Introducing the Open Dynamic Robot Initiative project

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We present a new open-source torque-controlled legged robot system, with a low-cost and low-complexity actuator module at its core. It consists of a high-torque brushless permanent magnet syncronous motor and a low-gear-ratio transmission suitable for impedance and force control [1].

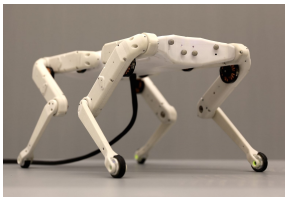
Using a modular design allowed us to build several robots based on the same operating principles: A first quadruped robot with 8 degrees of freedom (DoF) (Fig. 1a), an evolution with 12 DoF (fig. 1b), as well as a prototype biped with 6 dof (Fig. 2)

Thanks to the collaboration of several research teams we are able to master the entire chain of control and actuation. Another strong point of this project is that it is heavily documented and available on Github [2].

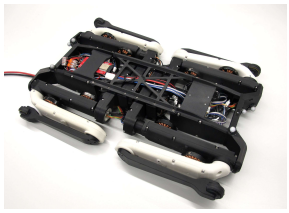
During this presentation I will detail the principles of operation as well as the mechatronics structure that forms the structure of these robots.

After a quick introduction of the advantages of using torque-controlled PMSM motors with low geared reduction, I will focus on the electronic structure that allows to control these robots at a frequency of 1 kHz with minimal latency from a remote computer via a wired or wireless link. Finally, I will present the first experimental results obtained with those dynamic robots and an ongoing opensource development to update the sensored field oriented motor driver electronic board to meet wider needs in terms of bandwidth, power and connectivity for bigger futur robots.

This work is a result of a collaboration between the Motion Generation and Control Group, the Dynamic Locomotion Group and the Robotics Central Scientific Facility at the Max-Planck Institute for Intelligent System , the Machines in Motion Laboratory at New York University's Tandon School of Engineering and the Gepetto Team at the LAAS/CNRS.



(a) 8 DoF - 2.2kg



(b) 12 DoF - 2.8kg

Figure 1: Solo quadrupeds

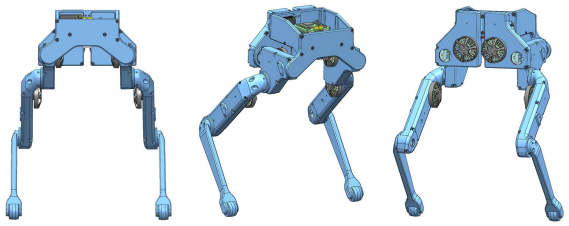


Figure 2: 6 DoF biped prototype - 1.25kg

References

[1] F. Grimminger, A. Meduri, M. Khadiv, J. Viereck, M. Wüthrich, M. Naveau, V. Berenz, S. Heim, F. Widmaier, T. Flayols, J. Fiene, A. Badri-Spröwitz, and L. Righetti, "An open torque-controlled modular robot architecture for legged locomotion research," *IEEE Robotics and Automation Letters*, vol. 5, no. 2, pp. 3650–3657, 2020.

[2] *Open dynamic robot initiative Github https://github.com/open-dynamic-robot-initiative.*