A hexapedal robot designed for ground contact force analysis

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Summary Hexapods stand out among legged systems in their stability over unstructured terrain. We have recently discovered that slipping is a routine part of cockroach locomotion,[1] as well as showing that some robotic hexapods can noticeably improve performance by including gaits with slipping[2]. The non-negligible slipping challenges conventional mechanical analysis and simulation tools locomotion. The indeterminancy of inter-leg force distribution and the combinatorial complexities of possible contact states also result in unreliable motion planning. Our group has found a highly simplified model[3] for friction dominated multi-legged locomotion which produces unexpectedly good motion predictions. Because experimental data on ground contact forces of hexapods is scarce, we designed a hexapedal robot platform equipped with Force/Torque (F/T) transducers and intended to produce the data needed to study why our model was successful. Here we present this robot's mechanics and some preliminary force data collected with it.

Methods We designed a hexapedal robot which has both laterally bendable spine moving in the horizontal plane and elastic legs bending in the frontal plane. This morphology provides what is functionally a 2-DOF motion for each of its 6 feet with only 7 motors. We installed three 6-axis F/T transducers (ATI Gamma) between the spine and each of the three legs. We tracked the motion of the robot using a reflective tag based system (8 Qualisys cameras at 125 fps) and calculated the ground contact forces by transforming transducer wrenches to the feet.

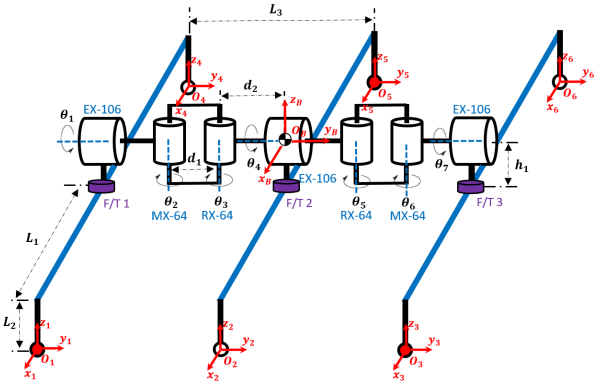


Figure 1: Simplified symbolic representation of links and joints of the Mechapod with transducers

Results and Discussion Figure 2 shows 11 steps of the robot running on foam tile fin the -x direction of the world frame, at speed 74.9±0.5[cm/s] for 2.0[m] over 26.44[s]. Our analysis suggested that individual leg forces are periodic, and not just their sum. Further work will aim at verifying our simplified model under various speed, surface and steering conditions.

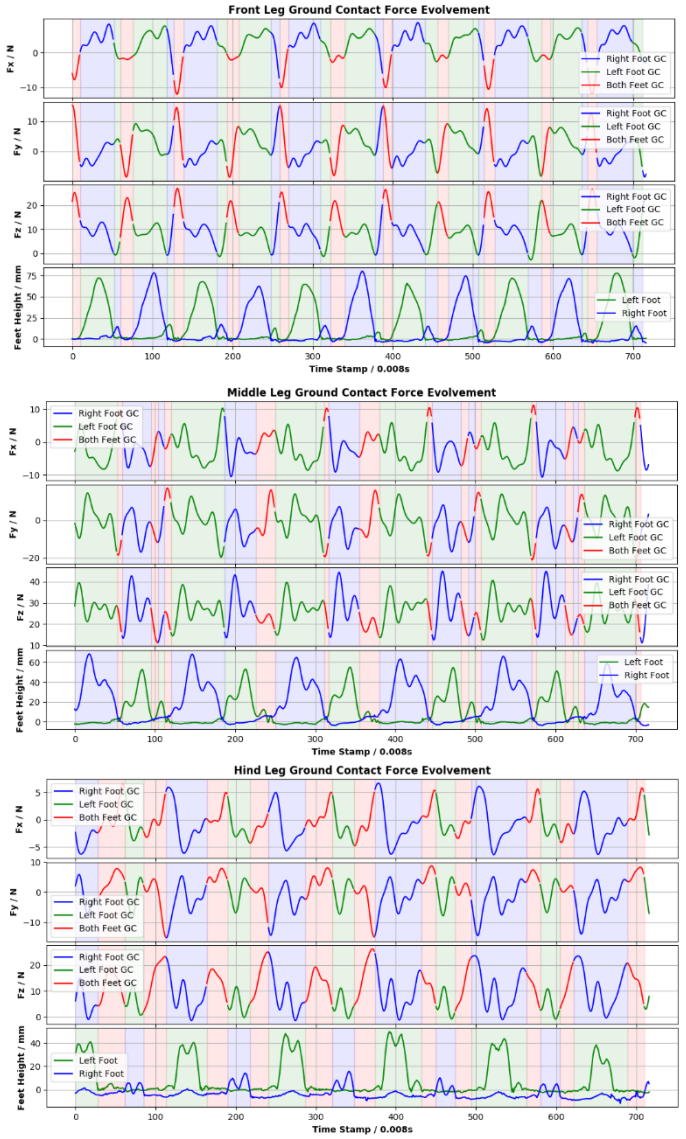


Figure 2: Ground contact force evolvement. The colours represent the type of ground contact (left foot-green, right foot-blue or both feet-red). Subfigures illustrate the ground contact forces decomposition along x, y, z-axis of the world frame. The bottom chart in each plot shows the height of the feet.

Acknowledgments This project is supported by US Army Research Office Grants (ARO) W911NF-17-1-0243 & W911NF-14-1-0573.

References

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