Dynamic Legged Locomotion of Modular Robots

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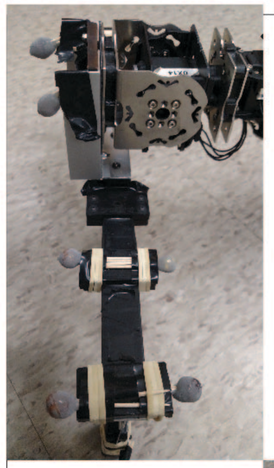
Abstract

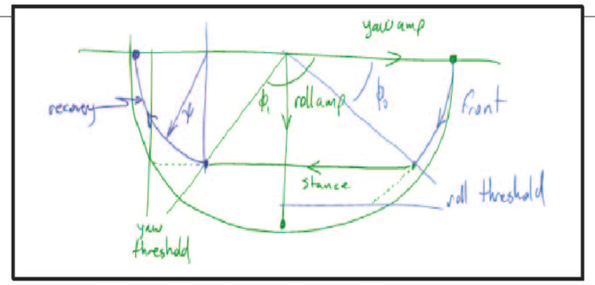
This project describes a bioinspired hexapedal robot that uses seven motors and is able to run dynamically.

The leg stiffness of the hexapod contributes to its dynamic motion, but it is not understood what factors directly affect the hexapod's gait.

The objective of this project is to gain data from the gait parameters of a new generation of robot with adjustable fore-aft and bendable stiffness and tripod gait as it moves over set distances.



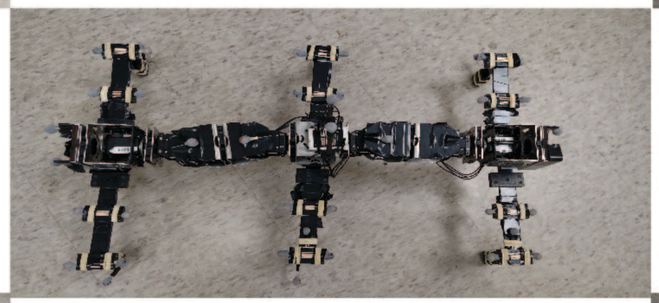
Front Leg with Motor



Visualization of Gait Parameters



Calibration Equipment



Mechapod with Markers

Tracking Trials

Qualysis Camera System was used to track the mechapods movements. The purpose of these cameras is to detect low refractive index items.

The Qualysis Camera System was calibrated before every trial set. This was done to create a better model of the markers attached to the mechapod.

A total of 40 markers were used to track the mechapod as it ran trials. Trials consisted of the mechapod running a set distance until it either reaches that distance or fails.

The Mechapod

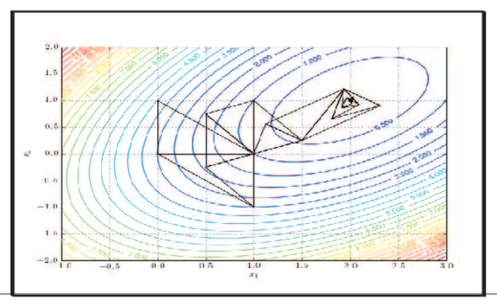
Each of the Mechapod's six legs have adjustable stiffness that play a key role in the speed with which it moves.

All seven motors are connected by wire to run the mechapod. If any of these motors are not connected when running trials, the mechapod will not move.

The markers on the mechapod are made to have a low index refractive coating. This allows the Qualysis Camera to track the mechapod's movements via the attached markers.



Connection Center



Nelder Mead Triangles



Qualysis Camera

Data Collection

Tracking data for each trial was analyzed in a python program which contained the specific gait parameters used for each trial.

A Nelder Mead Simplex Search algorithm was used to evaluate trial results. If the results of the current trial were worse than those of previous trials, the algorithm would change gait parameters in a direction that would yield a more desirable result in the next trial.

In this way, the Nelder Mead Search shows how different parameters interact with each other to form the specific gait of the mechapod.

Gait Parameters

The tripod gait mechapod has many aspects that contribute to its movement gait. This project focuses on 5 in particular.

1.) Gait Frequency
2.) Leg Roll Amplitude
3.) Leg Yaw Amplitude
4.) Sweep Angle
5.) Stance Period

References and Acknowledgements

[1] J. Sastra, S. Revzen, and M. Yim, "Softer legs allow a modular hexapod to run faster," in Climbing and Walking Robots (CLAWAR), 2012.

[2] J. Schmitt and P. Holmes, "Mechanical models for insect locomotion I: Dynamics and stability in the horizontal plane," Biol. Cybernetics, submitted, 1999.

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