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Quadruped-Walker

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Abstract: **The aim of the project is to build a four-legged walking robot that is capable of basic mobility tasks such as walking forward, backward, rotating in place and raising or lowering the body height. The legs will be of a modular design and will have two degrees of freedom per leg. This robot will serve as a platform onto which additional sensory components could be added, or which could be programmed to perform increasingly complex motions. It can be further used for various applications based on the requirement. Mammals are chosen as models because their nervous system is simpler than other animal species. Also, complex behaviors can be attributed to just a few neurons and the pathway between sensory input and motor output is relatively shorter. Mammals' walking behavior and neural architecture are used to improve robot locomotion. Alternatively, biologists can use Quadruped robots for testing different hypotheses.**

I. INTRODUCTION

Legged walkers are a class of robots that imitate the locomotion of animals and insects, using legs. It is well known that legged locomotion is more efficient, speedy, and versatile than the one by track and wheeled vehicles when it operates in a rough terrain or in unconstructed environment. The potential advantages of legged locomotion can be indicated such as better mobility, obstacles overcoming ability, active suspension, energy efficiency, and achievable speed. Legged walking robots have found wide application areas such as in military tasks, inspection of nuclear power plants, surveillance, planetary explorations, and in forestry and agricultural tasks

However, it is still far away to anticipate that legged walking robots can work in a complex environment and accomplish different tasks successfully. Mechanical design, dynamical walking control, walking pattern generation, and motion planning are still challenge problems for developing a reliable legged walking robot, which can operate in different terrains and environments with speedy, efficient, and versatility features.

II. BASIC CONCEPT:-

Quadruped animals (i.e.) Mammals acts intermediate between the birds and the humans hence the modeling of leg in birds we say it as BACK LEG since the knee region of bird's leg is reversed, where as in humans the knee setup is forward .i.e. FRONT LEG.Here the mammals exhibits hybrid leg model .i.e. both front and back leg which makes the robot more stable and gives chances to exhibit complex behavior during locomotion.

A single leg consists of a simple planar two-link arm which has its own masses and length which follows STATICS and KINEMATICS for choosing right torque and exact position to meet in. In this revolute joint when two forces act each other, the resultant force will aid the stability of the robot. Hence we can move one leg at a time leaving other legs contact with the ground which forms the tripod gait structure i.e. Stable structure.

The tripod gait we seen in this robot isn't the only workable gait. There are other perfectly usable gaits you can develop on your own.

III. CONSTRUCTION:-

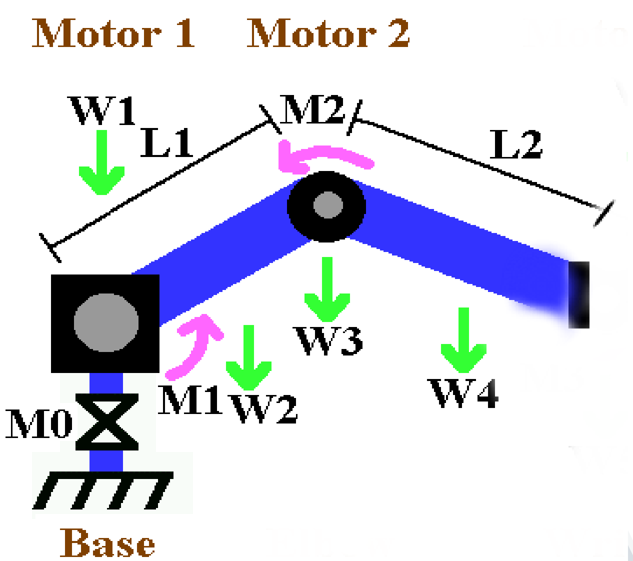
The list of issues we are about to consider while construction are Kinematics, Statics and Dynamics of our robot. For Trajectory planning, Kinematics is very important because to command leg's positions in terms of Cartesian coordinates. Statics deals with forces and torques required to move leg to different positions.

The body design of the quadruped robot based on geometry theorems;

Where x=20cm, so
Length = 20cm, Breadth = 5cm.
Length= **X**
X/4

Where x=20cm, so
Length = 20cm, Breadth = 5cm.

For designing two armed leg based on theories, the leg size must be x/2 (i.e. 10cm). So each arm must be x/4 (i.e. 5cm) in length and foot length must be x/10 (i.e. 2cm).



Where L1=L2=5cm;
The shape of each arm must be irregular rather than be rectangular. Weight of motors be,
W1=50 gms; W3=20 gms.
Weight of arm be W2=100gms; W4=100gms.
Based on above value the min torque required to move the leg will be,

Torque at M1 = 0.3 Nm.

Torque at M2 = 0.05Nm.

Since the base is fixed at the edges of the rectangular body, the base torque required can be ignored. By choosing the torque value greater than the value required for the motor, the robot can achieve its stability.

To construct a Robot arm at its base the min torque required increases based on the total weight of the robotic arm.

IV. ALGORITHM:-

To work with the robot i.e. to perform some tasks we need to develop some basic algorithms to work it either in structured or unstructured environment. Basic algorithms were designed to work with unstructured environment. BUG1 and BUG2 was the basic algorithm but we are going to use class 1 algorithm which states that "the robot can leave the obstacle that it encounters without exploring it completely".

Class 2 algorithms are more adventurous i.e. they are more human, they take risks. This algorithm will win real life scenes, though it may lose badly in an unlucky scene. Before moving into the class2 algorithm, we have to be clear with some basic assumptions and definitions,

Our robot motions skill must include 3 actions: - (1) coordinates of point starting (S) and target (T) location as well as current location. (2) The fact of contacting the obstacle. (3) The way of locomotion.

A local direction is a once-and-for-all decided direction for passing around an obstacle (Definition 1).

Robot is said to define a hit point on the obstacle, denoted H, when, while moving along a straight line toward point T, it contacts the obstacle at the point H. It defines a leave point, L, on the obstacle when it leaves the obstacle at point L in order to continue its walk toward point T (Definition 2).

For any path planning algorithm satisfying assumption of our model, the total
Path generated (P) by our robot between the starting and target location must be greater than or equal to the actual distance (D) between it, but never be less P (Definition 3*)*.

BUG 2 Algorithms:-

The three important properties under this algorithm were, Robot can encounter the same obstacle more than once.

Bug2 has no way of distinguishing between different obstacles. The straight line(S, T) that connects starting and target points play a crucial role in algorithm's working. The latter line is called M line (Main line).

The notations used*:* Subscript i will be used only when referring to more than one obstacle and superscript j will be used to indicate the jth occurrence of a hit or leave points on the same or on a different obstacle. Initially, $j = 1$; $L0$ = Start. Similar to Bug1, the Bug2 procedure includes a test for target reach ability, which is built into Steps 2b and 2c of the procedure.

V. BUG2 PROCEDURE:-

1. From point $Lj-1$, move along the M-line (straight line *(S, T)*) until one of these occurs:

(a) Target *T* is reached. The procedure stops.

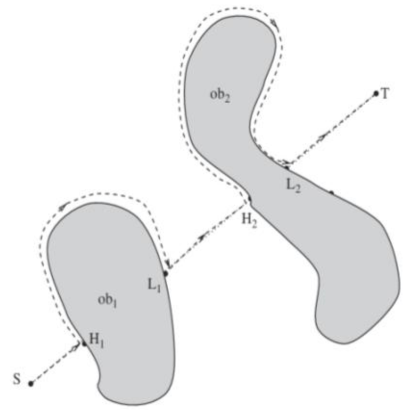
(b) An obstacle is encountered and a hit point, *Hj*, is defined. Go to Step 2.

2. using the accepted local direction, follow the obstacle boundary until one of these occurs:

(a) Target *T* is reached. The procedure stops.

(b) M-line is met at a point *Q* such that distance $d(Q) < d(Hj)$, and straight line *(Q, T)* does not cross the current obstacle at point *Q*. Define the leave point $Lj = Q$. Set $j = j + 1$. Go to Step 1.

(c) MA returns to *Hj* and thus completes a closed curve along the obstacle boundary, without having defined the next hit point, *Hj*+1. Then, the target point *T* is trapped and cannot be reached. The procedure stops



VI. FUTURE ENHANCEMENT:-

Replacing the simple obstacle detecting sensors with Stereo vision device so that we can perform more complicated operations since it will give information about distance of object it passing. It also knows the direction of the target (T) as well.

To make our robot more useful to perform many operations either in on field or off field applications, we can construct a ROBOTIC ARM at the base of the Quadruped robot. By doing so, we can use it in **farming lands**, **mining**, to operate in Remote **areas** and might be in **Space**. The arm is found to be useful to perform our operation by constructing required end effectors. These end effectors carry a tool for doing robot's job; this can be some kind of a gripper, a screw driver, paint or a welding gun or so on.