

6 Degree of Freedom Tri-Stage Micro-Positioner

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Abstract

The 6-Degree of Freedom Tri-Stage Micro Positioner (6DFTSMP) can generate high accuracy, small displacement, and high-resolution motions. The moving platform of the device has six degrees (6-D) of freedom motions (translation and rotation about three orthogonal axes, X-Y-Z). The 6DFTSMP is unique because it derives its input motion from a monolithic tri-stage base plate and has struts that may have specially designed flexures. The 6DFTSMP capitalizes on the availability of inexpensive high quality planar micro-positioning stages for the control of its moving platform. Because the struts, which connect the planar micro positioning stages with the moving platform are oriented in a parallel mechanism fashion the in-plane motion of the stages is converted into a translation and rotation about three orthogonal axes. Two experimental prototypes of the 6DFTSMP have been built and various mathematical models have been developed. A micro-position and orientation measurement sensor nest was designed and built to test various calibration and performance testing methods for this type of micro-positioner.

Brief Description of the Device

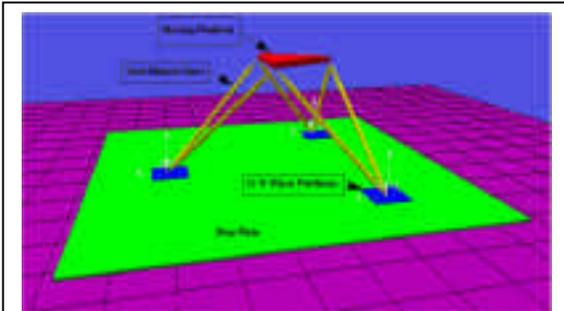


Figure 1. Schematic drawing of the 6DFTSMP

Figure 1 shows a schematic drawing of the 6DFTSMP with struts, which have flexures at both attachment points. The device consists of a base plate, six struts and a moving platform. The base plate is equipped with three X-Y micro positioning stages. Each of these stages is capable of generating motion in two orthogonal directions. The range of these motions depends on the design and size of these stages. The moving plate of

each X-Y stage supports two struts, which are firmly attached to the plate on one end and the moving platform on the other and allow motion to take place through elastic deformation of the struts and their flexures thus eliminating backlash and stiction. The moving platform is the load carrying part of the device.

The coordinates of the base plate support points of the struts form the base of the 6DFTSMP. The size and shape of the 6DFTSMP base changes, the struts deform, and the position and orientation of the moving platform changes when the moving plate of each X-Y stage moves. With proper calibration and sensors it is possible to control the position and orientation of the moving platform by commanding appropriate displacements of each X-Y stage moving plate. The three X-Y micro positioning stages are formed on the monolithic base. This simplifies the design and makes the 6DFTSMP

more compact. Also the use of a monolithic actuating base and a deformable three dimensional parallel mechanism structure eliminates backlash and stiction during motion. Because the actuation of motion takes place at the base there is no inherent limit to the size of the micro positioning stages, thus permitting a wider range of motion of the moving platform. For the same reason this design should make easier the MEMS fabrication of these devices.

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Key Words: Micro-positioner, flexures.