Dynamics of frog-inspired jumping robot

Over the years, significant progress has been made in the field of legged jumping robots, inspired by the dexterous movement patterns that organisms have evolved over millions of years. By applying the principles of bionics, engineers are trying to replicate the agile and adaptive movements of frogs into robot designs. These robots are particularly beneficial for tasks that span obstacles, work in hazardous environments, or in low-gravity conditions such as space, where they can navigate autonomously using their mobility.

Frogs are excellent models for this work because of their strong land jumping abilities and underwater swimming skills, and despite their complex biological structure, they are of great study value. The challenge is to design robots that can effectively mimic these functions, which has led to a split in research focus between frog-inspired jumping robots and swimming robots. Our team's project is interested in frog-inspired jumping robots, and we plan to build a more in-depth dynamic model and discuss its jumping process.

In this study, a simplified robot mechanism model is constructed, and the position, velocity and acceleration equations of the robot in the jumping stage are derived by using the D-H method. Then, based on the Lagrange method of multi-rigid-body dynamics, we formulate the dynamic equation of the robot in the take-off stage. Numerical solutions to the Lagrange equation are obtained through MATLAB, revealing the joint angle variation pattern, motion trajectory of the center of mass, and the velocity of the center of mass during the robot's take-off stage. The entire motion process is comprehensively illustrated by generating a trajectory diagram using Python, providing a holistic representation of the research findings.

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