Design of Mechanism using Optimization According to Task

In the field of robotics, most of the studies focus on how to control the given mechanism to accomplish the target task. However, many tasks can be simplified or solved by preparing specified mechanism without sophisticated control method. Therefore, we are studying the methodology to derive the appropriate mechanism for a given task by calculation from the viewpoint of kinematics.

One of the outcomes of this study is the methodology to constrain the motion of a pair of revolute joints by a wire to generate the coordinated motion. We proposed the method to derive the shape of non-circular pulleys, which decides the route the wire, pass through, to realize the target coordinated motion of the joints [1]. An example of the applications designed by the proposed method is the leg mechanism of the robot, as shown in Fig. 1. This leg mechanism can move forward supporting its weight by the constraint on joints without controlling joints.

We also have proposed the methodology to decide the displacements of joints according to the task. We proposed the optimization method to decide the joint displacements of a manipulator that realizes the given target trajectory of its end-effector with less number of joints [2]. In the proposed method, the calculation of the errors between the target trajectory and resultant trajectory generated by design using the differential inverse kinematics realize the optimization with small calculation cost. Fig. 2 shows the manipulator, which we designed using the proposed method, can draw a letter on an egg-shaped object. This manipulator can draw the target letter on the curved shape only with three joints.

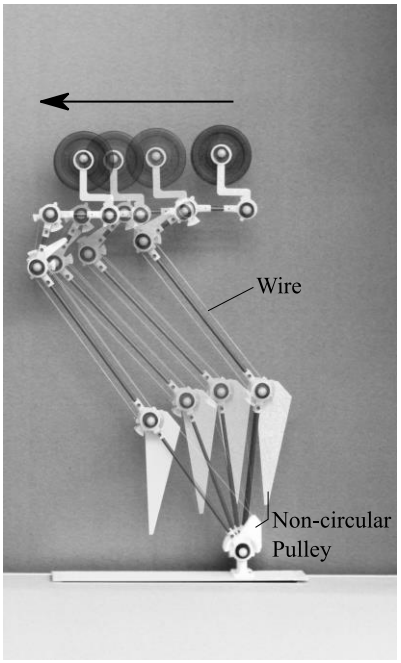

Figure 1. Constraints of the joints on the robotics leg using wires and non-circular pulleys.

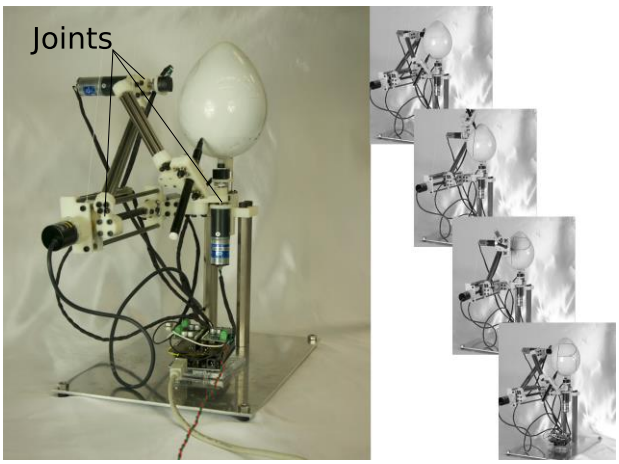

Figure 2. Mechanism to draw a letter on an egg-shaped object with less numbers of joints.

Keywords: robot design, optimization, kinematic synthesis, wire, non-circular pulley

References:

[1] Shouhei Shirafuji, Shuhei Ikemoto, and Koh Hosoda: "Designing Non-circular Pulleys to Realize Target Motion between Two Joints," IEEE/ASME Transactions on Mechatronics, vol.22 no.1, pp.487-497, 2016.

[2] Shouhei Shiarafuji and Jun Ota: "Kinematic Synthesis of a Serial Robotic Manipulator by Using Generalized Differential Inverse Kinematics," IEEE Transactions on Robotics, vol.35 no.4, pp.1047-1054, 2019.