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Modeling and Design Analysis of XY Flexure Stage Mechanism

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***Abstract*— In micro-electro-mechanical system (MEMS) flexural mechanisms are commonly used because of their advantages such as frictionless and wear less motion and high precision. Flexures depend on material elasticity for their functionality. In flexure mechanism motion is generated due to elastic deformation of the beam from which it is made. One of the typical advantages of flexural mechanism is to gain precise deformation and flexibility to obtain motion in desired direction. This paper deals with Literature review of various paper based on XY stage mechanism. The XY positioning stage presented has monolithic structure and it is made from single piece of material with DFM.**

***Keywords*— DFM**

INTRODUCTION

Micro and Nano-positioning stages play a very important role in modern technology. It finds applications in many fields, such as micro machining and scanning probe such as scanning tunneling, atomic force microscopy etc. Various XY scanning mechanisms are developed which ranges from screw type to high precision recirculation ball mechanisms. The Nano-positioning system is gaining more importance and finds its application in various areas of Nano technology .XY scanners developed up till now have many limitations such as limited scanning range, limited performance characteristics, accuracy, backlash and many more. Also it is difficult to develop appropriate control system to achieve desired performance. Hence new era of mechanisms called compliant/flexural mechanisms are developed for high speed precision applications. Flexures are a compliant structure that depends on material elasticity for their functionality. Motion is generated due to deformation at the molecular level, which results in two primary characteristics of flexures – smooth motion and small range of motion

1.1. Basic Building Blocks for Flexure Stages

In designing high performance planer two-axis error-free flexure stage (mechanisms) any linear motion flexure unit, which comes close to the stated idealizations, can be used as a building block to produce a two DOF planer mechanism. There are three types of building blocks which are used to design flexure stages.

They are as listed below:

1. Simple Beam Flexure
2. Parallelogram Beam Flexure
3. Double (or compound) Parallelogram Flexure (DFM)

1.1.1 Simple Beam Flexure

A simple beam is not a very good single degree of freedom flexure unit, but due to its simplicity may use it as a building block in the mechanism. From the figure the beam tip translates (δ) as well as rotates (θ) when it experiences a force (F) as shown in Fig. 1.1. Furthermore, it also moves in X direction (ε) which is called as parasitic motion which is not desirable.

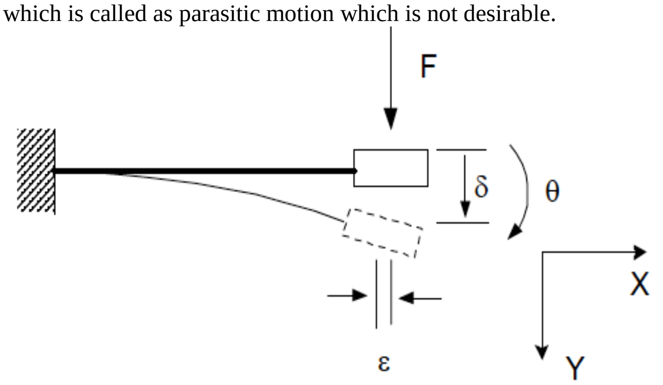

Fig. 1.1 Simple Beam Flexure

Deflection, angular rotation and parasitic error motion of cantilever beam depends on geometric parameters as well as material properties.

1.1.2 Parallelogram Beam Flexure

The parallelogram flexure unit is can be used in various flexural mechanisms. Fig. 1.2 provides a schematic of the flexure in its deformed and unreformed configurations. Beam bending analysis can be used to predict the force deformation characteristics of this flexure. On application of force in the Y direction results in the desired motion (δ), in Y direction, and also in undesired motions (ε) in the negative X direction, and rotational twist (θ). The accuracy is better but never the less undesired motions still exist. In-plane rotation of the motion sage in constrained quite well because the parallelogram flexure unit is considerably stiff in rotation.

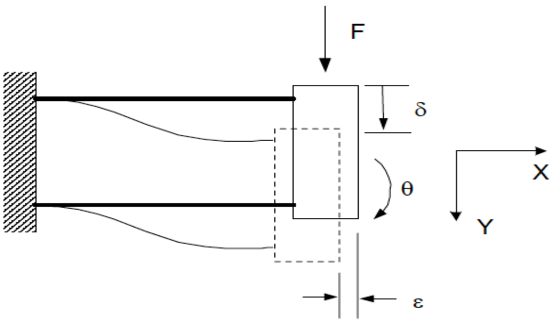

Fig. 1.2 Parallelogram Beam Flexure

It can be analytically shown that parallelogram flexure offers little resistance to relative motion in Y direction but is very stiff with respect to relative motion in X and rotation. Hence, it a much better approximation for a single DOF flexure as compared to the single beam used in the previous case.

1.1.3 Double Parallelogram Flexure (DFM)

The simple parallelogram flexure suffers from inherent motion errors due to its geometry. If used as a building block, these errors also appear in the resulting flexural mechanism, thus leading to inadequate performance measures. Instead of using a simple parallelogram flexure, if use the double parallelogram flexure unit, shown in Fig. 1.3, as the building block for two-axis planer flexural mechanisms, better overall performance can be achieved.

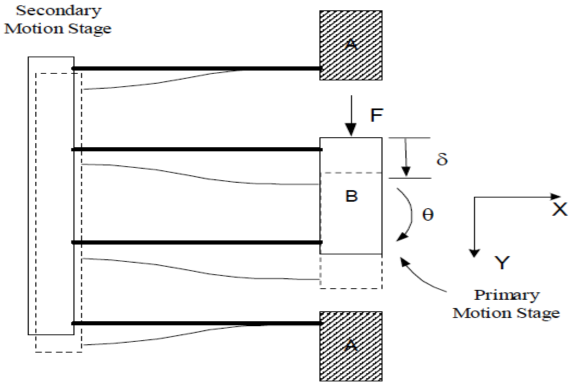

Fig. 1.3 Double Parallelogram Flexure (DFM)

It is also referred to as a compound parallelogram flexure, folded-beam flexure or crab-leg flexure. As seen from above fig DFM allows relative Y translation between bodies A and B, but is stiff in relative X displacement and rotation, although not as stiff as the parallelogram flexure. The parasitic error (ε), along X direction, is considerably smaller because any length contraction due to beam deformation is absorbed by a secondary motion stage. There exist rotational parasitic motions, which can be eliminated by appropriate location of the Y direction force. Hence, body A exhibits perfect Y-translation with respect to body B on the application of a Y direction force in the absence of X direction forces. As the parasitic error in double parallelogram flexure module is zero it can be used for designing flexure stages for precision application. for precision applications such as atomic force microscope (AFM), laser cutting, laser surgery and scanning probe microscope.

Literature review

This chapter reviews some of the past work published in the areas related to synthesis of flexure mechanisms. The various researchers have carried out research on flexure mechanisms. The literature referred belongs to journals from reputed publishers like Elsevier, IEEE etc.

Dongwoo Kang, Kihyun Kim, Dongmin Kim, Jongyoup Shim, Dae-Gab Gweon, JaehwaJeong (2009) presented the design of a compact high precision XY-scanner providing nanometer-level resolution and a millimeter-level travel range. The proposed XY-scanner is actuated with the help of voice coil motor (VCM) and double compound linear spring flexure guide mechanism. Design variables are optimized so that they satisfy the requirements of high resolution, long working range, high response speed, and compact size. To optimize design variables the sequential quadratic programming (SQP) method for optimization was used. The relationships between the design variables and the system parameters are complex hence they developed a design that provides the optimal trade off in terms of design variables. To increase the working range of XY scanner to the millimeter-level, leaf spring mechanisms having small thicknesses were used. Flexure mechanisms based on a leaf spring were modeled via the generalized computer-based method, which automatically generates equations of motion, solves them numerically, and makes it possible to simulate static and dynamic characteristics. The analytical modeling of mechanism is based on Lagrange’s equation. This project was design to maximize the first resonant frequencies of the XY-scanner to increase response speed while limiting the size of the scanner to 100 mm × 100 mm × 50 mm. Based on results of optimization, the XY-scanner was fabricated, and its performance characteristics were predicted. From the results of experimentation it was found that first resonant frequency of XY scanner was 26.68 Hz for the X-axis and 22.79 Hz for the Y-axis. The XY scanner has position resolution of 10 nm and working range of 2 mm and hence this designed scanner is successfully used in precision fields which require a nanometer-level resolution and millimeter working range [1].

Guangbo Hao(2014) presented a monolithic compact and decoupled XY CPM with minimized parasitic rotation has been proposed using the stiffness centre based approach, and modeled with comparisons with FEA. This innovative design approach makes all of the stiffness centers, associated with the passive prismatic (P) modules, overlap at a point that all of the applied input forces can go through. In addition to the performance characteristics including compact configuration, approximately kinematic static decoupling and minimized parasitic rotation, the proposed XY CPM also has a millimeter-level motion range (4 mm per bi-direction),and can well deal with the issue of actuator isolation. In comparison with the emerging monolithic XYCPMs obtained from the configuration of 4-PP kinematic ally decoupled TPM, the present XY CP Mainly has a smaller size, simpler modeling as well as smaller lost motion due to the use of only two legs. . Its load displacement and motion range equations are derived and geometrical parameters are determined for a specified motion range. Finite element analysis comparisons are also implemented to verify the analytical models with analysis of the performance characteristics including primary stiffness, cross-axis coupling, parasitic rotation, and input and output motion difference and actuator non isolation effect. Compared with the existing XY compliant parallel manipulators obtained using 4-legged mirror-symmetric constraint arrangement, the proposed XY compliant parallel manipulators based on stiffness centre approach mainly benefits from fewer legs resulting in reduced size, simpler modeling as well as smaller lost motion. Compared with existing 2-legged designs with the conventional arrangement, the present design has smaller parasitic rotation, which has been proved from the finite element analysis results. Compared with existing monolithic 2-legged designs with conventional arrangement (without stiffness centre overlapping), the present design has smaller parasitic rotation. In addition, the two-legged stacked XY CPMs with further reduced size are also presented in this paper. [2].

Jung-Jae Kim, Young-Man Choi, DahoonAhn, Beomseok Hwang, Dae-Gab Gweon, JaehwaJeong (2012) designed a mechanism for a single-axis flexure-based nano-positioning stage. A self-guided displacement amplification mechanism enables a large range of motion up to a millimeter with a compact stage size. This device has a skewed double-compound parallelogram structure that acts as a motion guide and provides displacement amplification, thereby eliminating a serial connection. Its structural symmetry improves positioning accuracy by reducing parasitic motion error and thermal deformation. A millimeter-range piezo-actuated nano-positioning stage is implemented using the self-guided displacement amplification mechanism. The stage was designed using design optimization frameworks to obtain the highest fundamental resonance frequency under constraints for predetermined travel range, stress, and size. The effectiveness of the proposed mechanism is experimentally verified. Also, we demonstrate that the fabricated stage has superior volume efficiency compared to other stages of similar size. [3].

Mei-Yung Chen, Hsuan-Han Huang, and Shao-Kang Hung (2010) presented a novel XY-dimensional sub micropositioner, including mechanism, control, and analysis. The design of the sub micropositioner utilizes a monolithic parallel flexure mechanism with built-in electromagnetic actuators and optical sensors to achieve the object of 3-DOF precise motion. This paper presents integration of electromagnetic actuator and the parallel flexure mechanism for planar positioning system, establishment of the mathematical modeling, development of an advanced adaptive sliding mode controller, and extensive experiments to test the realistic performance. Despite the features of high stiffness, thrust, and speed, lead screws suffer from lost motion, stick slip, and windup. The dry friction has been neglected in macro motion, but it is one of the most important factors limiting the performance in the precision positioning application. Therefore, to prevent the problem of such dry friction and backlash, regardless of the size of the travelling range, there are four common types of mechanisms used: in chworm like-clamping, inertial sliding/walking, flexure, and levitated mechanisms. This paper concerns the integration of the parallel flexure mechanism and electromagnetic drives with optical sensors serving as feedback sensors to achieve a high-precision positioned. Moreover, the stabilizing controller to be developed should be robust enough to tolerate these inevitable uncertainties and unmodeled dynamics. One of the methodology fields is named as adaptive sliding-mode controller (ASMC), which can perform online system identification implicitly or explicitly while tuning the controller gains to guarantee the stability of the closed-loop system [4].

NileshPawar, Dnyaneshwar Pawar, Prof.S.V.Deokar (2013) discussed the key performance attributes and challenges in XY mechanism design and new parallel kinematic XY flexure mechanism designs based on systematic and symmetric constraint arrangements are proposed. These constraint arrangements allow large primary motions and small error motions without running into over constraint problems. Flexure joints are widely used in precision-motion stages and micro robotic mechanisms due to their monolithic construction. Flexures are compliant structures that depend on material elasticity for their functionality. Motion is generated due to deformation at the molecular level, which results in two primary characteristics of flexures smooth motion with precision and high speed application. The dry friction has been neglected in macro motion, but it is one of the most important factors limiting the performance in the precision positioning application. Therefore, to prevent the problem of such dry friction and backlash, regardless of the size of the traveling flexural mechanism widely used. Analyze the forces transmitted through the flexures in the four bars and design the flexures to always point in the direction of the transmitted forces. For flexural mechanisms, it is also very important to design the flexures to never buckle under typical operating conditions. For 3D mechanisms where mobility arises from geometric constraints, it is important to analyze for the effect of misalignment and design the structure in a manner which ensures proper alignment. As a future work, heating elements will be embedded into or close to the flexures to decrease power consumption and to decrease the stiffness change response time for higher bandwidth motion control. Such active stiffness tunable flexure joints could be applied to any flexural miniature mobile robot and device [5].

Pengbo Liu, Peng Yan, and Zhen Zhang (2015) presented a two-dimensional parallel PZT-driven nano positioned with a novel mechatronicstructure of a large workspace and a high-natural frequency. The mechanical design with symmetric and parallel structures and two-stage displacement amplifiers is optimized for the purpose of ultra high-precision positioning with mechatronic requirements of large workspaces and high-bandwidth servomechanisms. The theoretical method and FEA method are both provided for the purpose of analysis and verifications of the static and dynamical properties of designed nanopositioner. FEA simulations agree very well with the theoretical analysis, with some acceptable deviations due to the deformations of the links between flexures.. The parallel kinematic X–Y flexure mechanism provides good geometric decoupling. The kinematic and dynamic analysis shows that the proposed design has a large work space and high bandwidth, which is further verified by finite-element analysis. The analysis results demonstrate that the designed nanopositioner has a large workspace more than 200mm and a high-natural frequency at about 760 Hz. Furthermore, the dynamical model of the nano positioner, including the dynamics of the PZTactuators, is also generated from the perspective of input/output transfer functions, and the parameters are identified by frequency-response experiments, which can be used for nano precision servo mechanism. Meanwhile, it indicates that the dimensional parameters of the nano positioned could be further optimized by taking the deformations into account. Experimental validations are also provided and compared with the theoretical analysis. It is worth noting that the present paper primarily aims to provide the overall mechanical design and analysis of the nano positioner. Feedback control of the nano positioning system and experimental studies will be presented in future works [6].

Prasanna S Gandhi, KaustubhSonawale, VaibhavSoni (2011) presented the assembling of flexure mechanisms as against fabricating them in monolithic fashion. The problem is looked at from the rigid body mechanism perspective and it is proposed to have DOFs to be exactly zero while determining the number of dowel pins. Two additional rules are arrived at introducing a new concept called “half joint”. The concept helps in achieving the final assembly. Physical insights into the proposed rules are developed by case study that considered assembly using and not using the proposed rules. Finally two actual mechanisms are demonstrated to be successfully assembled and tested for their working. The proposed guidelines can be useful in developing more complex flexure mechanisms in non-monolithic fashion. Flexure mechanism systems with ultra-high precision motion stages are increasingly being used for several applications including micro-measurement, micro/nano manipulation, micro fabrication, data reading, writing on CD and so on. Flexure linkages offer inherent advantages of being frictionless, highly repeatable, and having great design flexibility. Their main advantage is that they can be manufactured monolithic which is extremely crucial for micro and nano-scale applications. But Monolithic fabrications of these mechanisms limit the use of multiple materials in the system and hence become expensive especially for three dimensional mechanisms. For large range flexure mechanisms monolithic fabrication is a costlier affair. Efforts have been made by researchers to come up with assembly procedure to assemble these mechanisms without over constraining them. This paper discusses one such type of method to design and assemble various components of these mechanisms. The proposed guidelines which are based on criterion similar to Grubler’s include a very simple formulation to determine number of locating pins to be used in assembly and also their locations of these pins. A z-stage flexure mechanism was fabricated and assembled using these guidelines and found it to be working perfectly with repeated assembly and disassembly [7].

QingsongXu (2014) presented the design and development of a novel flexure parallel-kinematics precision positioning stage with a centimeter range and compact dimension. To achieve a decoupled and modular structure the stage mechanism was devised using leaf flexures. Structural parameters are carefully designed to guarantee the range, stiffness, resonant frequency, and payload capabilities in consideration of manufacturing tolerance. The parametric design is verified by conducting finite-element analysis, which reveals a reachable motion range over 20 mm in each working axis. A prototype XY stage is fabricated, which is actuated and sensed by two voice coil motors and laser displacement sensors, respectively. Experimental results demonstrate that the stage is capable of positioning with a workspace over 11 mm ×11 mm. It is more compact than existing works, which is reflected by a larger area ratio of workspace to planar dimension. Both static and dynamic tests exhibit a small crosstalk between the two axes, which indicates a well-decoupled motion property. The implemented feedback control enables a precision positioning with sub micrometer resolution and accuracy. The control band width and payload influences on stage performances are experimentally predicted [8].

QingsongXu.(2012) presented flexure-based micro positioning systems with a large workspace are attractive for a variety of precision engineering applications. In this paper, a new idea of multistage compound parallelogram flexure is proposed for the mechanism design of a novel parallel-kinematic XY micro positioning system, which has a motion range larger than 10 mm along with a compact structure. The established quantitative models and the stage performances are validated by conducting finite-element analysis (FEA) and experimental studies. Moreover, an enhanced model-predictive control (EMPC) is presented for positioning control of the system, which has a non-minimum-phase plant. It is shown that the EMPC is capable of producing a low magnitude of output tracking error by imposing an appropriate suppression on the control effort. Simulation and experimental studies reveal that the EMPC scheme outperforms the conventional proportional-integral-derivative (PID) and MPC methods in terms of transient response speed and steady state accuracy. The idea that is presented in this paper is extendable to design and control of other micro-/nano positioning systems with either minimum- or non-minimum-phase plants. The concept of MCPF that has been proposed in this paper is useful in designing a multi axis micro positioning system with both a compact size and a large workspace. A new XY micro positioning stage has been implemented for an illustration, which produces a workspace of 10.5 × 10.5 mm^2. Moreover, it owns a compact structure as reflected by the large area ratio (workspace to planar physical dimension) of 0.2407%, which is much larger than the existing parallel-kinematic XY stages driven by smart actuators. It has been found that the presented EMPC scheme is capable of improving the positioning performance in terms of settling time and steady-state error, as compared with conventional PID and MPC methods. Since the realization of the controller does not require the inverse of the plant model, it can be easily extended to both minimum and non-minimum-phase systems. Although only the leaf spring has been used in this research, the concept can be extended to the design of micro positioning systems with any other types of flexure hinges for achieving more types of motions [9].

Rachel Patil, SuhasDeshmukh, Y.P. Reddy, Kavidas Mate (2015) discussed investigation of basic building blocks of planar flexural mechanism such as single cantilever beam, parallelogram flexure and double parallelogram flexure based on various performance parameters such as deformation, stiffness, pay load capacity, parasitic error, angular rotation and cross axis coupling error etc. Planar XY Flexural Mechanisms have numerous applications in precision motion mechanisms. Flexural mechanisms generate relative motion between fixed support and motion stage using flexibility of material. This type of mechanisms offers frictionless motion, zero backlash and high order of repeatability. Flexural mechanisms consist of motion stage, flexible elements (building blocks) and fixed support. It is observed that Double Parallelogram Flexural Manipulator (DFM) offers better performance, hence experimental setup is developed using DFM. Comparison of different building blocks of flexural mechanism shows DFM offers better performance and is further experimentally validated. Also, FEA analysis of XY Flexural mechanism which uses DFM as building block is presented [10].

Rahul DevchandLakheri (2014) presented the effect of thickness, length & width variation of flexural member on static &dynamic behavior of flexural mechanism. ANSYS Software is used to create parametric model of flexural mechanism and do both static & modal analysis. Due to parametric modeling once we created model of mechanism in ANSYS & apply all constrain & load conditions. By varying dimensions of flexural member we can plot graphs of Thickness VS Deflection, stress etc. Above graphs will allow us to optimize flexural member. As both static & Modal analysis is done the results will be more effective &realistic for comparison. Ideally, it is desirable to mount the actuators for both the axes on ground, i.e., the fixed base. In this disclosure he has present a group of flexural mechanisms that are based on parallel elasto-kinematics. It is worthwhile to mention here that the motion of compliant mechanisms is not completely characterized by kinematics; it is strongly dependent on elastic deformations as well. Hence, the study of motion of flexural mechanisms is commonly referred to as elasto-kinematics. Mechanisms presented here make unique use of known flexural units and novel geometric symmetry to minimize or even completely eliminate actuator cross-sensitivity, and parasitic coupling between the two axes. In Static analysis many graph are plotted, these graph shows effect of thickness, length & width on deflection-stress characteristic. While Modal analysis section shows different mode shapes & mode frequency. And effect of thickness, length & width on deflection while flexural member executes vibrations. Thus it helps for design of Flexural member [11].

S. H. Patil, Prof. M. V. Kavade (2012) presented the designs of flexure mechanisms that can be used over a wide range of macro, meso or micro scale precision machines where decoupled multiple degrees of freedom are required. Potential applications can be found in optical instruments, Micro and Nano Electro Mechanical Systems, precision metrology; etc Parallel elasto kinematics is used for planer flexure mechanism design that results in simple and compact embodiments. Two axis (2 DOF) planer mechanism designs based on the simple beam flexure, the parallelogram flexure and the double parallelogram flexure as building blocks are presented. Novel ideas for using symmetry to increase out of plane stiffness and improve performance and robustness in design are presented. Errors due to imperfect building blocks are corrected by use of geometric symmetry. The beam flexure is an important constraint element in flexure mechanism design. Planar flexural mechanisms are best suitable candidate for high precision, high speed scanning applications .Parallel kinematic planar flexure mechanism design based on systematic constraint pattern that allow large range of motion without causing over-constraint or significant error motion are discussed in this paper. The standard parallelogram and double parallelogram flexure module are used as a constraint building block and its force displacement characteristics are employed mathematically for predicting the performance characteristics of planar flexure mechanism design. Mathematical predictions are validated by means of Finite Element Analysis [12].

Sebastian Polit and Jingyan Dong (2011) presented the design analysis fabrication and testing of a high-bandwidth piezo-driven parallel kinematic nano positioning XY stage. This monolithic stage design has two axes and each axis is composed of a doubly clamped beam and a parallelogram hybrid flexure with compliant beams and circular flexure hinges. The doubly clamped beam that is actuated by a piezoelectric actuator acts as a linear prismatic axis. The parallelogram hybrid flexures are used to decouple the actuation effect from the other axis. The mechanism design decouples the motion in the X- and Y-directions and restricts parasitic rotations in the XY plane while allowing for an increased bandwidth with linear kinematics in the operating region. Kinematic and dynamic analysis shows that the mechanical structure of the stage has decoupled motion in XY-direction while achieving high bandwidth and good linearity. The stage is actuated by piezoelectric stack actuators, and two capacitive gauges were added to the system to build a closed-loop positioning system. The results from frequency tests show that the resonant frequencies of the two vibration modes are over 8 kHz. The stage is capable of about 15 μm of motion along each axis with a resolution of about 1 nm. Due to parallel kinematic mechanism design, a uniform performance is achieved across the workspace. A PI controller is implemented for the stage and a closed-loop bandwidth of 2 kHz is obtained. A high-bandwidth piezo-driven parallel kinematic nano positioning stage was developed, which can provide high-speed high-accurate positioning in XY plane. The design, analysis, fabrication, and experimental testing were presented. The monolithic stage design has two axes and each axis is composed of a doubly clamped beam and a parallelogram hybrid flexure with compliant beams and circular flexure hinges. The mechanism design decouples the motion in the X- and Y directions and restricts parasitic rotations in the XY plane while allowing for an increased bandwidth with linear kinematics in the operating region (or workspace). FEA is adapted to verify the dynamic responses from theoretical analysis. The stage is actuated by piezoelectric stack actuators, and two capacitive gauges were added to the system to build a closed-loop positioning system. Due to PKM design, a uniform performance is achieved across the workspace. A PI controller is implemented and a closed-loop bandwidth of 2 kHz is obtained. The high-speed nano positioner is expected to address applications such as high-throughput nano scale metrology, imaging, and manufacturing [13].

Sharad S. Mulik, Suhas P. Deshmukh, Rachel Patil, Amruta P. Patil, Haresh S. Monde (2015) presented parametric analysis of flexural mechanism based on double parallelogram flexure module. DFM is used as building block for design of XY flexural mechanism. Parametric model of DFM and XY mechanism is developed using Design Modeller ANSYS. FEA analysis is carried out to determine stiffness, parasitic motion and rotation of motion stage.FEA analysis was carried out to optimize design parameters of mechanism, the performance characteristics of two mechanisms were analyzed in this paper. Mechanism 1 is supported at one end, which gives rise to vertical motion of motion stage due to self-weight. Mechanism 2 is symmetrically supported and provided a lesser or zero vertical motion. The biflex mechanism has high accuracy due to symmetric layout [14].

S. Awatar (2004) presented analytical modeling of different XY flexure mechanism having large range of motion and low parasitic error. The modeling of XY flexure mechanism is based on performance characteristics of building blocks such cantilever beam, parallelogram flexure and double parallelogram flexure used to build it. An analytical formulation incorporating geometric nonlinearities is used in deriving the characteristics of these flexure building blocks. Issues related to qualification and quantification of undesirable motions, mobility, stiffness variation within the range of motion, determination of centre of stiffness, and sensitivity to manufacturing and assembly tolerances are also discussed in this paper. Influence of symmetry in reducing error motions is analytically illustrated. Comparison of linear and non-linear closed form analysis was discussed in this paper. To verify analytical results a prototype of 300×300 mm was manufactured by using wire EDM process and tested at National Institute of Standards and Technology (NIST).The prototype flexure stage has a 5mm x 5mm range of motion, with cross-axis errors of the order of one part in one thousand, and motion stage yaw errors of the order of a few arc seconds. The double parallelogram flexure module (DFM) has zero parasitic error and it can be used in precision applications [15].

CONCLUSION

With respect to above all work following conclusion are drawn:

- In micro-electro-mechanical system (MEMS) flexural mechanisms are widely used because of their advantages such as frictionless and wear less motion and high precision. It finds applications in many fields, such as micro machining and scanning probe such as scanning tunneling, atomic force microscopy etc. Various XY scanning mechanisms are developed which ranges from screw type to high precision recirculation ball mechanisms. The Nano-positioning system is gaining more importance and finds its application in various areas of Nano technology
- It is observed that out of three flexure, double parallelogram flexure has less or zero parasitic errors so it can be use for high precision and high range devices like scanning purpose.
- Flexure is based on material elasticity property so we can choose stainless steel, aluminum and copper as a flexure material

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