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Path Planning for Rolling Locomotion of Polyhedral Tensegrity Robots

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Abstract

Tensegrity structure is a great candidate for robots due to its light-weight, deformability and mobility. Previous researches have verified the feasibility of locomotive robots based on tensegrity systems [1, 2]. To realize long distance locomotion for tensegrity robots, path planning is usually needed. However, the path planning of locomotive tensegrity robots has not been studied yet. This paper proposes a path planning approach for rolling locomotion polyhedral tensegrity robots. A typical six-bar icosahedral tensegrity robot as shown in Figure 1 is considered. It has 8 closed equilateral triangles and 12 open isosceles triangles on its surface. The tensegrity robot can stand stably on ground with one of the triangles as its base of support. The rolling of the system is achieved by transferring its supporting base between a close triangle and an open triangle. By expanding the surface of the tensegrity robot, the law of the locomotion can be identified. The expanded triangles constitute the possible position map of the tensegrity robot as shown in Figure 2. If the position of the robot is represented by the center of its base triangle, the possible locomoting paths of it form a pattern as shown by the orange lines in Figure 2. The possible path can be described by a function G = (V, E, D), where V is the points representing the position of the tensegrity robot; E is the connectivities of the points; and D is the distribution of obstacles. Given the start point, target point and the function G, an optimal path considering both distance and terrain characteristics can be found by Dijkstra algorithm. Typical examples are carried out with a prototype of the six-bar tensegrity robot. The proposed approach is verified experimentally. A typical numerical result of the path planning and corresponding experimental result are shown in Figure 3 and Figure 4, respectively. The approach proposed in this paper can be extended to tensegrity robots with polyhedral configuration and rolling locomotion gait.

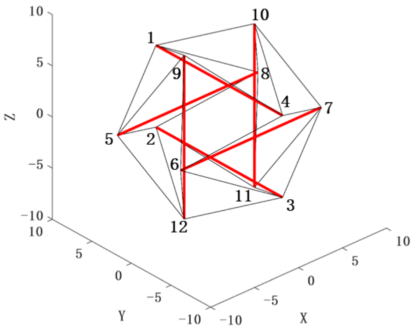

Figure 1

Six-bar icosahedral tensegrity

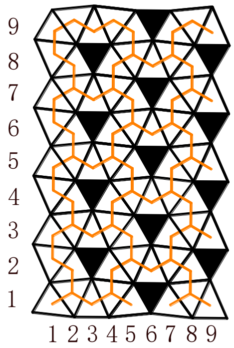

Figure 2

Position and path

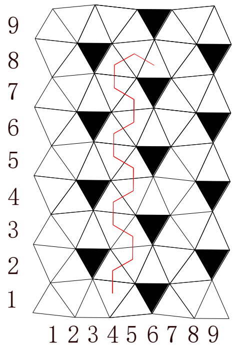

Figure 3

Numerical result

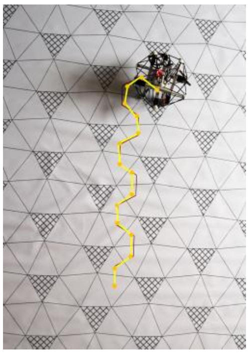

Figure 4

Experimental result

References

[1] K. Kim et al., Rapid Prototyping Design and Control of Tensegrity Soft Robot for Locomotion (2014 Ieee International Conference on Robotics and Biomimetics Ieee-Robio 2014). 2014, pp. 7-14.

[2] A. Luo and H. Liu, "Analysis for Feasibility of the Method for Bars Driving the Ball Tensegrity Robot," Journal of Mechanisms and Robotics-Transactions of the Asme, vol. 9, no. 5, Oct 2017, Art. no. 051010.