Design of a Monolithic Compliant Swimming Robot

Abstract

Compliant mechanisms use the flexibility of their members to transfer an input displacement, force or torque to another point on the mechanism through the large deformation of its flexible links or joints. Fewer number of links, no friction, no backlash and simple design are the most important features that make them an ideal candidate when light weight, low cost and high performance are desired. The only challenge while designing a compliant mechanism is deriving the equations of motion as flexible links or flexure hinges go under large deformation.

We designed a monolithic compliant swimming robot consists of a dc motor, flexible links, rigid crank, ball bearing and a base. The crank is connected to the motor using the ball bearing. The tail is designed as a lumped compliant mechanism in which the elastic deformation concentrates more on the flexure hinges to mimic the fish tail. As the motor is actuated and crank starts rotating, the flexible link attached to the crank actuates the rigid link. Rigid link is also coupled with flexure hinges to restrict its motion to tail back and forth in the water. Mechanism cad model is created, and motion analysis are performed both in Solidworks and Adams View. The entire mechanism is 3D printed using PETG filament and preliminary results are obtained from experimental testing. It's been observed that mechanism successfully swims in the forward direction through the deformation of the flexible links and tail. The next steps will be the investigation of other actuation methods such as magnets or shape memory alloy wires and control of motion using Arduino nano so that the swimming robot will follow a desired trajectory.