

Raptor 2: Design of fast biped robot for 3D environments using active tail stabilization

Jinyi Lee¹, Jongwon Park², Jinwoo Lee³, Kyung-Soo Kim⁴ and Soohyun Kim⁵
^{1,2,4,5}Department of Mechanical Engineering, KAIST, Daejeon, Republic of Korea
²Korea Atomic Energy Research Institute, Daejeon, Republic of Korea
(¹jylee87, ⁵soohyun @kaist.ac.kr)

1. Motivation

Legged robots will need to be fast, robust and efficient for real world applications.

In this research, we aim to design a high speed bipedal running robot on 3D environments based on active tail stabilization method, Raptor 2 robot.

2. State of the Art

Many legged robots have been studied and developed so far, but only a few robots have achieved stable fast legged locomotion. In Legged locomotion, usually leg actuators should satisfy highly coupled two control objectives (leg configuration and body balance simultaneously)[1][2]. It aggravate legged robot performance (computation load, complicated structure, etc.). The FastRunner is a biped robot consist of under actuated linkage legs and tendon networks passively. It achieved a running speed of 35.4 km/h in simulation [3]. However the FastRunner robot is not proper for 3D uneven dynamic situations. Animals use their tails as dynamic stabilizers to improve locomotive performance [3]. Thus, active tail stabilizer in animal can be an effective solution for maintaining legged robot balance. The MIT Cheetah robot has a tail to reject disturbances [4]. However, this long tail design is limited in stroke such that balance controllability is restrained.

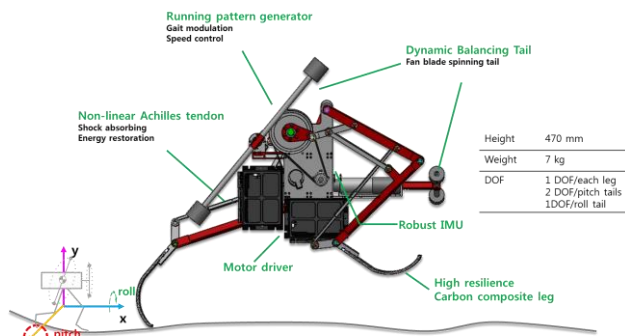


Figure 1 The solid model of the Raptor 2 robot

3. Own Approach

For fast running, hardware of the robotic leg should be light weight and have low moment of inertia. We developed under-actuated nine-bar linkage structure which is driven by a single actuator on the basis of the Raptor robot [5][6]. To reduce rolling moment by touch down impact, hip angle is leaned 9 degree/each leg, which make toes gather.

Despite recent advances in robot control technologies, the realization of agile dynamic movement still remains as difficult problem, because legged robot should satisfy the two control problems. A tail-actuated control method is

effective solution which can stabilize the body orientation. The principle of balancing the body angle by an active tail is angular momentum conservation. We investigate and suggest a novel fan blade spinning tail so as not to lose controllability due to motor speed saturation or limited stroke. The proposed tail stabilizer is designed to be actuated in roll and pitch direction.

4. Current Results

We verified the effectiveness of the proposed light weight robot design using static and dynamic simulation. The proposed active tail stabilizer was analyzed and verified 2D Pitch balancing effect motion. In this results, we are convinced that the proposed mechanism and robot design are suitable for dynamic running of Raptor 2 robot on 3D environments.

5. Best Possible Outcome

The proposed active tail stabilizer and light weight robust leg structure is the basis of a stable 3D running. Also we will apply optimized gait pattern algorithm and the least cost balance control. Optimized balance and gait controller will make the robot run fast on uneven terrain successfully.

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