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Design, Analysis and Modeling of XY Flexure Mechanism with Compliant Mechanical Amplifier-A Short Review

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ABSTRACT

In precision engineering flexural mechanism are widely used because of their advantages such as friction free and wear free motion, high precision, high reliability. The flexure mechanism is a mechanism which gives motion due to elastic deformation of the beam used to build it. Piezoelectric actuators are used to apply input force/displacement in flexural mechanism. They have limitations such as low range of motion. Hence there is need of amplifying the input force/displacement. When we combine piezoelectric actuator with mechanical displacement amplifier we can achieve high range of motion. This paper deals with design and analysis of XY flexural mechanism with compliant mechanical amplifier.

Keywords— Text mining, categorize data, Web content classification, Naïve Bayes classifier.

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I. INTRODUCTION

Flexure mechanism is widely used in precision engineering. The operation of flexure mechanism is based on elasticity of material. The motion is generated because of molecular deformation on the application of force hence the motion produced is friction and wear free. Flexure mechanism offers low stiffness in direction of DOF and high stiffness in direction of DOC as shown in below fig.

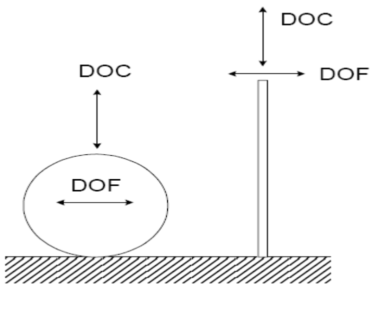

Fig.1 Example of typical constraint element

Piezoelectric (PZT) actuators are commonly used to apply force/displacement in XY flexure stage. The disadvantage of PZT actuators is their relatively short motion range and hence the XY flexure stage also possesses small range of motion. So it is desirable to amplify the output of actuator. Most of the amplifiers used in precision engineering are fully compliant. They achieve their motion due to deformation of their parts instead of rigid body joint used in conventional amplifier. Compliant amplifier based on flexure hinges offerslarge displacement compare to beam flexure.

II.LITERATURE REVIEW

Yangmin Li et al. [1] presents modeling andevaluation of XY micromanipulator for application in micro-positioning stage.Mathematical model of XY stage based on pseudo rigid body simplification and lumped model method for kinematics and dynamics of stage is derived. Nonlinear modeling and relation between input fore and output motion is also discussed. The micromanipulator discussed in this paper has monolithic structure and based on circular flexure hinge. Mathematical results are compared with Finite Element Analysis and experimental results.

QingsongXu et al. [2] discussed analytical modeling to find amplification ratio which is based on Euler-Bernoulli theory.

Mathematical expression to find amplifier's input stiffness and frequency also presented. Amplifier studied is based on compliant bridge type mechanism which uses circular flexure hinge. Byusing particle swarm optimization (PSO) method the design of amplifier is optimized. With the help of experimental results analytical and Finite Element Analysis results are validated. The prototype produced has an output displacement of 1mm.

Jinglong Chen et al.[3]presents rhombic micro-displacement amplifier (RMDA) for piezoelectric actuator (PA). The geometric amplification relations are analyzed and linear model is built to analyze the mechanical and electrical properties of this amplifier. Next, the accurate modeling method of amplifier is studied for important application of precise servo control. The classical Preisach model (CPM) is generally implemented using a numerical technique based on the first-order reversal curves (FORC).

J. Li et al. [4] presents amicromechanical amplifier with large displacement- ratio and self-limited output as a result of bifurcation effect. The large output displacement is achieved by amplifying a small input motion through the elastic deformation of the compliant configuration, which realizes the self-limited output by bifurcation effect. The displacement ratio found is 54.2. Output displacement achieved is maintained constant due to bifurcation effect.

C. F. Lin and C. J. Shih [5] present topology optimization for mechanical compliant amplifier used in MEMS. Topology synthesis approach can generate a creative initial optimized configuration and can generate approximately well locations of hinges. It is particularly useful to form a monolithic compliant mechanism in MEMS application. However, the formation of hinges-like portion istypically encountered as a major unsolved problem. An approach using the analyticsingle-axis flexure hinge integrated with the formal optimization as a post-design process to obtainoptimum flexure hinges and its location for promoting the overall performance is proposed in this paper.

Xiao-Ping S. Su et al. [6] presents design theory and synthesis of compliant microleverage mechanisms for single-stage andmultistage microlevers.A compliant microleverage mechanism can be used as a mechanical amplifier in micro-electro-mechanical systems (MEMS) to transfer an input to output for achieving mechanical or geometric advantages, such as amplifying force or displacement.The analysis of a single-stage micro leverage mechanism is presented as the building block for the multistage micro leverage mechanisms.

Matthew B. Parkinson et al.[7] proposes a device topology based on a four-link mechanism with compliant segments in place of rigid hinges.Finite-element analysis and optimization were used to develop a Pare to set of solutions quantifying the force/displacement trade-off for a variety of loading conditions.Depending on these conditions, the proposed device is capable of multiplying force inputs by 23.7and displacement inputs by588.

Hong-Wen Maa et al.[8] presents kinematic theory to analyze the displacement amplification ratio of a bridge-type flexure hinge and concluded the flexure hinge as a pure multi-rigid body with ideal pivots. Elastic beam theory was used to analyze the theoretical displacement amplification ratiowhile considering the translational and rotational stiffness of the flexure pivots. The model of theoretical displacement amplification ratio explainswhy the bridge-type displacement amplification mechanism has high amplification ratio.

ShoryaAwtar [9] presents mathematical modeling of several XY flexure mechanism having large range of motion and low parasitic error. The modeling of XY flexure mechanism is based on characteristics of building blocks used to build it. Comparison of linear and non-linear closed form analysis is presented in this paper. At last analytical results are compared with results of FEA and experiment.

III.CONCLUSION

Based on the available literature it is found that flexure based mechanisms are extensively used in micro and nano engineering. Piezoelectric (PZT) actuators are used to apply force/displacement in XY flexure stage. Compliant mechanical amplifiers are used to amplify the input of XY flexure stage applied by piezoelectric actuators. The lot of research was done on the flexure mechanisms and compliant mechanical amplifier but it is separately. Future work is aimed at producing XY flexure stage with compliant mechanical amplifier which is based on circular flexure hinge.

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