Study on Theo-Jansen Four Leg Walking Robot

Swapnil S. Dange#1, Amol M. Jadhav#2, Kiran P. Bharambe#3, Suraj K. Chaudhari#4
[1,2]Assistant Professor (Mech Dept), [3,4]BE Scholar (Mech Dept)
Sir Visvesvaraya Institute of Technology, Chincholi, Nashik[1, 3, 4]
Shree L. R. Tiwari College of Engineering[2]
Swapnil.dange@pravara.in[1]
Amoljadhav2015@gmail.com[2]
Kiranbharambe807@gmail.com[3]
Surajc670@gmail.com[4]

Abstract— This paper is to study about the Theo-Jansen four leg walking robot. The objective is built up new mechanical robotic walker using eight bar link mechanism. The system uses a robot which is capable of walking towards the object according to user remote control. The main advantages of Theo-Jansen four leg walking robot is gives the fast response, low power consumption, higher energy efficiency, greater mobility, less environmental damage. We are using a simple mechanism i.e. uses a limiting parts such as bearings, hinges, springs etc. By using a Theo-Jansen four leg walking robot to improve transportation of raw materials from one position to another position and also increased rate of transfer. With improvement and implementation of new technology the cost of expenditure also increased and industries have had to setup roads for smoother movement of these wheel based vehicles. Theo-Jansen mechanism has a capability to extend an adaptive and controllable mechanism on irregular ground. We investigated a new extension mechanism which enables the walking mechanism to transmit between walking and climbing modes.

Keywords— *Robot, mechanism, Theo-Jansen.*

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1. INTRODUCTION

The advent of new high-speed technology and the growing computer Capacity provided realistic opportunity for new robot controls and realization of new methods of control theory. This technical improvement together with the need for high performance robots created faster, more accurate and more intelligent robots using new robots control devices, new drivers and advanced control algorithms. This project describes a new economical solution of robot control systems. The presented robot control system can be used for different sophisticated robotic applications. The objective of this project is to build a new mechanical robotic walker using 8 bar link mechanism. The system uses a Robot which is Capable of walking towards the object according to the user remote control. The main aim of this project is to fabricate a Mechanical walker robot using the wireless remote. As it is a wireless Robot it can be easily mobilized and can be controlled.

An eight-bar linkage is a one degree-of-freedom mechanism that is constructed from eight links and 10 joints. These linkages are rare compared to four-bar and six-bar linkages, but two well-known examples are the Peaucellier linkage and the linkage designed by Theo Jansen for his walking machines. This project makes use of an on-board computer, which is commonly termed as micro controller. It acts as heart of the project. This on-board computer can efficiently communicate with the output and input modules which are being used. The controller is provided with some internal memory to hold the code. This memory is used to dump some set of assembly instructions into the controller. And the functioning of the controller is dependent on these assembly instructions. In this project we use micro controller, which is programmed to control the input and output modules interfaced to it. The controller makes use of a remote, which is used to control the robot. The project consists of micro controller based motherboard is present with the Robot itself. It is interfaced with some DC motors for moving the robot, and a RF for receiving the instructions from the remote.

I. CRANK BASED WALKING MECHANISM:-

In this section examine the desirable and undesirable traits of crank based walking mechanisms for the purpose of energetically efficient and stable locomotion over moderately variable terrain. A linkage is “crank-based” when the circular movement of one point in the linkage translates to movement elsewhere in the linkage; this means the circularly moving part of the linkage can be attached to a crank so that the motion of the mechanism is easily driven shown in fig.1.
The foot of a walking mechanism is the part of the mechanism that comes in direct contact with the ground as indicated in Fig 1. As the crank turns, the foot traces out a cyclical path relative to the body of the walker; this path is known as the locus.
The direction of movement of the linkage to the crank and the foot through the locus are indicated. Additionally, a fixed point in the linkage relative to the body of the walker is indicated with a black square. The locus can be divided into four parts: the support, lift, return, and lower phases. These phases are illustrated in Fig. 1

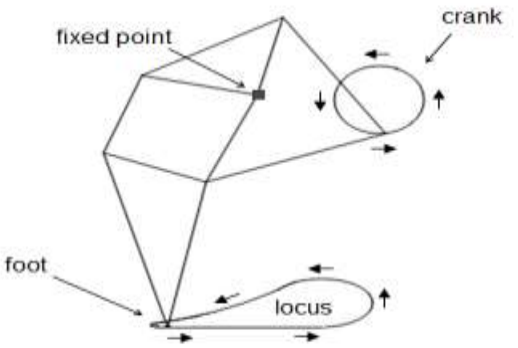

Fig. 1 A crank based leg system with the foot, locus, and crank labeled.

Throughout the support phase, the foot is ideally in contact with the ground. During the lift the foot is moving toward its maximum height in the locus. During the return, the foot reaches its maximum height off the ground and moves in the same direction as the body of the walker. Finally, during the lower the descends in height until it makes contact with the ground.

The step height is the height of the foot off the ground when it enters the lower phase and is shown in Fig. 2

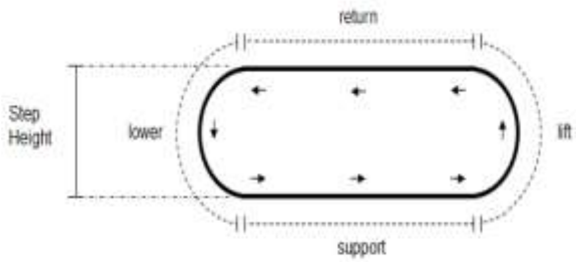

Fig. 2 Step Height

Fig. 2 shows, a theoretical foot locus is traced out by the bold black line with arrows indicating the direction of motion of the foot through the locus. Step height and lift, return, lower, and support phases are labeled.

II. ADVANTAGES OF WALKING ROBOT

Walking machines possess several advantages over wheeled machines in areas of variable terrain. Consider a wheel moving a constant velocity **V**; every point on its perimeter is moving at a constant velocity **V** tangent to the curve of the wheel as shown in fig. 3

A comparable walking mechanism would be one which moves at a constant velocity **V**, and where the "foot" of the walker traces out a similar circular path with a constant velocity **V** at all points on the path (also shown in Fig. 3). The most obvious advantage of the foot over the wheel is that the foot may step over inconsistencies in the terrain. Local maxima and minima may be completely avoided by simply stepping over them. This results in less loss of energy during locomotion and allows the vehicle to maintain a constant velocity and height over variable terrain [2].

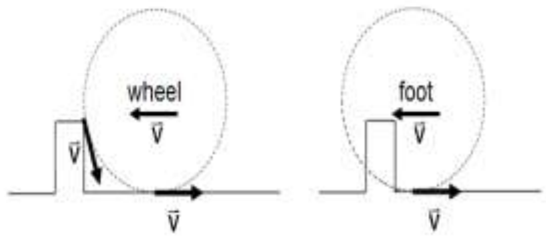

Fig. 3 Overview of Walking.

Fig. 3 Comparison of wheel and foot response to a local maximum in the terrain. The dotted lines indicate the perimeter of the wheel or the path of the foot. The arrows indicate the direction of movement. The foot may step over the obstacle completely, while the wheel must move over the obstacle. Now consider a case where the comparable foot and wheeled systems approach an obstacle that cannot be avoided [2].

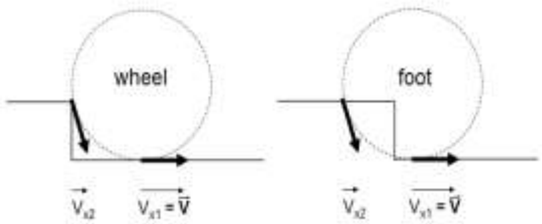

Fig. 4 Overview of walking robot

When the edge of the wheel makes contact with the higher ground, it forces the velocity of the vehicle to immediately slow. This edge has a total velocity **V**, but only a fraction of that velocity is in the direction, so the vehicle quickly slows from **V** to Vx2. The foot encounters a similar change in velocity, but it has the advantage of being able to slide along the ground. Although this scenario is not ideal, dragging the front foot across the raised terrain reduces change of velocity in the x direction. Both models must still overcome the potential energy barrier posed by the increased height of the terrain [2].

Fig. 4: A comparison of a wheel and a foot (moving in a wheel-like path) approaching an inconsistency in the terrain. The x component of the velocity of the edge of the wheel and the foot's path are indicated. Furthermore, the wheel causes a great deal of environmental harm3. Its inability to avoid obstacles means that it erodes more terrain than a foot when moving comparable vehicles. Additionally, wheeled vehicles work best on terrain with no inconsistencies; this has led to paving of many permanent roadways, another form of environmental degradation [2].

2. LITERATURE RIVIEW

"Swadhin Patnaik'', "**Analysis Of Theo Jansen Mechanism (Strandbeest) And Its Comparative Advantages Over Wheel Based Mine Escavation System** he says that I decided to implement linkage based locomotive systems on standard load carrying tippers and trucks as a replacement for the conventional tyres. The first mechanism which I came across for such purpose was Klann mechanism which actually mimics the motion of the biological organism [1].

"Amanda Ghassaei", "**The Design and Optimization of a Crank-Based Leg Mechanism**" he says that This paper describes the design and fabrication process of a 2n-legged passive walker based on the work of Theo Jansen the primary focus of this paper is the design of a crank-based leg linkage. The linkage was simulated in Mathematica, and an analysis of the leg design, including an analysis of the foot path and center of mass is provided and compared to the Theo Jansen mechanism [2].

"Kazuma Komoda and Hiroaki Wagatsuma", "**A study of availability and extensibility of Theo Jansen mechanism toward climbing over bumps",** he says that In the present study, we proposed an extension mechanism of the Theo Jansen linkage for climbing over bumps. The linkage is useful to mimic animal locomotion,we hypothesized that an additional up-and-down motion in the linkage center provides different motion patterns from the original internal cycle [3].

"Kazuma Komoda and Hiroaki Wagatsuma", **"A proposal of the extended mechanism for Theo Jansen linkage to modify the walking elliptic orbit and a study of cyclic base function** The 21st Annual Conference of the Japanese Neural Network Society, March 2012", he says that In the present study, we proposed an extension mechanism of the Theo Jansen linkage to generate various walking patterns. The advantage of the linkage is that the best proportions of link lengths provides a smooth locomotive leg movement like animal gaits with a sharp-pointed elliptic orbit while the disadvantage is less flexibility to change the orbit without any change of link lengths.

3. SELECTION OF DEGREE OF FREEDOM

The number of joints in a robot roughly translates to the degrees of freedom. In the design process three different possibilities were considered.

The foot of the leg is constrained to a spherical surface. However the up-down and forward-back motion is approximately linear and provides a method to propel forward or backward while adjusting to some uneven terrain. A two degree of freedom leg offers very limited capabilities and produces legs which act similar to uneven wheels. Legs with two degree of freedom also prevent the robot from adjusting its step sizes to compensate for the environment rendering one degree of freedom inadequate. A three degree of freedom design offers superb maneuverability allowing the robot to adjust too many situations.

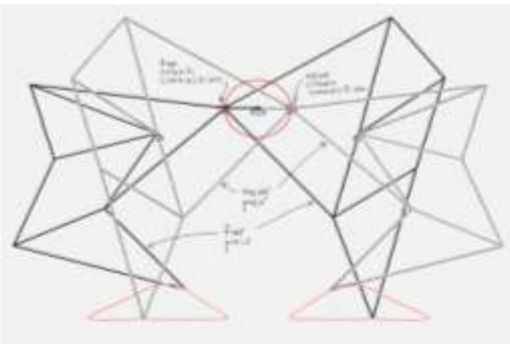

Fig. 5 Motion of the tip of the leg

4. COMPONANTS

I. *DC MOTOR-*:

DC motors are commonly found in wheeled robots. DC motors rotate as long as power is applied and stops when power is removed. A continuous rotation at a constant speed can be achieved by applying a constant voltage. However, extra support circuitry including a sensor for feedback is needed for position control.

II. STEPPER MOTOR

A stepper motor is a very simple DC motor. Because it has no brushes or contacts, it operates by having its magnetic field electronically switched to rotate the armature magnet. This setup allows the motor to rotate and halt at specific angles. There are two types of stepper motors bipolar and unipolar. The bipolar stepper motor consists of two coils. The current direction is reversed in each coil to achieve four separate positions. The unipolar stepper motor consists of four coils. When each coil is energized individually and working in proper sequence, the motor shaft turns the inherent number of degrees per step. Regardless of the type of stepper motor used there is no closed loop feedback unless an external position sensor is used.

Actuator Used in Project Pneumatics and hydraulics increase the cost and weight of the robot without offering any functional benefits. To reduce weight the pump or compressor can be taken off the robot and a tether can be extended to the robot to provide the pressurized fluid. Unfortunately this means the robot would have a tether and a limited walking range. Although DC motors are inexpensive they lack position control and are not directly suitable for this robotic application. Stepper motors have an open loop position control and can easily skip steps resulting in poor correlation between expected and actual position. RC servos were chosen because of their relatively low cost and their ease of control. The main drawback of an RC servo was the loss of feedback position control to the external device providing the control pulse. Windshield Wiper Motors Wiper Operation: There are three major components to a wiper motor:

- Motor
- Rotary to linear motion converter mechanism
- Parking switch

5. CONCLUSION

Our study demonstrated that various elliptic orbits for walking, climbing, stepping in a place and rolling back by using the cyclic motion of the linkage center. This paper is to study about the Theo-Jansen four leg walking robot. The objective is built up new mechanical robotic walker using eight bar link mechanism. In future we have to use this robot to perform different type of operations automatically by using sensors. When we are making this robot in high heat resisting material then we are using this robot in nuclear power plant or in place with high radiation level.

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