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The Development of Solar Spider by Using Klann'S Mechanism for Artificial Intelligence Works

Nisha Sutkar and Sudarshan Bhalshankar

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THE DEVELOPMENT OF SOLAR SPIDER BY USING KLANN'S MECHANISM FOR ARTIFICIAL INTELLIGENCE WORKS.

Nisha V. Sutkar [1], SudaRshan D. Bhalshankar[2]

nishasutkar95@gmail.com [1], sudarshanbhalshankar111@gmail.com [2]

M.E (Design Engg.)[1], M.E (CAD/CAM) [2]

PradnyaSurya Engineering Works. Pvt Ltd.

pradnyasuryaengineerinworks@gmail.com [1,2]

Abstract.

*A single leg consists of a **six-bar linkage** made up entirely of **pivot** joints that converts **rotating motion** into linear motion. One hundred and eighty degrees of the input crank results in the straight-line portion of the path traced by the foot. The result of two of these linkages coupled together at the crank and one-half cycle out of phase with each other is a device that can replace a wheel and allow the frame of the vehicle to travel relatively parallel to the ground. The remaining rotation of the input crank allows the foot to be raised to a predetermined height before returning to the starting position and repeating the cycle. Two of these legs coupled together at the **crank** can act as a wheel replacement and provide vehicles with a greater ability to handle obstacles and travel across uneven terrain while providing a smooth even ride. Initially it was called the **Spider Bike** but the applications for this linkage have expanded well beyond the initial design purpose of a human-powered walking machine. This linkage could be utilized almost anywhere a wheel is employed from small wind-up toys to large vehicles capable of transporting people*

*The relationships for the linkage have been **established** and are covered by several patents. The simplicity and scalability of the walking device, along with a little imaginative engineering, lead to numerous possibilities. The Klann linkage provides many of the benefits of more advanced **walking vehicles** without some of their limitations. It can step over curbs, climb stairs, or travel into areas that are currently not accessible with wheels but do not require microprocessor control or multitudes of inefficient actuator mechanisms. It fits into the technological void between these walking devices and axel-driven wheels.*

Keywords:- **Robotics-Leg , klann-Mechanism, Intelligent-Robot, Robotics- Memory, Kinematic- Linkage.**

I. INTRODUCTION.

Four bar linkage are the closed loop kinematic Linkage; they perform a wide variety of motions with a few simple parts. This project discusses the design & fabrication of one such mechanism (four bar mechanism). In this project Six Leg Kinematic movement works on Grashof's principle which states that the sum of the length of the shortest and longest links must be less than or equal to the some of the other two links. However this condition is necessary but nor sufficient. Mechanism satisfying this condition will fall into crank-rocker mechanism, double crank mechanism and double rocker

mechanism. A frame, connecting rod, crank & a lever constitute to obtain the required motion, In this project we tried to show mainly the application of simple four bar mechanism. The invention provides a walking device which stimulates a gait of a legged animal. The device includes a frame with spaced axial mounts, a leg, axially connected upper and lower rocker arms which limit reciprocating leg motion. The leg is driven by a connecting arm powered by a rotating crank.

Both rocker arms and the crank are axially mounted to frame. The leg has a hip joint axially connected to the upper rocker arm for limiting hip motion, a foot and a knee joint axially connected to the connecting arm. The connecting arm has three axial connecting sites, one for connecting to the knee, another to the crank, and a third connecting site defined as a centrally disposed elbow joint connecting site which connects onto the lower rocker arm and limits knee joint motion. Under power, crank rotation is transferred to the connecting arm causing the leg to move in an accurate reciprocating movement of a restricted actual pathway which stimulates the gait of the legged animal. The walking device may be manually powered or motorized by applying motorized power to the crank axles.

Klann mechanism is a planar mechanism designed to simulate the giant legged animal and function as a wheel replacement. Here we are using a single leg consists of a six-bar linkage made up entirely of pivot joint that converts rotating motion into linear motion. The linkage consists of the frame, a crank, two grounded rockers, and two couplers all connected by pivot joints. The proportions of each of the links in the mechanism are defined to optimize the linearity of the foot for one-half of the rotation of the crank.

The remaining rotation of the crank allows the foot to be raised to a predetermined height before returning to the starting position and repeating the cycle. Two of these linkages coupled together at the crank and one-half cycle out of phase with each other will allow the frame of a vehicle to travel parallel to the ground. The Klann linkage provides many of the benefits of more advanced walking vehicles without some of their limitations. It can step over curbs, climb stairs, or travel into an area that are currently not accessible with wheels but does not require microprocessor control or multitudes of actuator mechanisms.

II. LITERATURE REVIEW.

RICHARDJ.SIMPSON [1]-The six leg spider mechanism is a planer mechanism designed to simulate the gait of legged animal and function as a wheel replacement. The linkage consists of the frame, a crank, two grounded rockers, and two coupler all connected by pivot joints. The proportions of each of the links in the mechanism are defined to optimize the linearity of the foot for one-half of the rotation of the crank. The remaining rotation of the crank allows the foot to be raised to a predetermined height before returning to the starting position and repeating the cycle. Two of these linkages coupled together at the crank and one-half cycle out of phase with each other will allow the frame of a vehicle to travel parallel to the ground. The Klan linkage provides many of the benefits of more advanced walking vehicles without some of their limitations. It can step over curbs, climb stairs, or travel into an area that are currently not accessible with wheels but does not require microprocessor control or multitudes of actuator mechanisms. It fits into the technological space between these walking devices and axle-driven wheels.

MUSTAFA.JAIN [2)- Four bar linkage are the closed loop kinematic linkage, they perform a wide variety of motions with a few simple parts. This project discusses the design & fabrication of one such mechanism (four bar mechanism), In this project Six Leg Kinematic movement works on Grashof's principle which states that the sum of the length of the shortest and longest links However this condition is necessary but nor sufficient. Mechanism satisfying this condition will fall into crank-rocker mechanism, double crank mechanism and double rocker mechanism. A frame. connecting rod, crank & a lever constitute to obtain the required motion. In this project we tried to show mainly the application of simple four bar mechanism.

AUSAMA AHMED, MICHAEL HENREY, PAVEL BLOCH [3]: The preliminary design of a robot for future planetary space applications is presented. This hexapod robot has legs inspired by the spider, which it uses to man oeuvre across

horizontal surfaces. Designed as a scientific platform for future research, mechanically, this robot is lightweight, compact and modular. A Field Programmable Gate Array (FPGA) is used as a controller, with one soft processor controlling each leg, adding additional modularity. This robot is shown to be capable of walking across horizontal surfaces, and future versions will be capable of climbing vertically, using bio-inspired dry adhesives.

NICK VALLIDIS [4]: Mobile robots are finding their way into a number of tasks that are unfit for humans. Such tasks include those which are extremely repetitive, require great accuracy, or need to be performed in hazardous environments. For these reasons many wheeled vehicles have been designed and developed. More recently there has been an explosion of legged robot designs. These have many advantages over their wheeled counterparts. They allow the traversal of rougher terrain and can continue to function even after losing use of a leg (if so designed). These features are very useful in hazardous environments where maintenance cannot be performed.

III. BIOLOGICAL INSPIRATION FOR LEGGED LOCOMOTION SYSTEM.

Many of the animals in nature have adopted legs for various environmental coactions. Centipedes, spiders, cockroaches, cats, camels, kangaroos, and human are among those, cither with different number of legs or with different kind of wartime. It is understandable that people tumid their attention to those walking animals, after in was recognized that the busman invented wheeled and tracked systems did not satisfy all the nodes. In this sense, ledged systems have a peculiarity of imitating the nature. This imitation is obvious in structural similarity between legged robots and imitated animals, however, for today the imitation is not limited to structural design. Today researchers are trying to understand the underling biological principles of walking in animals, namely the operational and control structures (Hughes, 1965, Wilson, 1966: Pearson, 1976; Cruse, 1979: Cruse et. al, 1983; Cruse, 1990). The results of such biological researches have been utilized in robotics via inspirations. Among many of them are Cruse et al. (1998), Expensive et al (1996 Pfeiffer et al, (1995), and Clark. et . (2001)In research in biological sciences and robotics applications the most important item is the planed coordination of leg movements.

The plan of walking, namely the "gait pattern" determines the sequence of stepping of legs with their stance and swing durations in cache step. Mahajan et al (1997) gives the following definition for gait: "The gait of an articulated living creature, of a walking machine, is the corporate motion of the legs, which case be defied as the time and location of the placing and lifting of each foot, coordinated with the motion of the body, in order to move the body from one place to another. Animal gaits can be divided into two main groups as statically stable and dynamically stable. In statically stable gets, the ground projection of the center of gravity of he system always bias in the polygon determined by the supporting legs. In every stop, a new polygon is formed and the center of gravity always stays inside these polygons The six and eight-Teed animals adopt, mostly, statically stable gaits The disadvantage of such units is that the locomotion is comitial slow in under to sustain the static stability, Dynamically stable gaits, an the other hand, are the straits, in which the center of the body is always in a dynamical motion. In dynamically stable gaits the center of gravity is not inside a polygon detained by the supporting legs. This means that, in dynamically stable baits there occur orientations in which the animal cannot stand statically without tilting down. Therefore, the animal has to be in motion in all phases of dynamically satiable gaits. Two legged animals have to adopt dynamically stable gaits, and four legged animals adopt dynamically stable gaits, although they can also adopt statically stable gaits The walk gait that is adopted by almost all four legged animals, the trot gait of horses, the rack gat of camels, the canter and gallop gaits of horses, and the bound gait of dogs are some of the dynamically stable gaits of four legged animals in nature.

IV. MATHEMATICAL RELATED TO SIX LEG KINEMATIC.

1) Protraction: The movement of the leg in vehicles the leg moves towards the front of the body.
2) Retraction: The movement of the leg in which the leg moves towards the rear of the body

3) Power Stroke: The phase of stepping of one leg, in which the foot is contacting the ground, the leg is supporting the body (contributing to lifting) and propelling the body. In forward walking the leg retracts during this phase. It is also called stance phase or support phase
4) Return Stroke: The phase of stepping of one leg, in which the foot is in the air, being caromed to the starting point of the next power stroke. In forward walking the leg protracts during this phase it is also called swing phase or recovery phase.
5) Anterior Extreme Position (AEP: The extreme forward position that the foot can be placed In forward walking, this is mostly the target of the foot in return stroke, and starting point of the foot for power stroke.
6) Posterior Extreme Position (PEP) The extreme backward position that the foot can be Placed. In forward walking, this is mostly the position of the foot where the power stroke ends, and the return stroke starts
7) Duty Factor. The ratio of the part of the walking cycle during which the leg makes contact with the ground
8) Ipsilateral Phase: The phases lag between two neighboring legs on the same part of the body
9) Contralateral Phase: The phases lag between opposing legs ten the two parts.

V. CONSTRUCTION & WORKING PRINCIPLE.

Principle:-

Each leg movement is due to the motion of the four bars. This four bar mechanism Follows the GRASHOF's LAW. The law states that for the motion of this four relative to each other, the sum of the longest and the smallest link should be greater than the sum of the remaining two sides.

Components :-

1. DC MOTOR-100 RPM
2. CHAIN DRIVE-LENGTH 80 CM
3. SPROCKETS- NO.-3
4. ALUMINIUM STRIPS
5. LOCK NUTS
6. BOLTS
7. 12VBATTERY

Construction:-

The four bar chain is formed by connecting four metal plates at the end and bolted together so that there should have relative motion between them. The six pair of four bar are used in this mechanism to provide motion to the Mechanism. Three pair of mechanism are connected along the Centre rod length and connected with the crank which imparted motion to them. The extreme pair have same angle of rotation at the some instances while the link at the center will be out of phase by 180 degree with the remaining links. Half rotation of the crank is used for the motion of the mechanism while the other half revolution is used for lifting the assembly. thus by the whole assembly is rotated and moving.

Working:-

Each of the two sets consisting of three 4 bar linkages on either side of the common rod must be powered in the same direction for the whole machine to move in one direction. Thus the power from a single motor is divided by sprockets and a chain. When the motor is given the electrical input from the mains it runs the sprocket connected to its shaft. The sprocket in turn moves the chain meshed to it. Thus the chain transmits power to both the sprockets. Now the sprockets, moving in one linkage and these links move synchronously with four on the ground at one time and two on the ground at another. Thus forward motion is given to the machine by the legs which reciprocate on the ground.

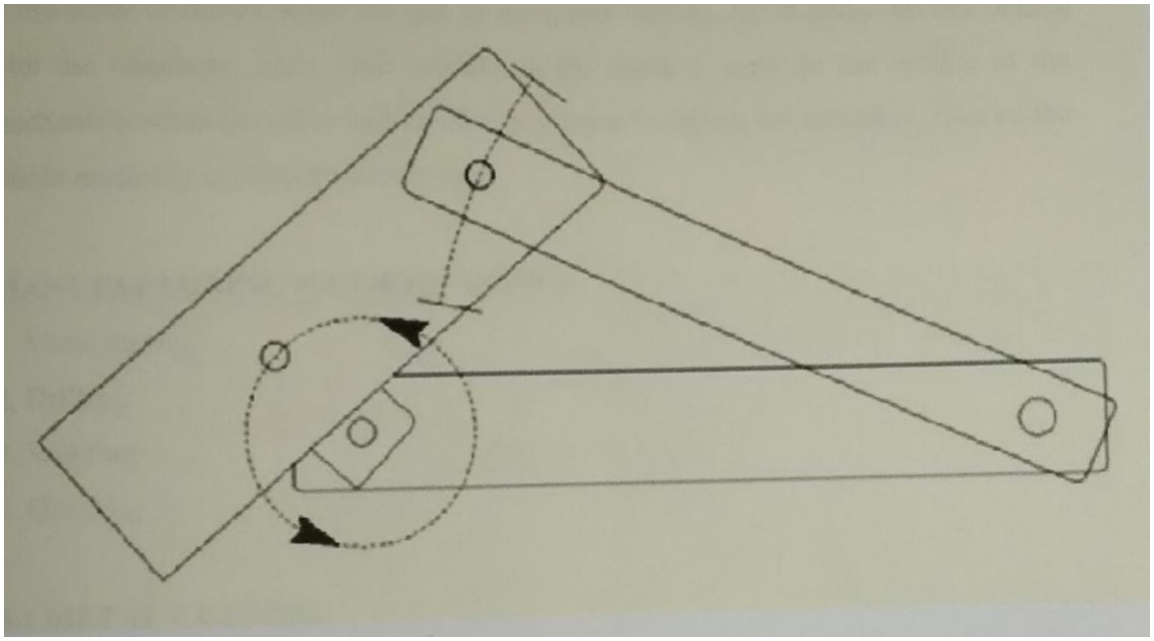

Fig. 1 Basic principle of six leg spider mechanism.

VI. DYNAMIC ANALYSIS.

Dynamic Force Analysis of a Four bar Mechanism In the four bar mechanism shown in Figure 1, Link I is the ground link (sometimes called the frame or pixel link), and is assumed to be motionless. Links 2 and 4 cache rotate relative to the ground link about fixed pivots (A and D). Link 3 is called the coupler link, and is the only link that can trace paths of arbitrary shape (because it is not rotating about a fixed pivot). Usually one of the "grounded links" (ink 2 or 4) serves as the input link. Which is the link which may either be turned by hand, or perhaps driven by an electric motor or a hydraulic or pneumatic cylinder. If link 2 is the input link, then link 4 is called the follower link, because its rotation merely follows the motion as determined by the input and coupler link motion. If link 2 is the input link and its possible range of motion is unlimited, it is called a crank, and the linkage is called a crank-rocker Crank-rockers are very useful because the input link can be rotated continuously while a point on its coupler traces a closed complex curve. Fig.1. A Simple four-bar linkage. The dynamic force analysis problem was solved using the matrix method by reducing it to one requiring static analysis For this purpose, D'Alembert's Principle which states that the inertia forces and couples, and the extremal forces raid torques on the body together give statically equilibrium, was considered. The inertia forces Fig's and inertia moments Twi's are given by, Where, mi is the mass of the link I, li is the moment of inertia about an axis passing through the center of mass gi and perpendicular to plane of rotation of the link I, au and gain are the acceleration and angular acceleration of the center of mass of the itch respectively.Fig.2. The Free-body diagrams of (a) Link 2(crank/input link) (b) Link 3(coupler) (c) Link 4(follower fink) Given position, velocity, acceleration, and inertia properties such as mass and mass moment of importing for etch moving link of a four-bar linkage, force analysis for the linkage can be performed. From the free body diagrams (Fig.2.) three static equilibrium equations, in terms of forces in the X und Y directions and moment about the center of suavity of the link, can be written for each link.

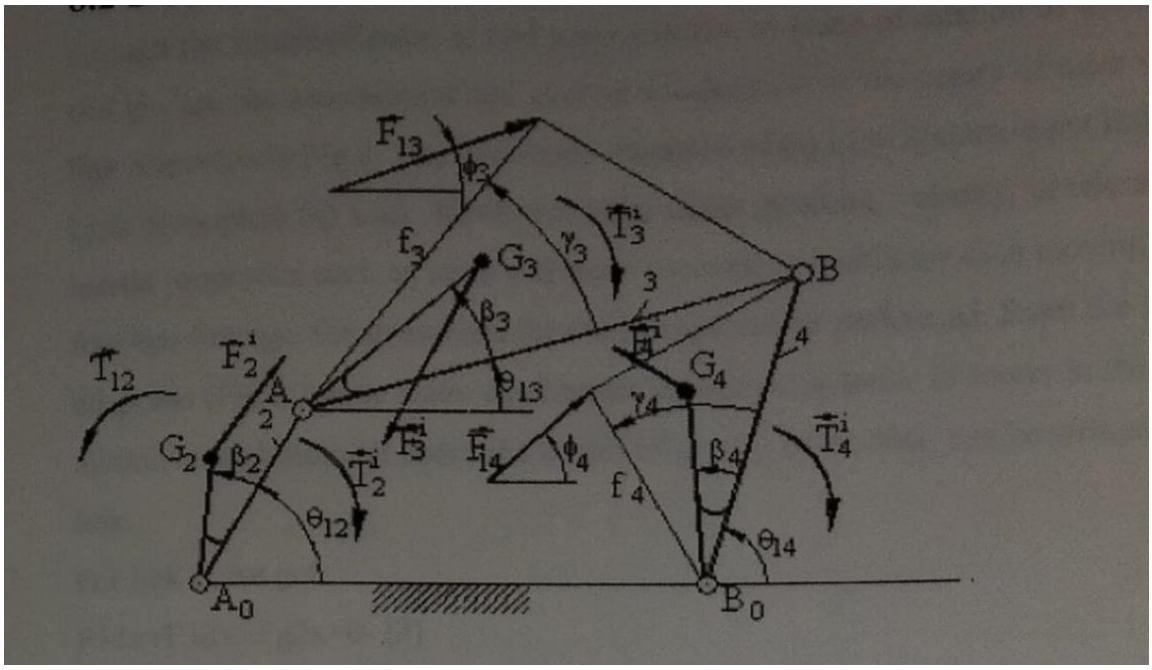

Fig. 2 Dynamic Analysis

Fig. 3 six leg spider mechanism.

VII. ADVANTAGE & DISADVANTAGES.

Advantage:-

1) The wheeled locomotion is most advantageous in hard and even terrains
2) It provides smooth and fast locomotion with a high payload-weight-to mechanism weight ratio, and efficient energy consumption.
3) Ease of Operation.
4) Flexible and Accessible.
5) Cost effective And Ease of Construction.
6) Ruggedness And Efficient to Operate

Dis- Advantage :-

However, wheeled locomotion is disadvantageous in uneven and smooth terrains

1) In the existence of obstacles higher than the radius of the wheels or big holes on the surface, the wheeled locomotion becomes impossible.
2) Since the wheeled vehicle follows exactly the ground surface the locomotion is subject to rocking and vibrations due to the steps and holes on the ground.
3) If the surface is not hard enough, for example sandy, muddy or snowy surfaces, the wheels are unable to drag the vehicle.

VIII. APPLICATION.

1) Potential applications would include anything that currently uses wheels. The possibilities are limited only by the imagination.
2) Proposed concepts such as the ones reported on regarding remote media reporters or various military land drones could be improved with this linkage.
3) It would be difficult to compete with the efficiency of a wheel on smooth hard surfaces but as conditions increase rolling friction, this linkage becomes more viable and wheels of similar size cannot handle obstacles that this linkage is capable of.
4) This version would broadcast audio and video similar to wireless baby monitors that would be received by a unit attached to your television.
5) Further development could result in a production version of a wheel chair that could handle curbs, sand, gravel, and stairs.

IX. RESULT.

We take opportunity to present this project report on "Six leg spider mechanism'. We have made sincere attempts and taken every care to present this matter in precise and compact form. In our project we construct six leg mechanism in different way with aiming objective to save manual effort. To complete this objective we integrate and assemble different parts. We construct Six leg spider mechanism by adding the parts like sprockets, chain drive, M.S. bars etc. We assemble these parts in proper way and built our project which operates on electrical energy. Thus, our Six leg spider mechanism results in positive way that fulfills our objective to reduce manual efforts.

X. LEARNING EXPERIENCE.

It has been very good learning experience to work on this project. The whole learning experience includes technical as well as non technical aspect of engineering. It helps to improve our technical knowledge of research and development, designing, analysis of drawing and assembly etc. For designing we used AUTO CADI software. Welding and fabrication work help us to recover and understand practical approach towards manufacturing processes. We get introduced with various nontraditional aspects like planning the project work, co-ordination, control, communication, group coordination, problem solving technique etc. which gives us big experience. The most important thing is that it enabled us to bridge the gap between theory and practical approach.

XI. CONCLUSION.

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding. planning, purchasing, assembling and machining while doing this project work. Wo feel that the project work is a good solution to bridge the gates between institution and industries.

Thus we have developed a "Six leg spider mechanism" which helps to know how to achieve low cost automation. The operating procedure of this system is very simple, so any person can operate. By using more techniques, they can be modified and developed according to the applications.

XII. REFERENCES.

1. Design and prototype of a six-legged walking insect robot Servet Soyguder and H asan Alli Mechanical Engineering Department, Firat Un iversity, Elazig, Turkey Industrial Robot: An International l Journal Volume 34 · Number 5 · 2007 · 412–422
2. R.Nagarajan and M,Saravanan, “Performance Analysis of Multicarrier PWM Strategies for Cascaded Multilevel Inverter,” European Journal of Scientific Research (EJSR), Vol.92 No.4, pp. 608-625, Dec. 2012
3. R.Nagarajan and M,Saravanan, “A Carrier - Based Pulse Width Modulation Control Strategies for Cascaded Multilevel Inverter,” International Review on Modeling and Simulations (IRMOS), Vol 6.No1, pp-8-19, Feb. 2013.
4. A study of availability and exit usability of Theo Jansen mechanism toward climbing over bumps Kazuma Komoda (PY)1, and Hiroaki Wagatsuma 1 Department of Brain Science and Engineering, Kyushu I institute of Technology 2 RIKEN Brain Science Institute.
5. R.Nagarajan and M, Saravanan, “Comparison of PWM Control Techniques for Cascaded Multilevel Inverter” International Review of Automatic control (IRACO), Vol.5, No.6, pp. 815-828. Nov. 2012.
6. G. Vidhya Krishnan, R.Nagarajan, T. Durka, M.Kalaiselvi, M.Pushpa and S. Shanmuga priya, "Vehicle Communication System Using Li-Fi Technology," International Journal of Engineering And Computer Science (IJECS), Volume 6, Issue 3, pp. 20651-20657, March 2017.
7. Artificial active whiskers for guiding underwater autonomous walking robots T. Rooney_, M.J.Pearson, J. Welsby, I. Horsfield, R. Sewell, S. Dogramadzi Bristol Robotics Laboratory, University of the West of England, Bristol, BS161QD, UK
8. M.Dharani Devi and R.Nagarajan, “Implementation of Different PWM Control Strategies for Cascaded MLI,” Journal of Network Communications and Emerging Technologies (JNCET), Volume 7, Issue 7, pp. 49- 55, July-2017.