

Design and Locomotion Analysis of a Novel Cube Mechanism with Probabilistic Rolling

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This paper proposes a novel cube mechanism that is capable of probabilistic rolling locomotion. The mechanism composes of 8 vertex modules and 12 links, as shown in figure 1. And the projection diagram of kinematics analysis is also shown in figure 1.

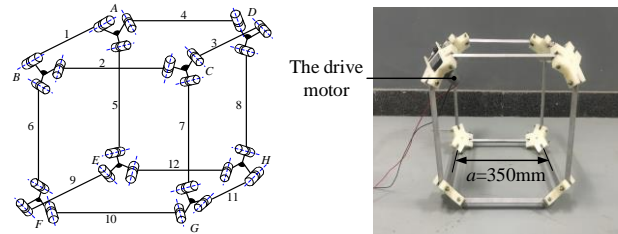


Figure 1. The schematic diagram and prototype of the mechanism

As the mechanism is symmetrical, it is projected to the xOz plane. Then, the mechanism is equivalent to a planar 6-bar linkage for analysis. When the drive motor is controlled to run, the planar 6-bar linkage is deformed into the shape shown in figure 2. At this moment, the planar 6-bar linkage lands on only point O . So, it will rotate around point O . There two probable locomotion directions (clockwise and counterclockwise). This stochastic process accords with Bernoulli experiment in ideal condition.

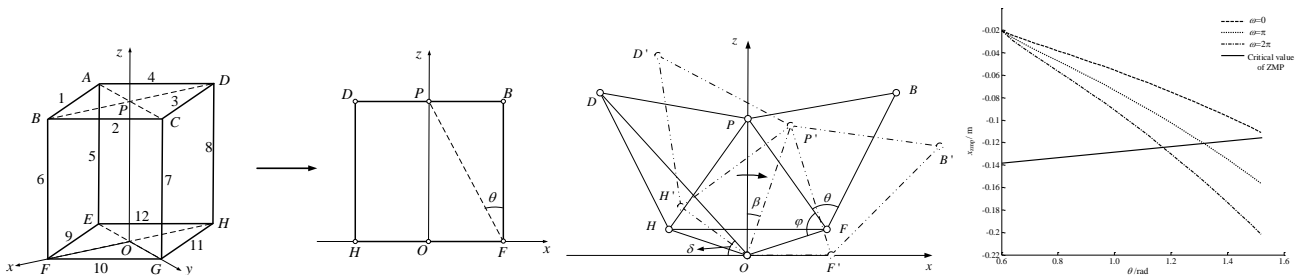


Figure 2. The projection diagram, kinematics model and the curve of $XZMP$

The rolling simulation of a locomotion cycle is done and the result is shown in figure 3. There are two probable directions in each rolling gait. The rolling locomotion can be realized with alternate two types of gaits which are advancing gait and turning gait.

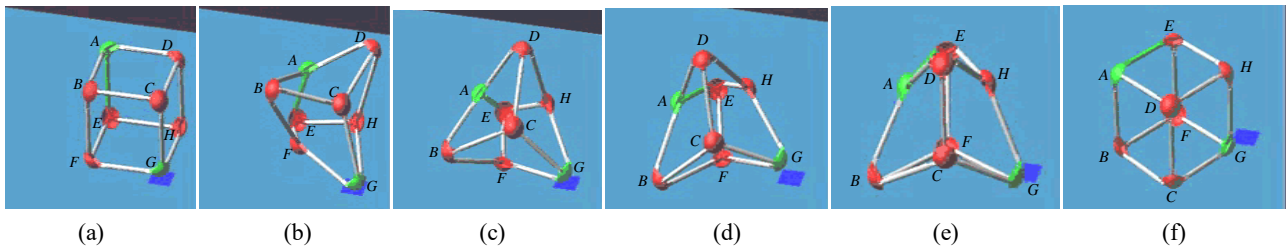


Figure 3. The rolling simulation

(a) the starting position; (b)-(c) the advancing gait; (d)-(e) the turning gait; (f) the ending position

Then, a prototype is made and the tests are carried out to verify the locomotion function of the mechanism, as shown in figure 4 and figure 5.

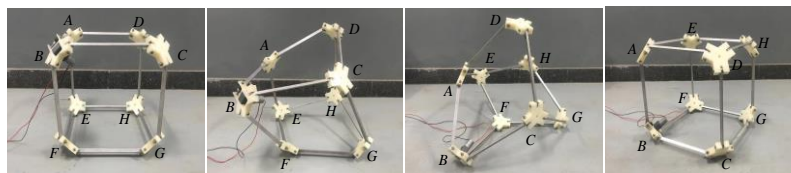


Figure 4. The rolling test of a locomotion cycle

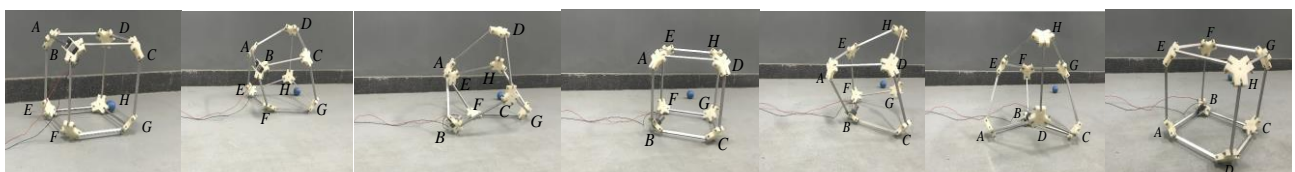


Figure 5. The rolling test of two locomotion cycles