of actuators include hydraulic motors, pneumatic cylinders, and linear actuators. Sensors are used to help the spider bot navigate its environment. The most common type of sensor is the sonar sensor, which uses sound waves to detect objects in its path. Other types of sensors include infrared sensors, which can detect heat, and ultrasonic sensors, which can detect vibrations.

The controller is the spider bot's brain. It tells the spider bot how to move its legs in order to achieve its desired goal. The controller is typically a computer that has been programmed with a specific set of instructions. Spider bots have a variety of uses. They can be used for jobs like window cleaning, terrain mapping, and bridge inspection. They can also be utilized for riskier jobs like disarming land mines or defusing explosives. Other methods have irregularly been employed in addition to the legged robot optimization criteria given in the preceding sections.

10.2 THEO JANSEN MECHANISM

Theo Jansen is known for his walking Strand best device made from plastic tubes, which is powered by wind, roaming on Dutch coastlines. Theo Jansen Theo Jansen has demonstrated the utility of the Theo-Jansen connection with his sculptures of the Strand best, which use replicas of the connection, with the cranks turned by the sails on the wind, providing a walking movement. The same mechanism for Jansen linkages is used for building the robots other legs. One of the links is designated as an crank, whose movement is controlled by the motor.

The links are connected at appropriate lengths, creating complex movement, like an animal legs moving. I used mathematical optimization techniques to design the legs so that development was possible.

First, I wanted to create the two hinge points where the legs would be attached to the rest of the machinery. Given we already know the overall form of the mechanism, we know which we want. Now we need to think how we can build the mechanism manually. We used a system for controlling a mini four-legged robot, and implemented that mechanism using a robot media.

In the current work, the Theo Jansen Mechanism is used as a locomotive driving mechanism for legged robots. The Jensen coupling is a planar foot mechanic designed by the kinetic sculpture artist Theo Jansen for generating a fluid walking movement. Many have created variations of Theo Jansen design using an eight-bar mechanism forming each leg. As mentioned above, most of Theo Jansen redesigns for walkers required many of the leg-parallel mechanisms, as the flat part of a good-looking toe-path is actually curved in some way.

Theo Jansen stranded creatures owe their natural gait to an artist mechanical algorithm, which is based on the eleven sacred numbers (which he explained at length at his website). Dutch physicist-artist Theo Jansen has taken kinetic art outside of the galleries, breathing life into strange beasts made from complex gears, that use the wind to drive a very finely tuned mechanism. Before you take on your own wind-inspired Jansen-inspired creatures, you need to understand the mechanisms that underpin the legs of a beast, so you can choose energy--and thus, movement--best. To answer this, Jansen developed the wind-stomach system, which

powered earlier generations of windless-condition Standees. Wind-stomach. By connecting Jansen source of power, the wind stomach, with various components throughout the besets body through a system of medical tubes, Jansen created a method to trigger the beasts various behaviours, like changing orientation and lifting the body a bit from the sand. Figure 12 Time-varying Y-coordinates at toes of a theo-jansen coupling presenting time-varying Y-coordinates at toes of the mechanism for a Jansen coupling, there is an apparent difference of 0.034 m between each legs lowest points.

If you've ever seen a Theo Jansen mechanism in action, you know how amazing they are. These mechanisms are designed to walk on their own, using the wind to power them. But how do they work? In this blog post, we'll take a closer look at the Theo Jansen mechanism and how it works. We'll also discover how these mechanisms can be used to solve real-world problems.

Theo Jansen's mechanism is a type of walking machine that uses a system of linked plastic tubes and discs to create a mechanical "foot" that can walk on any terrain. The machine is powered by the wind, and can be steered by the user. Theo Jansen's mechanism is a type of walking machine that uses a system of linked plastic tubes and discs to create a mechanical "foot" that can walk on any terrain. The machine is powered by the wind, and can be steered by the user.

The machine works by using a series of levers and pulleys to convert the energy of the wind into forward motion. The user can control the machine by moving the levers, which changes the position of the discs and tubes.

The Theo Jansen mechanism is a great example of how simple machines can be used to create complex machines. By understanding the basic principles of levers and pulleys, anyone can build their own Theo Jansen mechanism.

CHAPTER 11

RESULT AND DISCUSSION

This system may be made more elastic by using varying link lengths for the front, middle, and rear legs. This robot's effectiveness can be increased in the future with the addition of sensing and vision technologies. It is essential to create stance and an insect that is similar to walking. A literature review indicates that there are a few different spider bot models. However, we are creating something that is more effective and can travel over difficult terrain specifically for military purposes.

Jansen's mechanism is an example of a four-bar linkage, and is used to create reciprocating motion. The mechanism consists of four bars, two of which are connected at their ends by joints. The other two bars are connected to each other at one end by a joint, and to the first two bars at the other end by a joint. The mechanism is powered by a motor, which drives one of the bars. The motion of the motor is transferred to the other bars by the joints, and this results in reciprocating motion. The mechanism is named after its inventor, Theo Jansen, who has used it to create a number of interesting creations, including a walking machine. Jansen's mechanism is a good example of how four-bar linkages can be used to create complex motions

There are many variations of the Theo Jansen mechanism, but the most common one features a rectangular frame with four legs. Each leg has two joints, which allows the mechanism to move in a variety of ways. The Theo Jansen mechanism is named after its inventor, Dutch artist and engineer Theo Jansen. Jansen first designed the mechanism in the early 1990s as a way to create life-like movement. He has since used the mechanism in a variety of his sculptures, which he calls "Strand beasts" (beach animals).

The Theo Jansen mechanism is powered by the wind, which turns a series of gears that move the legs. The mechanism can also be built with motors, but Jansen prefers to use the wind power because it is more efficient and environmentally friendly.

11.1 KINEMATIC MODELING OF ROBOT

In these three different situations are considered for kinematic modeling. First is when robot approaches the step. Second is when it starts advancing climbing on the step. The third is when it is climbed the step. Different forces acting on the robot are shown. With help of the moment calculation the torque required to climb the step is found. This design wasn't used on final because optical sensors can be unreliable for this task. A four-leg robot, also called a quadruped, is a robotic platform that uses four legs for loco motion. There are many different designs of four leg robots, but they all share the common goal of imitating the movement of a real animal. One advantage of four leg robots over traditional two-legged robots is that they are more stable and can carry heavier loads. They are also able to navigate rougher terrain and climb stairs more easily. Additionally, four leg robots can be faster than their two-legged counterparts.

However, there are certain difficulties in developing and producing four-legged robots. One difficulty is that each limb must be controlled individually, which may be challenging. Another issue is that the extra legs add weight and complexity to the robot, making it harder to manage. Overall, four-legged robots have several benefits over typical two-legged robots and are an important area of robotics study.

The methods for designing systems that were covered in the first two parts took their cues from natural tactics. Legged robots are machines, nevertheless, and this needs to be remembered. Therefore, the proper implementation from the mechanical and physical views should be the first factor to be taken into account throughout their design process.

In keeping with this idea, Gabourey and Drafee (2001) collated the qualities of a number of different structures that might be used as the legs of artificial locomotion systems. Hirose and Arakawa (2000) looked at a number of design principles for legged vehicles. The major goal is to increase the system's power output. (concept of 'coupled actuation') and to maximize the energy efficiency ('actuator gravitational decoupling' idea). The approach of actuator gravitational decoupling has been used in numerous robots (Genta and Amati, 2001; Koyachi et al., 1991; Senta et al., 1995) and may be implemented not only during system design, but also during locomotion posture (Hirose and Arikawa, 2000). Empirical understanding of mechanics and physics is used as a method in some circumstances while creating a robot. The Equipments are designed with the goal of minimising situations that penalise the performance of the robot under consideration. Another strategy for optimising the robot construction based on biology research (Alexander, 1990) takes into account legs furnished with actuators that introduce joint compliance. The kinetic and potential energy of the robot legs and body can therefore be stored and released during the various phases of the locomotion cycle. This strategy is used by Raby and Orin (1999) using a passive hexapod robot (Figure 1). The suggested robot features legs with two degrees of freedom (DOF), one rotational at the hip and one prismatic at the knee, with a spring at each joint to allow for some compliance. After optimizing the locomotion parameters, they conclude that is required a small amount of energy to keep the robot in the periodic locomotion

CHAPTER 12

SUMMARY AND CONCLUSION

The study found that elliptic circles can be utilized as a means to create different types of movement in a walking robot, by utilizing the cyclic movement of the linkage center. The researchers' objective was to develop a new automated walker, using an eight-bar linkage system, that can be equipped with sensors to perform various tasks. The robot can be made with high heat-resistance materials to allow for its use in environments with high levels of radiation, or for military purposes, such as bomb detection. Moreover, it can be used in hospitals for the transportation of goods, making it a versatile device.

Despite the potential benefits of legged locomotion systems, such as the ability to traverse complex terrain, there are several limitations that must be addressed. One of the major drawbacks is that the existing systems are slower and more challenging to construct than traditional locomotion systems. Additionally, they require complex control algorithms. Another issue is the higher energy consumption of these robots compared to traditional forms of locomotion. To address these limitations, optimization strategies should be employed to enhance the efficiency and force distribution in walking robots, especially in situations involving soft or rough terrain.

In conclusion, the study demonstrated the potential for elliptic circles to be used in creating various types of movements in walking robots, and the researchers' objective was to develop a versatile automated walker. However, there are several limitations that must be addressed to improve the efficiency and force distribution of legged locomotion systems. By optimizing these systems, legged locomotion could become an efficient transportation mode, potentially competing with traditional forms of locomotion.

One of the major drawbacks of this technology is its higher energy consumption, when compared with traditional forms of locomotion. It is verified that the locomotion efficiency of the existing robots is very low when compared with living animals, or wheeled vehicles. Therefore a deeper attention should be devoted to the optimization of such systems, and it is verified that different optimization strategies have been proposed and applied to these systems either during its design and construction, or during its operation, namely in the gait selection and on its adaptation to the terrain and locomotion conditions

Another important issue in walking robots that is frequently optimised is the element of force distribution in the robot legs (or feet) (Chen et al., 1998). The likelihood of each foot to slide should be minimised, which is an acceptable foundation for allocating contact forces among the feet. Because the effective coefficient of friction between foot and ground is never known with certainty, the obvious method is to try to minimise the maximum of the angles between contact forces and normal to the surface at the contact spots (Waldron, 1997). This issue is exacerbated when the ground surface is soft

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ANNEXURE

- Submitted the research paper title "DESIGN AND FABRICATION OF SPIDER BOT" for RIACT 2022 on 25th September 2022.
- Received comments and updated paper.
- Submitted the review paper title "SPIDER BOT USING THEO JANSEN MECHANISM REVIEW".
- Paper presented in ICDTM 2023 on 9th April 2023.

ANNEXURE:

- SUBMITTED THE RESEARCH PAPER TITLE "DESIGN AND FABRICATION OF SPIDER BOT" FOR RIACT 2022 ON 7th September 2022
- PRESENTED THE RESEARCH PAPER ON 25th September 2022
- RECEIVED REVIEWER COMMENTS ON 18th OCTOBER AND THE PAPER UPDATED AS PER AIP TEMPLATE AND SUBMITTED TO CONFERENCE EDITORIAL BOARD.
- SUBMITTED REVIEW PAPER TITLED "SPIDER BOT USING THEO JANSSEN MECHANISM" REVIEW AT ICDTM 2023 SASTRA UNIVERSITY ON 2nd APRIL 2023
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