Compliant Mechanism Research and Design

ME 297 Research Project

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I. Abstract

The basis of this project was to model, design, and test several planar compliant mechanisms aimed at amplifying the input mechanical motion. Such compliant mechanisms use flexure hinges (which are slender, flexible portions that bend and enable relative rotation of two adjacent rigid links) instead of classical joints. The goal was to design and test several models to generate a compliant mechanism producing the greatest amount of amplification as possible while remaining within the limitations of the material that was chosen for the physical testing. Another design objective was to achieve a dual-symmetry output which was parallel to the input. Major differences between the different models chosen for physical testing are focused on the flexure geometry because of the wide range of output variations produced by minor changes in the flexures. ANSYS fininte element analysis software was utilized for the design analysis of several different models, but one basic design with the aforementioned geometric variations proved to generate the best results for the desired objective. The fabrication, done by wire electric discharge machining (EDM), of the final designs was in progress at the writing of this report; therefore, the physical testing and comparison between experimental results and theoretical data will be completed at a later time.

II. Introduction

The intention of this research project was to study a class of compliant planar mechanisms designed to substantially amplify the mechanical motion at the input ports, and alter the design parameters as necessary to produce maximum displacement amplification. The output amplification was to be achieved through a design objective of implementing two stages of displacement amplification which will produce a motion that is fully parallel to the input motion. Compliant mechanisms use flexible portions, generally known as flexure hinges, instead of classical rotation and translation joints; their elastic deformations – usually of bending or torsion – enable the relative motion between rigid links. Compliant mechanisms have advantages such as compactness, no assembly (because the adjacent links are monolithic), no maintenance, no friction losses, and precise motion. The basic design objective is schematically represented in Figure 1 which is shown below.

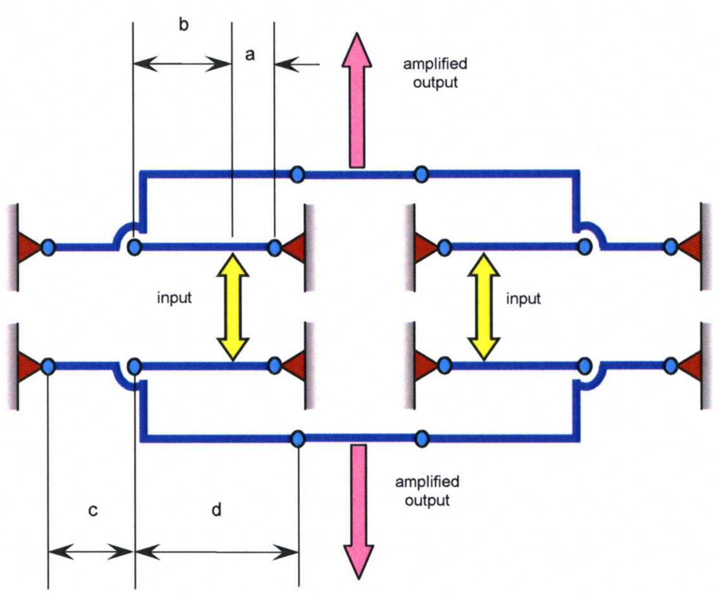

Figure 1. Double-symmetry uni-directional motion-amplification mechanism