Exploration of the Design, Dynamics and Control of Self-Decoupled, Cable-Driven Serial Robots

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Motivation

- Motion coupling is a major challenge in cable-driven serial robots, as the movement of the cables that drive the upper joints can affect the motion of the lower joints.
- Existing decoupling method includes software compensation and mechanism compensation. The software compensation methods can increase the computational burden to the control system, and current mechanism compensation method may increase the size of robot or the complexity of the cable routing.
- There is lack of research on the unique dynamics of cable driven-serial robot, and suitable control systems are also urgently needed.

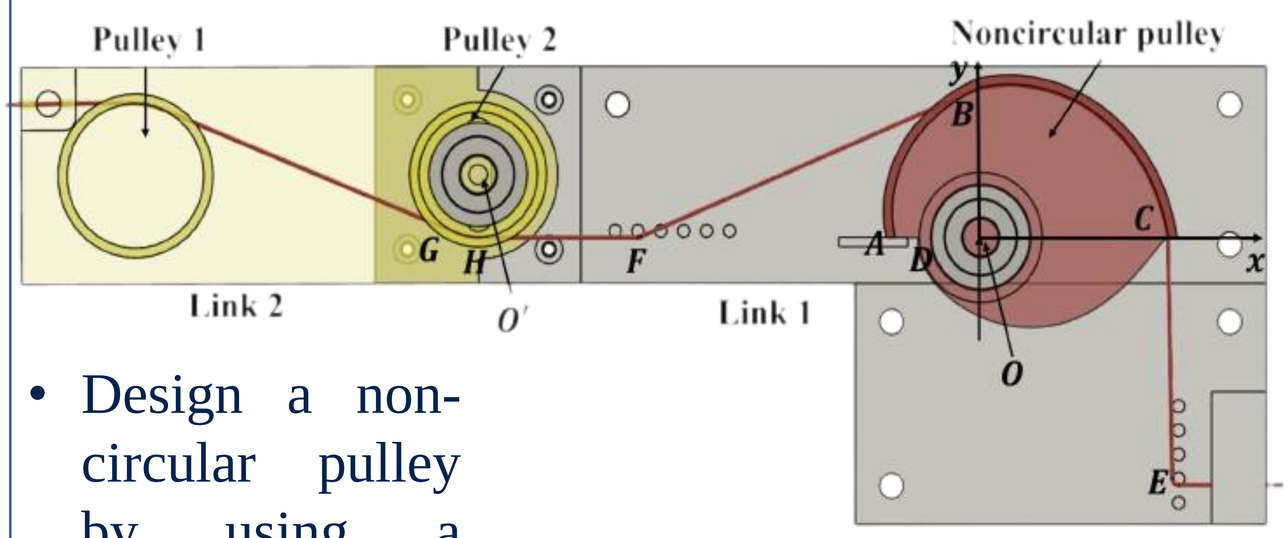
Objective

- Realize self-decoupling by coupling one passive Degree of freedom (DOF) on each joint, while maintaining a compact structure of robot.
- Analyze the dynamics of the cable-driven serial robots and build a suitable controller based on the modeling of the dynamics.

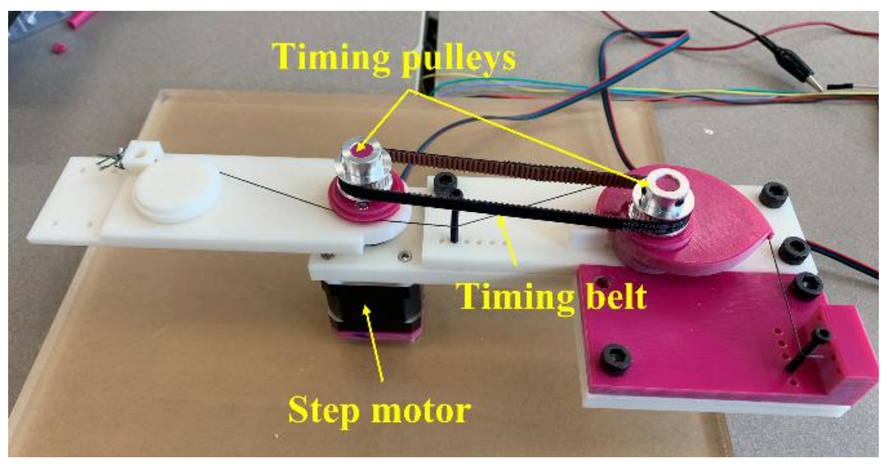
Broader impact

- It generated an instructive principle to overcome the critical challenges in decoupling the motion of cable-driven serial robots, expanding the serial robotic application in broad engineering and scientific areas.
- One high school student and two graduate students participateed in the project for engineering skill preparation.

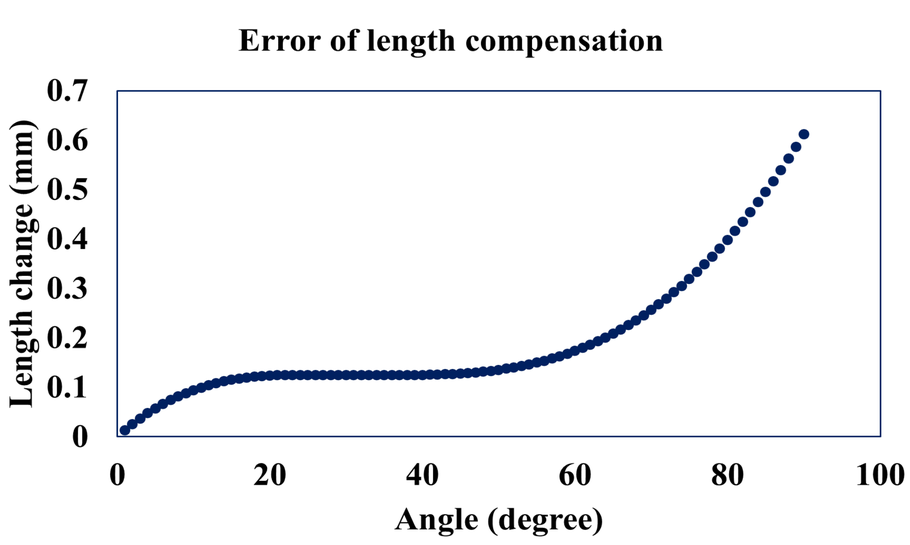
Method

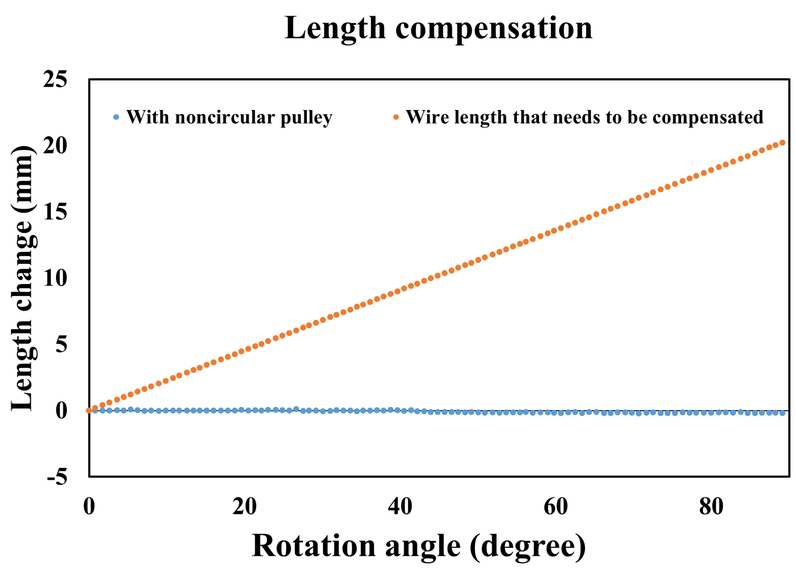


- Design a non-circular pulley by using a numerical analysis.
- Couple it as a passive DOF with the active joint .



Results





- Decoupled robotic links are designed based on a noncircular pulley.
- The experiment shows that coupling a noncircular pulley can compensate for length change with very small errors, demonstrating a motion decoupling.

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