Single-DOF multi-mode mechanisms constructed by plane-symmetric four-bar spherical linkage and orthogonal Bricard linkage

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SINGLE-DOF MULTI-MODE MECHANISMS CONSTRUCTED BY PLANE-SYMMETRIC FOUR-BAR SPHERICAL LINKAGE AND ORTHOGONAL BRICARD LINKAGE

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1. INTRODUCTION

Reconfigurable mechanisms have attracted great interest in the field of mechanisms in recent years, mainly including multiple motion modes mechanisms [1], metamorphic mechanisms [2], kinematotropic mechanisms [3] or variable-DOF mechanisms[4], variable topologies mechanisms [5], discontinuously movable mechanisms [6], and so on. There are lots of single-loop mechanisms with multiple motion modes [4, 7, 8] were proposed while few research focused on multi-loop mechanisms with multiple motion modes [9, 10]. In this paper, we propose a type synthesis method to construct a multi-mode double-loop linkage, which is further used with the orthogonal Bricard linkage to construct a 1-DOF multi-mode multi-loop mechanism.

2. A DOUBLE-LOOP LINKAGE WITH MULTIPLE MOTION MODES CONSTRUCTED BY PLANE-SYMMETRIC SPHERICAL FOUR-BAR LINKAGE

Like the construction of Waldron's hybrid 6R linkages [11], a 1-DOF double-loop linkage is constructed by merging two plane-symmetric spherical four-bar linkages 1234 and 3567 such that they share joint R3 and links 235 and 347, as illustrated in Fig. 1(a). This 1- degree-of-freedom (DOF) double-loop linkage is in fact a double-loop 7R linkage with four binary links and two ternary links. Based on the motion mode analysis method proposed in [4, 8] or by observation, we can find that the double-loop linkage has four 1-DOF motion modes (Fig. 1(b)-(e)), among which the mechanism can switch through one transition configuration (Fig. 1(f)). In the transition configuration, all the R joint axes are coplanar, and the instantaneous DOF of the mechanism is 3.

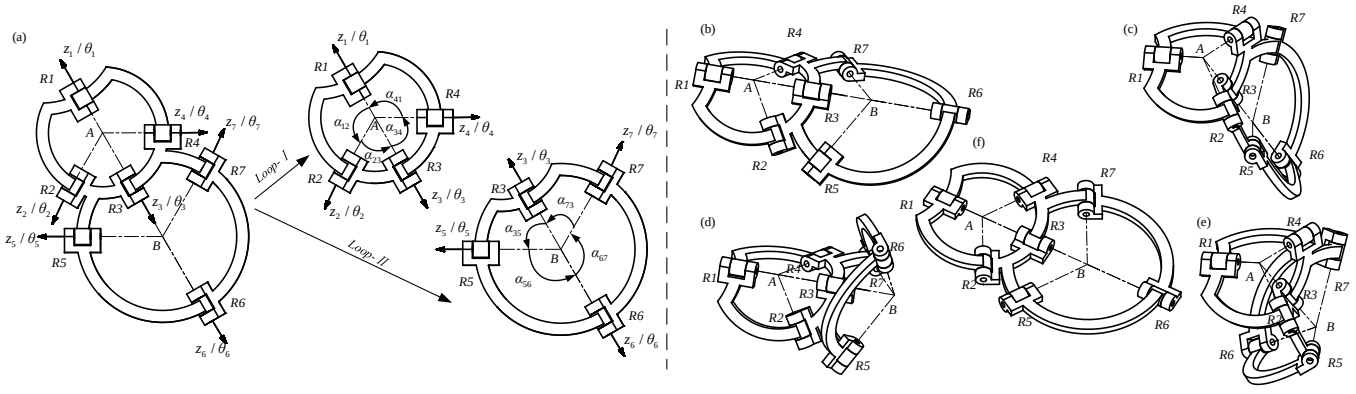

Figure. 1 A multi-mode double-loop linkage: (a) Construction of the double-loop linkage; (b) Motion mode 1; (c) Motion mode 2. (d) Motion mode 3; (e) Motion mode 4; (f) The transition configuration.

3. A 1-DOF MULTI-MODE MULTI-LOOP MECHANISM BASED ON THE DOUBLE-LOOP LINKAGE AND ORTHOGONAL BRICARD LINKAGE

The 1-DOF double-loop linkage is a multi-mode mechanism with four single-DOF motion modes. Using the same construction method mentioned in Section 2, a 1-DOF multi-mode multi-loop mechanism can be constructed with three double-loop linkages and one orthogonal Bricard linkage, which is shown in Fig. 2. It is readily to observe that the singularity occurs when all the

joint axes of the multi-loop mechanism are coplanar except the joint axes R2, R4 and R6, which is the unique transition configuration for the multi-loop mechanism to switch among motion modes. Since each of the double-loop linkages in the multi-loop mechanism can switch to any motion modes in the transition configuration, the multi-loop mechanism exhibits 64 =4^3) single-DOF motion modes resulting from the combination of motion modes of the three double-loop linkages. The four single-DOF motion modes of the multi-loop mechanism with three-fold symmetric properties are illustrated in Fig. 2 (b)-(e).

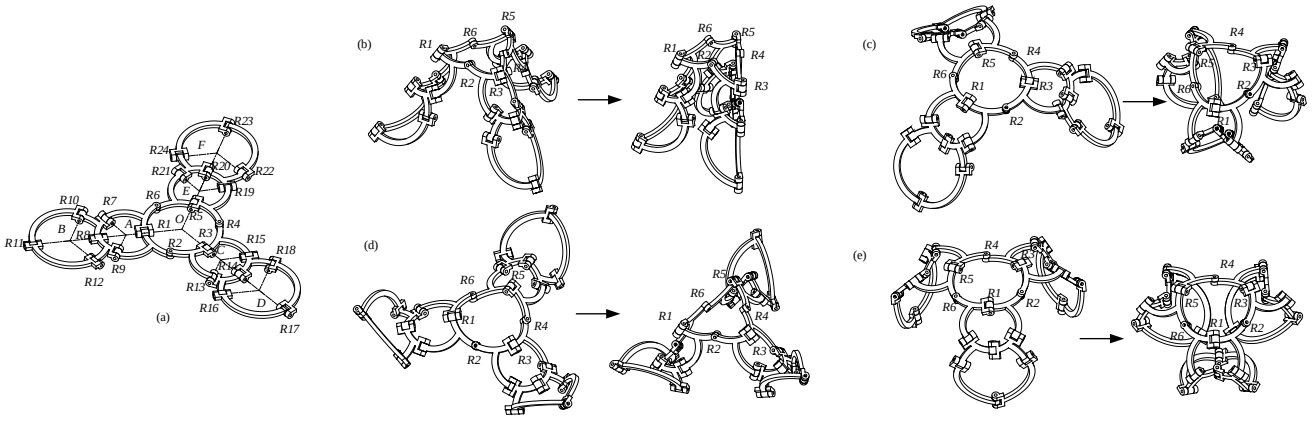

Figure. 2 Single-DOF multi-loop mechanism in: (a) a transition configuration; (b) prism deployment motion mode; (c) grasping motion mode 1; (d) grasping motion mode 2; and (e) grasping motion mode 3.

4. CONCLUSION

A construction method has been proposed to construct a 1-DOF multi-mode double-loop linkage and 1-DOF multi-mode multi-loop mechanism. The proposed 1-DOF double-loop linkage has four single-DOF motion modes, which can be transited among each other through one transition configuration. A 1-DOF multi-mode multi-loop mechanism has been constructed with three double-loop linkages and one orthogonal Bricard linkage. Several motion modes of the multi-loop mechanism exhibit good symmetric properties, which can be used for grasping, and deploying.

The above construction method complements the existing the construction approaches and can be used to design more multi-mode multi-loop mechanisms using different multi-mode single-loop linkages, providing a new avenue for the design of mechanisms with multiple motion modes.

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