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DESIGN AND MANUFACTURING OF MECHABOT: A REVIEW

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ABSTRACT--*Since wheel was invented back in the Stone Age, it was the primary components used in all forms of mechanical transportation. Even today it is the components of choice for almost any type of moving mechanism like cars and etc. However, the wheel has always had major disadvantages with short elevation changes. For the other application people look at animal and human legs which are already proven to work effectively on different types of terrain. It would perform very well as a platform with the ability to handle stairs and other obstacles better than wheeled or tracked vehicles. In this mechanism links are connected by pivot joints and covert the rotating motion of the crank into the movement of foot similar to that of animal walking.*

Keywords: *Gear Mechanism, Pivot Joint, Klann Mechanism, Circuit, Battery.*

I. INTRODUCTION

It would be difficult to compete with the efficiency of a wheel on smooth hard surfaces but as condition increases rolling friction, the linkage becomes more viable and wheels of similar size cannot handle obstacles that linkage is capable of. Eight leg mechanical robots can be applicable for the making of robots. It has a wide range of application in the manufacturing of robots. A large version could use existing surveillance technology to convert your television into a real-time look at the world within transmitting range. In toy industries for making robotic toys it has got many applications. It can also be used for military purpose. By placing bomb detectors in the machines, we can easily detect the bomb without harmful to humans. It can be used as heavy tanker machines for carrying bombs as well as carrying other military goods. It is also applicable in the goods industries for the small transportation of goods inside the industry. The mountain roads or other difficulties where ordinary vehicles cannot be moved easily can be replaced by our hexapod robots. Heavy loads can be easily transported if we made this as a giant one. The geometry and conditions can be changed according to application needs. It can travel in rough surfaces very easily, so this machine can be used in rough surfaces were ordinary moving machine cannot travel.

II. LITERATURE SURVEY

Mayo Funatsu. al [1] study and investigate the slip condition on a vertical wall surface and propose a cm-scale hexapod robot with claws that can climb the vertical wall and investigated the relationship between the grip using the claws of the leg and the surface properties of the wall theoretically and experimentally. The robot realized vertical and horizontal movement on a vertical concrete wall. the volume force such as gravity is proportional to the length cubed and the area force such as muscle force is proportional to its cross section, i.e., the length squared, an object is more capable of overcoming gravity the smaller it is. This scaling effect allows a small robot to fly easily, accelerate rapidly, and climb a vertical wall with minimal difficulty.

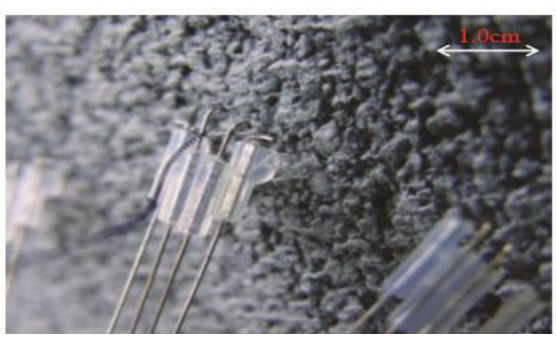


Figure 1. Surface of Concrete Wall and Claw of the Robot [1]

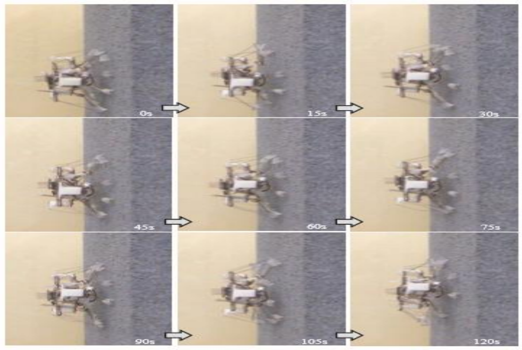


Figure 2. Stroboscopic pictures during climbing on concrete wall [1]

Dominik Belteret. al [2] describes a method for planning motion of a six-legged walking robot. The presented procedures allow determining the traversable areas, and to find the appropriate path to the goal positioning automatically. Collisions between parts of the robot are detected. The robot avoids collisions with the ground, deadlocks, and unstable postures and carefully selects footholds. The obtained path is executed in a robust way by using the compliance of the legs in figure (3). While walking the robot creates an elevation map of the terrain, which is then used in further planning. The presented method is implemented as modular software, allowing for modification of the particular modules within the RRT-based framework.

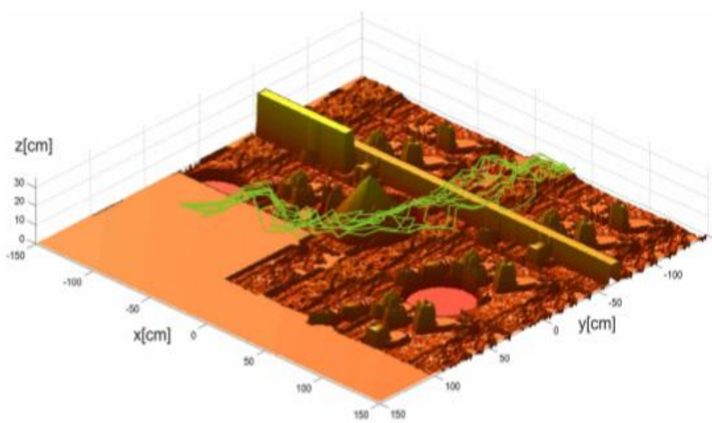


Figure 3. Results of RRT series experiments [2]

Umar Asif [3] introduced an approach of stable walking, based on fault tolerant technique for the recovery of the robot during its locomotion over uneven terrains. The results signify that the control is capable of enabling the robot continue its walk after the occurrence of joint and sensor failures. However, the performance is sometime less than the desirable, mainly because of the generation of unexpected environmental disturbances in the form of slip. In the presence of ground slippage resulting in unacceptable foothold locations, achieving an optimal and robust tolerant adaptive walking solution is complicated. The test was conducted using the FDD method by considering both pitch and roll adjustment of the body. The robot path is depicted by the ZMP position of the robot as evident in figure (5).

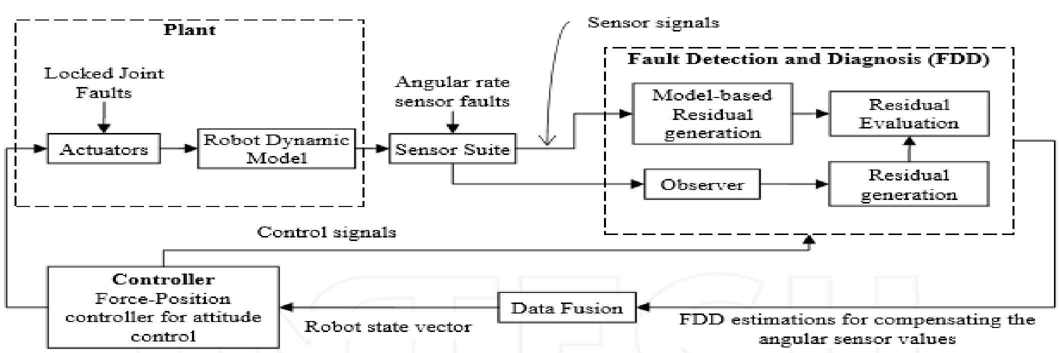
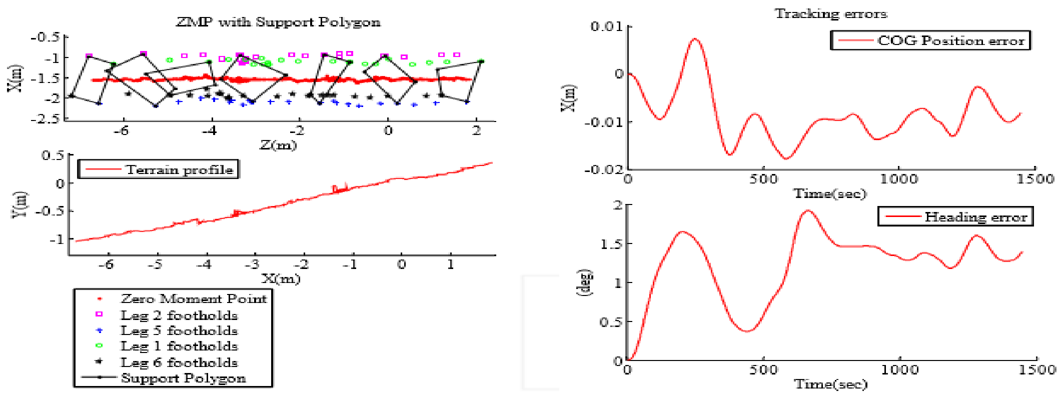


Figure 4. Overall control framework of the proposed system [3]



(A) **(B)**

Figure 5. Results of a straight line walking experiment while considering both pitch and roll adjustments of the body [3]

M.Dohi. al [4] study and aimed to develop hexapod walking robots for agriculture. A leg of robot is composed of one prismatic joint that moves to body in parallel and two rotational joint. Next, straight advancement and turn gait of this robot was formed with genetic algorithms. An experiment to confirm the stability and operation of the gait, and to form stable and flexible gait in natural environment. The reason for this is that the robot could be to go straight in a small number of steps by moving the supporting legs and Moving legs at the same time. When turning, the rotation angle of a gait by GA was approximately 180 degrees that is twice rotation angle of the large beetle by the same number of steps. This shows that the formed gait evolved by GA like the living thing according to the purpose which the fitness function requests. Figure (6) shows the relations between the generation and the best fitness value of the gene when a left turn gait is formed according to the population of genes.

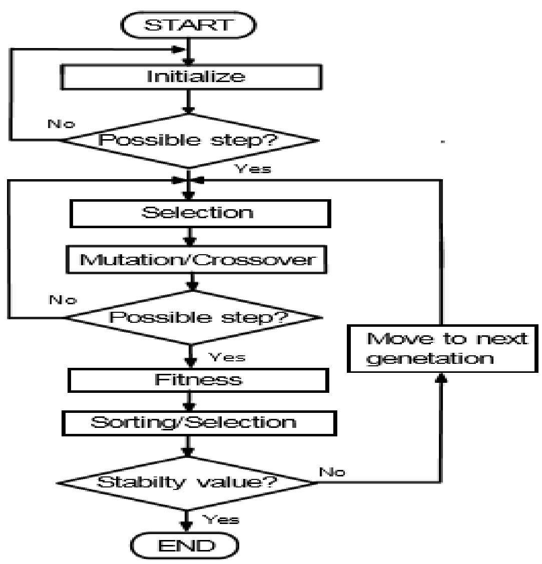


Figure 6. Flow chart to form turn gait with GA [4]

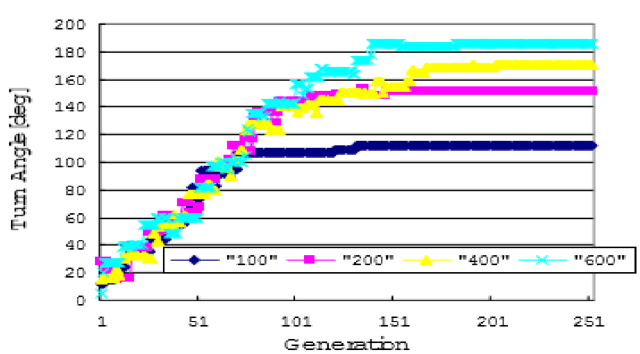


Figure 7. Results of each population of genes [4]

Mănoiu-Olaru Sorin. al [5] study and found that Free fall analysis is useful for investigating what happens with the robot on uneven terrain or for accidents shown in figure (8) that may happen due to lose of contact, slippery surface, servomotor failure, power supply failure.

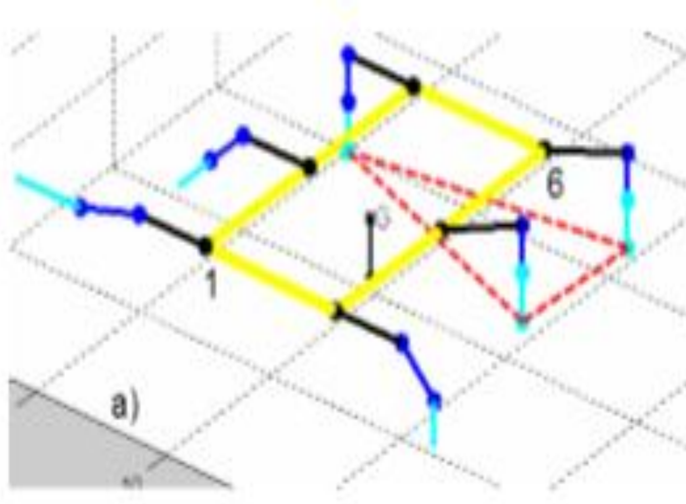


Figure 8. Phase of falling [5]

Furthermore, transitory analysis represents a more important case for locomotion, gait generation. When starting to develop a gait cycle we can have a big picture of what happens when the robot starts to move, how the support polygon changes and what actions must be applied to the robot in order to meet condition of stability. This analysis can also be interpreted as a continuation of free fall analysis case if the condition of stability shown in figure (9) has been met.

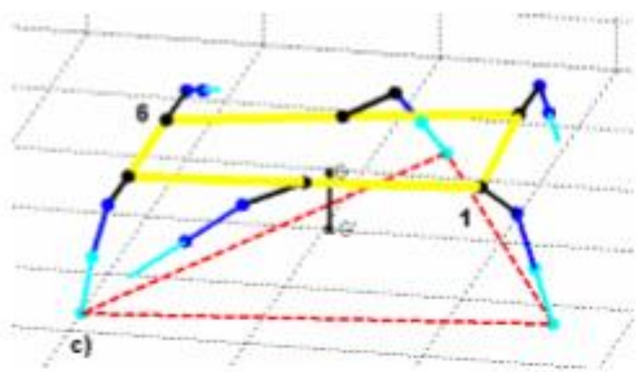


Figure 9. Phase of statically stable [5]

The interface was designed to be simple and intuitive and to offer the user a simple and efficient way to control every aspects of the robot (angles, masses, lengths).

Abin Simon. al [6] paper relates to a mechanism that is allow extraterrestrial rovers shown in figure (10) to climb high stepped terrain and have a suspension system in place to provide restoring force for the arms to come down and provide traction for the wheels over the ground. The leg mechanism ensures that a vehicle can traverse over a considerable height greater than the chassis height which could be as much as thrice the diameter of the wheels. Additionally, as the mechanisms are actuator-powered, the slope of the rover can be adjusted in such a way that it does not topple for a wide range of inclination and allows the rover to traverse over highly rugged terrain. It provides a large amount of traction with the ground even on terrains where there is a negative slope or vertical drop of around 1m using a spring-damper suspension mechanism. Furthermore, innovative mechanism has been implemented for which suitable Kinematic linkage analysis and dynamic analysis was conducted to analyses that it is capable of traversing desired terrains.

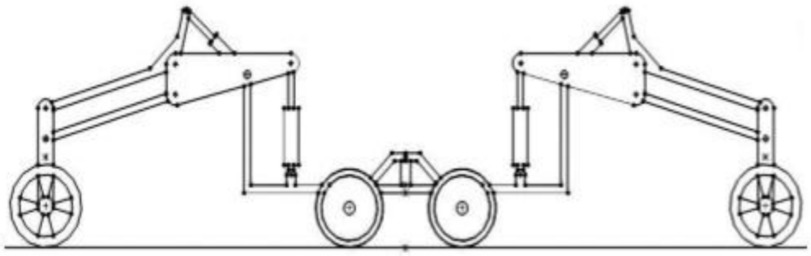


Figure 10. Side view of spider mechanism on a rover [6]

Hasan Alli et.al [7] in this study, they design a six-legged walking insect robot shown in figure (11, 12) whose structure is based on the biomechanics of the cockroach .The walking robot is driven by two stepper motors. A six-bar Watt's chain forms the kinematic chain for the legs, and is actuated by a cam mechanism and transmission bar. Springs mounted on the legs mimic important muscle characteristics. The motion mechanisms are governed by a PLC controller. Intelligent biological inspiration has been used to design a simple and more insect-like robot for the better application of current technology. Reducing the number of drive motors leads to a lighter structure and simpler control. It is well-known that the complexity of a control system depends on number of actuators used, and more actuators mean more difficult control and higher cost. These problems can be overcome by designing special mechanisms. The cam mechanisms and connecting rods and springs in their design reduce the number of actuators shown in Table (1) and ease the control insect robot.

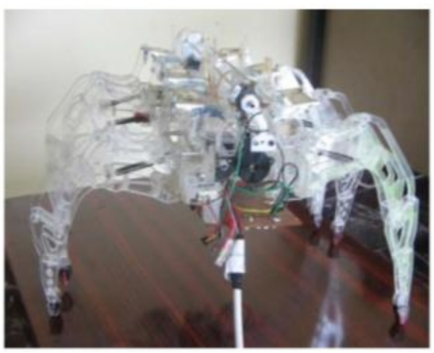


Figure 11. Front view of the prototype [7]

Figure 12. Top view of the prototype [7]

Table 1. Actuator number, leg number and speed of some leg robots [7]

Robots	Number of actuators	Number of Legs	Speed(cm/sec)
Insect robot	2	6	5.40
Rhex	6	6	-
Robug iii	16	8	10.0
Dante ii	6	6	1.70
Genghis	6	6	3.80
Commet	6	6	5.00

III. METHODOLOGY

A single leg is a six-bar linkage that consists of the frame, pinions, electric motor, crank, connecting arm, lower rocker, leg and an upper rocker. The ground points for the upper and lower rocker in this configuration are vertically in line to allow a coupled pair of legs to articulate like the front wheels of a typical car for steering.

The frame is made of plastic because plastic is light in weight and it is very important to reduce the weight of device as much as it is possible. Also other parts i.e. Links are made of plastic. Four gears and two pinions made of plastic material are used.

Electric motor is mounted on frame and pinion is connected at the shaft of electric motor. Two gears are in mesh with pinion on either side with the help of leg connection. The leg has a hip joint axially connected to the upper rocker arm in order to limit hip motion and a knee joint axially connected to connecting rod. The connecting rod has three axial connecting sites. The first connecting sites is for connecting knee, second is for crank connection and third is for connecting lower arm with connecting rod for limiting knee joint motion.

3.1. Klann Mechanism

The klann linkage is a planar 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 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. It fits into the technological space between these walking devices and axle-driven wheels.

3.1.1. Power Transmission Mechanism

Power is supplied by motor to pinion which in turn rotate crank i.e. Gears and crank rotation is transferred to connecting arm causing leg to move in an accurate reciprocating movement. Instead of using motorized power, the device can also be manually powered. A single leg consists of five linkages and a crank made up of pivot joints that convert rotating motion into linear motion. The mechanism works on klann mechanism. For 180° rotation of crank, straight-line portion of the path trace by the leg. For next 180° of crank rotation, leg is raised to a predetermine height before returning to starting point and cycle is repeated.

3.2. Material Assign:

Fabrication work of all parts and assembling, it is necessary to check out deformation and stress in the robot. Plastic is assigned to all linkages and fames and gears. Since robot is symmetric on both side of the center plane, considering only half position since result will be same on both side. Also this will reduce the solving time.

3.2.1. Contacts

When two separate surfaces touch each other such that they become mutually tangent, they are said to be in contact. Contact is changing-status nonlinearity. That is, the stiffness of the system depends on the contact status, whether parts are touching or separated.
Since all links are in motion, thus revolute joint is given between contacts of parts. Between gears bonded contact is given.

4.3. Result of Modal Analysis:

Modal analysis determines the vibration characteristic i.e. natural frequencies show in figure (13) and mode shapes of a structure or a machine component while it is being design. The natural frequencies and mode shapes are important parameters in the design of a structure for dynamic loading conditions.
The procedure for a modal analysis consists of four main steps:
1. Build the model.
2. Apply loads and obtain the solution.
3. Expand the modes.
4. Review the results.

	Mode	Frequency [Hz]
1	1.	0.
2	2.	1.3428e-003
3	3.	4.891e-003
4	4.	151.7
5	5.	165.48
6	6.	171.28
7	7.	176.75
8	8.	258.81
9	9.	335.33
10	10.	391.37
11	11.	398.98
12	12.	400.21
13	13.	574.47
14	14.	643.37
15	15.	689.35
16	16.	719.12
17	17.	932.69
18	18.	1019.
19	19.	1063.6
20	20.	1137.1

Figure 13. Different Frequencies Results [8]

Modes are expanded and deformational on each mode is determined. Deformation at least and highest frequency is within limit and thus body is found to be safe.

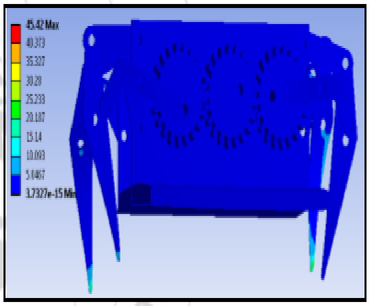


Figure 13. Van-misses stress Results [8]

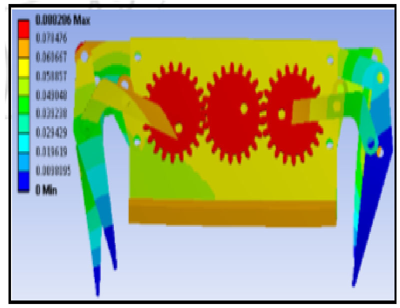


Figure 14. Total Deformation Results [8]

IV. CONCLUSION

On looking towards engineering application the Robot has a wide range of application in the manufacturing of robots, use in existing surveillance technology, used for military purpose, Small good transportation industry, and rough terrain travels etc. After surveying this simple constructional robot can prepare which can fulfill all the above applications. There are many mechanisms, but Klann Mechanism can select for easy working. Klann Mechanism has simple construction and movement of linkage. The main aim of design and manufacturing of mechabot is to provide simple working of mechanical components with electrical circuit.

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