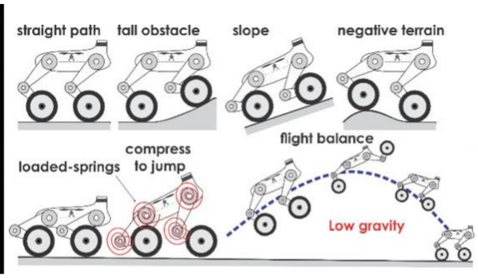
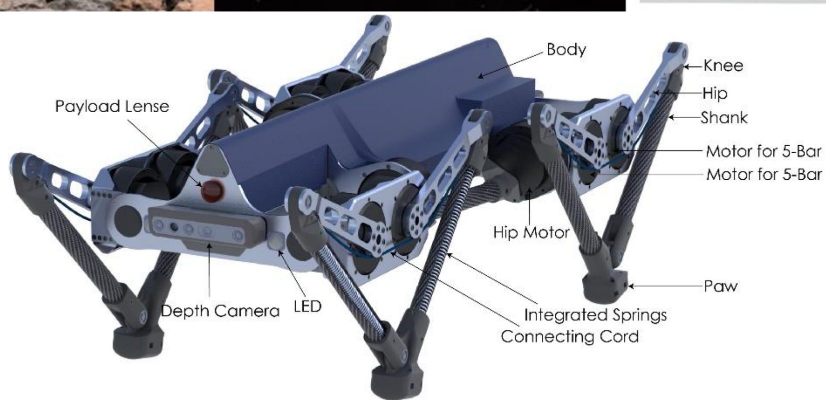
Development and implementation of control policies for jumping and in-air-stabilization of a Jumping Quadruped in Mars Gravity

Abstract: Over the last decade, satellites, telescopes, landers, and wheeled rovers have been the main form of space exploration. As the field of legged robotics has developed and matured significantly in recent years, we now see the opportunity to explore more diverse and interesting terrain in space using specialized quadruped robots optimized for challenging off-world planetary environments, such as craters, caves, and lava tubes. Legged robots, such as the Boston Dynamics Spot and the ANYbotics ANYmal, present a set of advantages in mobility and versatility in complex environments over traditional wheeled robots and rovers. Jumping legged robots may be able to traverse the geometrically complex subterranean voids of lava tubes on planets such as Mars. A jumping legged robot for Martian surface and lava tube exploration will retain the key advantages of quadruped systems in overcoming rough terrain, while also being able to coordinate its actuators and exploit the low gravity environment of Mars and compliant leg designs to jump for significant height and thus overcome large obstacles. This project thesis aims to contribute to the modeling, control, and simulation of such a jumping legged robot that is currently being built and tested by our team at NTNU. The main goal of the project thesis is to study, develop and implement classical and newer methods to enable the robot to perform mid-air stabilization using its legs, jumping, and walking. This continues the work of previous master students with similar topic.





Tasks:

- Study and understand classical problem formulations, terminologies, and common methods.
- Study and understand the work on the split task of reorientation and jumping.
- Setup the simulation environment with simulated gravity and simplified robot.
- Use the exiting robot design to create a simplified model and start setting up the learning pipeline.
- Train the control policy and evaluate/improve the performance in simulation environment.
- Implement the control policy on a real robot.

Literature (indicative):

[1] Work done by previous students on this project: https://www.youtube.com/watch?v=HiSdlfyblaM and https://olympus-rl.github.io/
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[14] xRelevant project: https://www.spacehopper.ethz.ch/

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