DESIGN AND CONTROL OF BIOMIMETIC WALKING ROBOT: SMART WALKER

DEPARTMENT OF MECHATRONICS ENGINEERING

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Abstract

Missions of walking robots in distant areas require use of the teleoperation mode. However, the capabilities of a human operator to sense the terrain and to control the robot are limited. Thus, a walking robot should have enough autonomy to take an advantage of its high locomotion capabilities in spite of a limited feedback from the remote operator. The proposed method employs several modules for planning the robot's path and trajectories of the feet, foothold selection, collision avoidance, and stability analysis. By using this method the robot can autonomously find a path to the desired position and discriminate between traversable and non-traversable areas. The rapidly exploring random trees concept is used as a backbone of the proposed solution

Introduction

Basically, our robot consists of body part, legs, joints and connections. Detailed drawings of robot parts were made using Solid Works solid modeling program. After all the parts were drawn, our robot was assembled using the same program. After the assembly was analyzed, we observed the operation of the robot with simulation. All these stages will be completed successfully and the parts were produced using 3D printer.

Figure 1. Basic leg structure

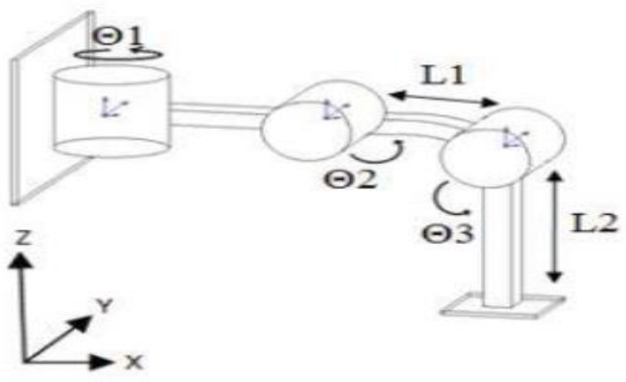
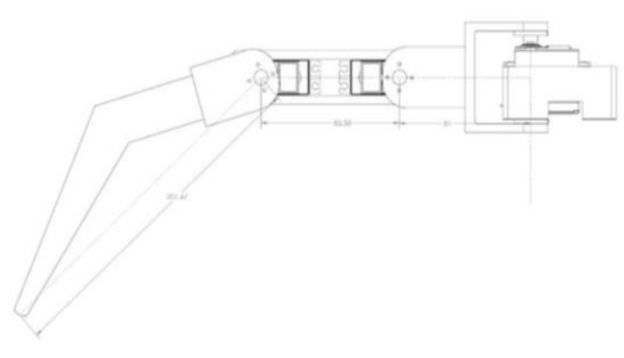


Figure 2. Smart Walker leg structure



Purpose of the Study

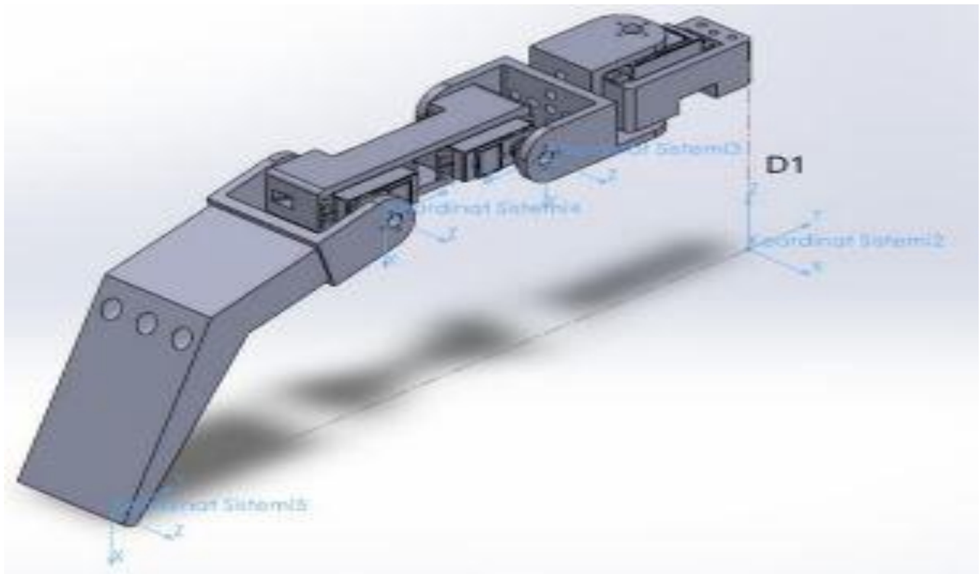
Visually impaired people may have difficulty getting from one place to another and finding a place. Although there are signs on the sidewalks for the visually impaired, there may be difficulties in finding a place on some roads. These difficulties can be life-threatening. For example falling, injury due to falling, traffic accidents etc. We have developed a robot based on this problem, our aim is to guide the visually impaired people around the campus and make life easier for them.

Theoretical Review

Forward Kinematics (Direct Task):

Each leg of our hexapod robot is considered a serial manipulator, with the leg fixed to the body and the end effector on the ground. When we apply the Denavit-Hartenberg (D-H) method for a leg, we place the axes as seen in the figure below.

Figure 3. Frame assignment to find DH parameters



Denavit Hartenberg Table for our Design

Link	θ_i	d_i	a_i	α_i
1	θ_1	d_1	0	0
2	θ_2	0	L_1	90
3	θ_3	0	L_2	0
4	0	0	L_3	0

The homogeneous transformation matrices of the legs links can be obtained as:

$$T_{base}^{coxa} = T_{femur}^{coxa} T_{tibia}^{femur} T_{base}^{tibia}$$

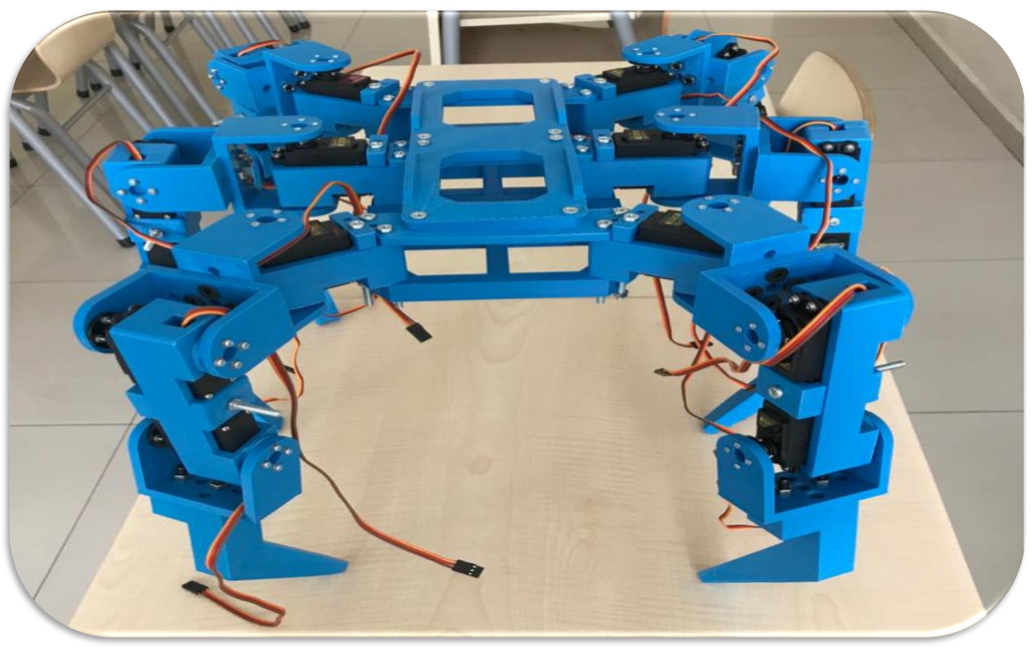
Where P_x , P_y and P_z refers to position matrix between the foot tip coordinate and the body coordinate as:

$$P_x = L_1 c\theta_1 + L_2 c\theta_1 c\theta_2 - L_3 c\theta_1 s\theta_2 s\theta_3 + L_3 c\theta_1 c\theta_2 c\theta_3$$

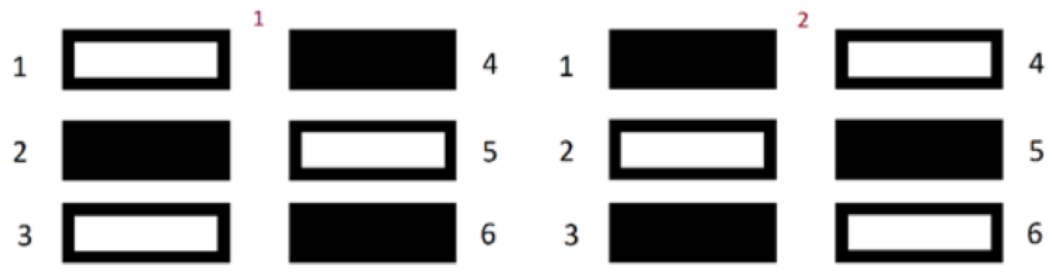
$$P_y = L_1 s\theta_1 + L_2 s\theta_1 c\theta_2 + L_3 s\theta_1 c\theta_2 c\theta_3 - L_3 s\theta_1 s\theta_2 s\theta_3$$

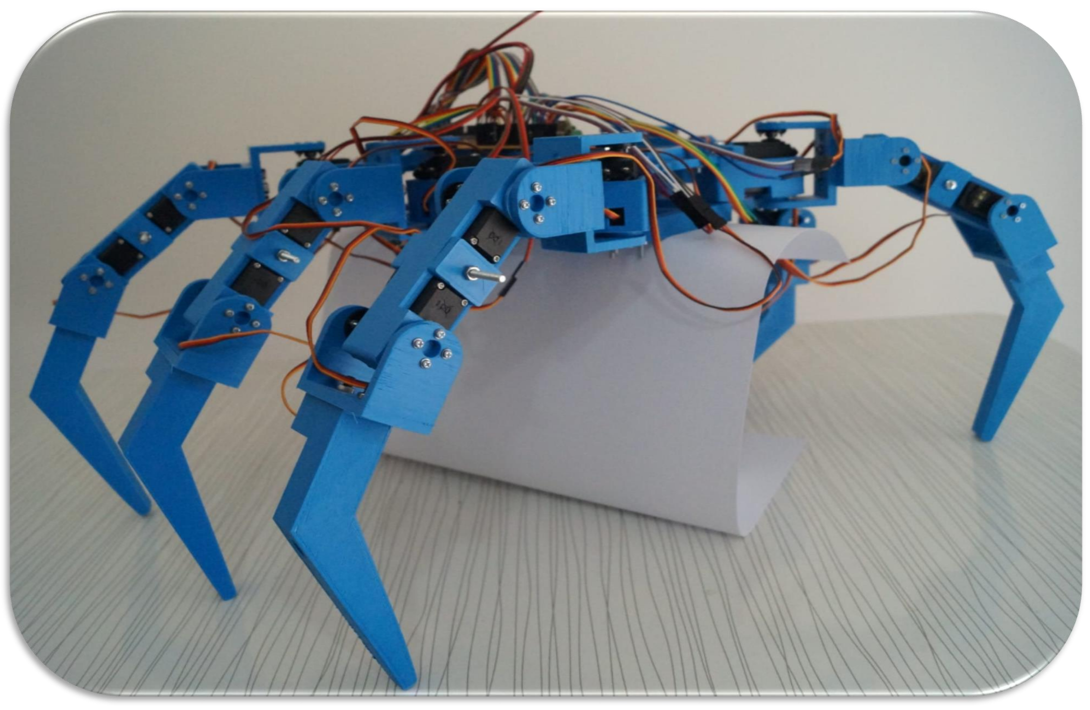
$$P_z = d_1 + L_2 s\theta_2 + L_3 c\theta_2 s\theta_3 + L_3 s\theta_2 c\theta_3$$

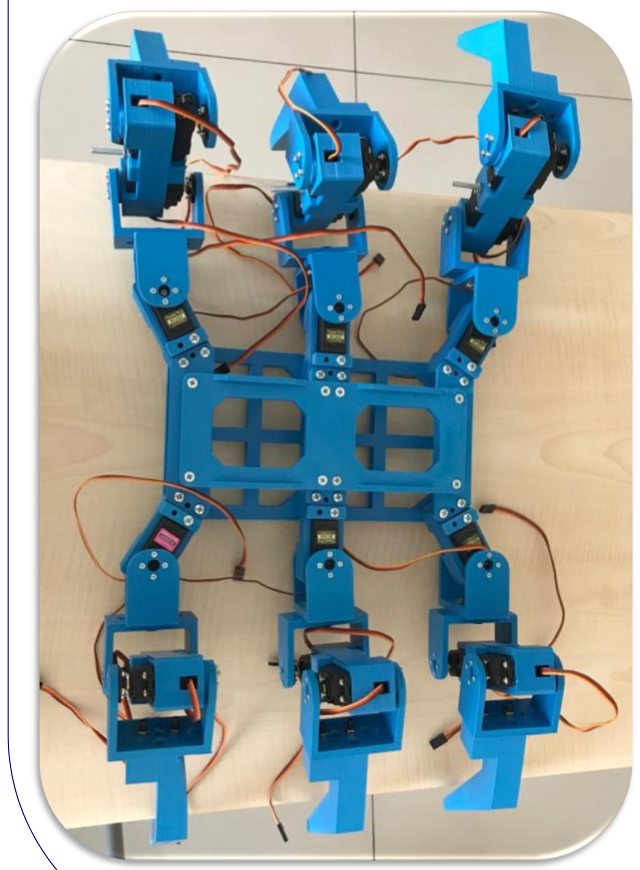
Experimental Setup

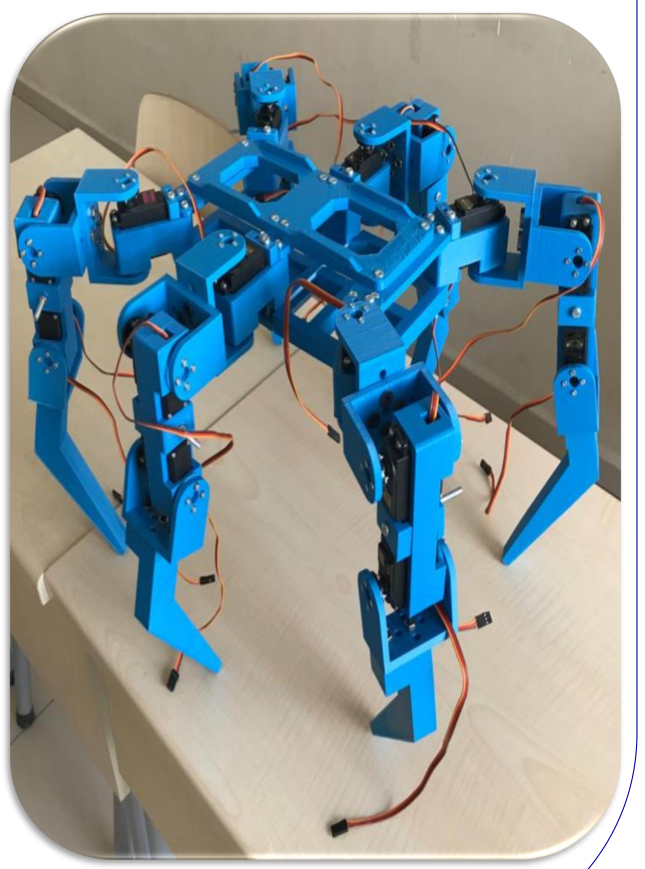


To control our robot's movement, we use an algorithm to decide which legs to use while stepping, there are different gaits to control the movement of the legs. Some of these gaits are tripod gait, wave gait, and ripple gait.

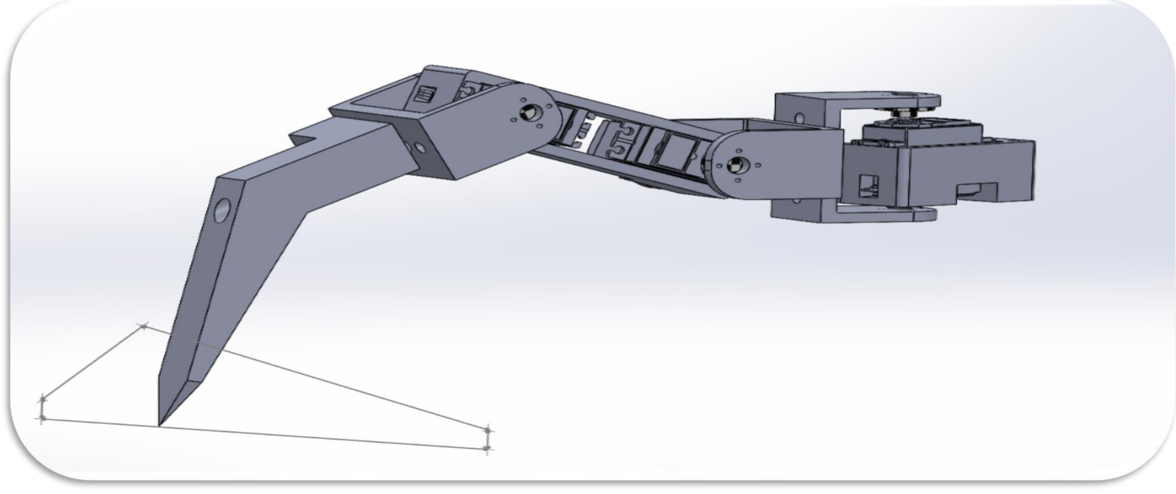


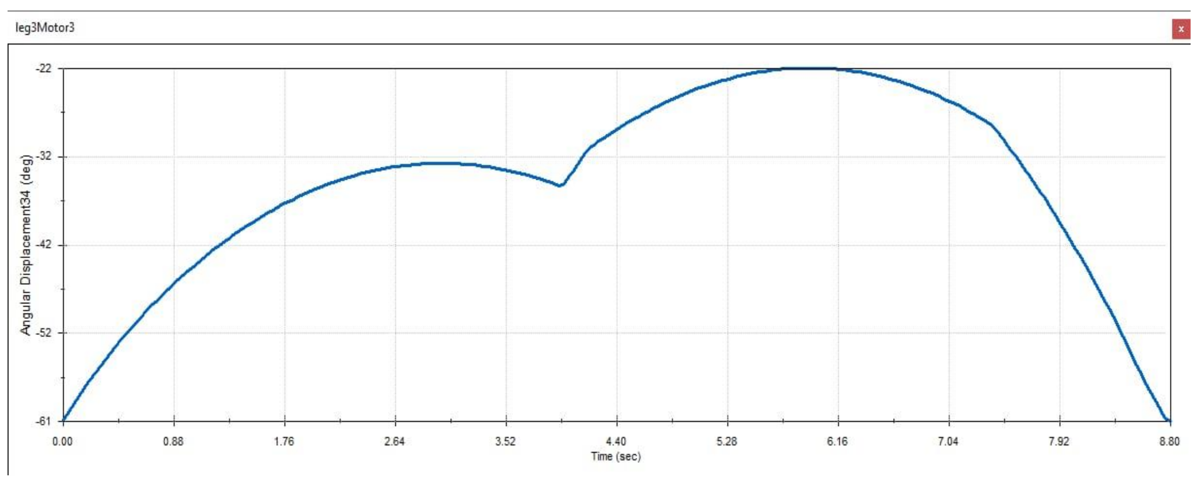






Results and Discussion





Our path graph for our third motor that we use in the third leg is as stated above.

In this study, the 6-legged robot was inspired by some insects. The requested action was successfully performed. Necessary calculations were explained and completed as necessary.

References

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