LLAMA Quadrupedal Robotic Platform

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Abstract— **The U.S. Army Research Laboratory (ARL) Robotics Collaborative Technology Alliance (RCTA) program has advanced robotics technology over the past 10 years through making investments in core technologies that support the Army's autonomous mobility goals advancing the state of the art. One platform that was created to encompass some of the advancements of autonomy in a highly mobile platform was the Legged Locomotion and Movement Adaptation (LLAMA) platform. The LLAMA platform is a quadrupedal legged platform with the ability to autonomously traverse a large range of terrains.**

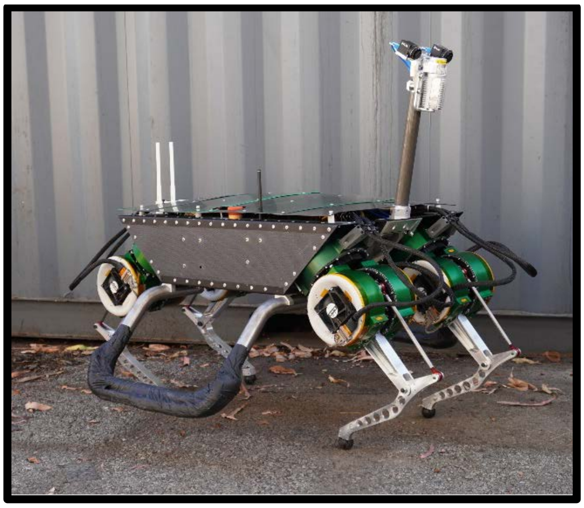
The LLAMA platform is a human scale robot approximately 75 kg, with 3 degrees of freedom fully actuated legs. Each leg is driven by three identical electric actuators designed by Thin Gap. The actuators are lightly geared (5.25:1) to increase torque density while minimizing reflected inertia and providing a strong signal for current-based proprioceptive controllers. The platform is powered by a custom lithium-ion battery pack (or can be tethered from shore power) managed by a unique Energy Management Unit (EMU) that balances the energy supplied by the battery power with a capacitor bank system that utilizes recirculated energy from the legs during each step.

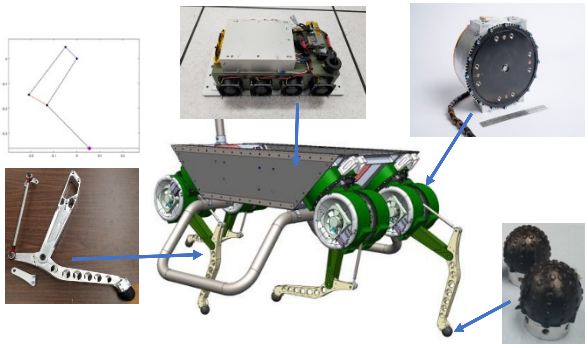
Keywords—Legged robotics, quadruped, reactive control, deliberative control

I. Introduction (*Heading 1*)

This presentation will summarize two of the technology advancements that came out of the LLAMA development effort. 1.) Advanced foot-step controllers for a human scale quadruped and 2.) Use of simulation to analyze a quadrupedal robot. Two different types of controllers developed for this platform include a Reactive Controller for traversing low roughness terrains and a Deliberative Controller designed for careful traversal of complex terrains through calculated foot placements. The controllers utilize encoder and proprioceptive force sensing feedback in conjunction with an IMU and vision perception suite. Both of these controllers were tested in field experiments.

To advance the development of the controller, high fidelity dynamics models were created, allowing safe insight to the performance potential of the LLAMA platform before being tested. Through this simulation environment, it was possible to push the limits of the platform within the bounds of the motor parameters and gain insight to control parameter stability sensitivity. A high-level planner was developed within simulation to enable a virtual switch between efficiency and speed of locomotion. [1]





References

[1] M. Y. Harper, J. V. Nicholson, E. G. Collins, Jr., J. L. Pusey, and J. E. Clark,"Energy Efficient Navigation for Running Legged Robots" IEEE IRCA 2018.