1STAR, a One-Actuator STeerAble Robot

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EXTENDED ABSTRACT

We present a novel dynamic gait to control in-plane locomotion [1] (forward, back, clockwise and counter clockwise rotations) of a compliant legged hexapedal robot using a single actuator. The gait exploits the compliance disparity between alternate stance tripods, to generate rotation by controlling the acceleration of the robot [2]. The direction of turning depends on the configuration of the legs -tripod left or right- and the direction of the acceleration. Alternating acceleration in successive steps allows for continuous rotation in the desired direction. A simplified model of a robot is made and a numerical simulation was performed to analyze the behavior and optimize robot parameters. The robot is capable of rotating with a coefficient of friction as low as 0.2 but its performance improves as the COF increases up to 0.6. Beyond that, little change is noticed.

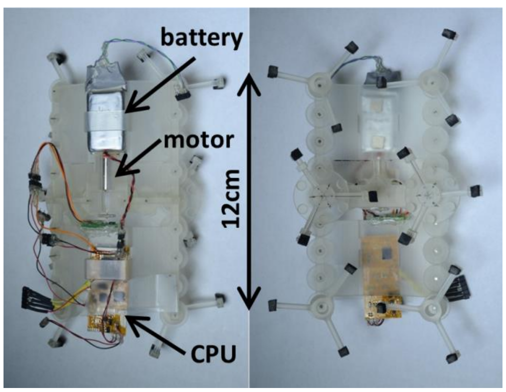

Figure 1.The Experimental robot 1STAR

The locomotion gait is proven experimentally using a purpose-built experimental robot actuated by a single motor (Figures 1 and 2). The robot is capable of crawling straight or turning in either direction as commanded (Figure 3). The experimental robot supplied physical validation of the single actuator concept. The robot achieved an alternating longitudinal acceleration with an amplitude of roughly 0.4g, which, together with proper phasing of the legs, allowed the robot to turn in either direction based on the tripod configuration. The turning radius is roughly 0.5m, at a speed of roughly 0.3m/s, and the robot can switch the direction of turning by changing the phase of the legs. The energy consumption of the alternating velocity gait required slightly more energy (22%) in comparison to straight locomotion.

The VICON experimental results in Figure 3 show the robot performing a slalom (a) and obstacle avoidance maneuvers (b) which include going straight and turning either direction, while Figure 3c shows the robot making a full circle in one direction and another in the opposite direction.

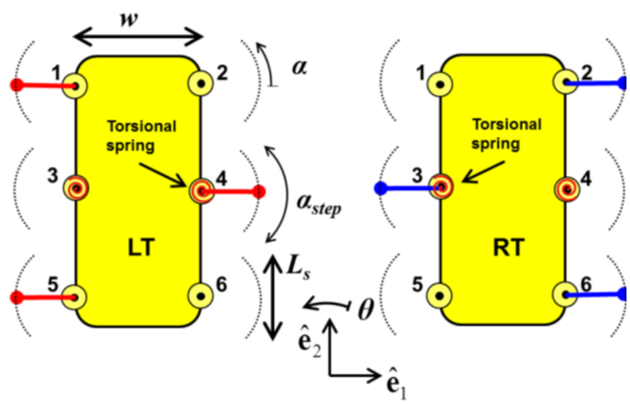

Figure 2. Robot Model. The center legs are compliant while the front and back legs are rigid.

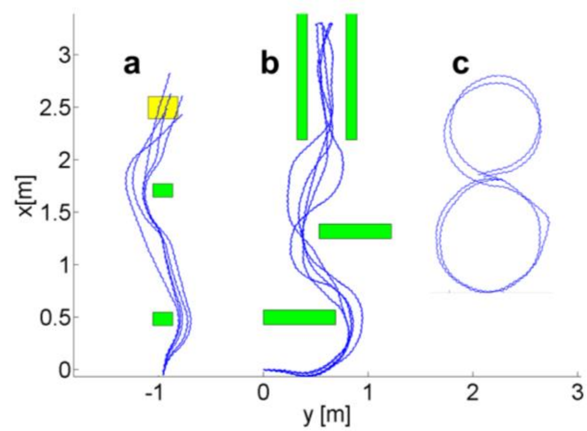

Figure 3. The path of the robot from the VICON.

[1] D. Zarrouk, A. Pullin, N.J. Kohut, R.S. Fearing, "Sprawl tuned autonomous robot", IEEE International Conference on Robotics and Automation 2013.

[2] D. Zarrouk, R.S. Fearing, "Compliance-based dynamic steering for hexapods", IEEE International Conference on Intelligent Robots and Systems, pp. 3093-3098, 2012.

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