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Simulation the motion of a parallel micromanipulator

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Abstract:-In this work a parallel mechanical system is described that will be part of the system of aerospace exploration QUETZALCOATL.
This work presents the simulation, aided by computer, of the movement of a close loop mechanical system for positioning that we have defined as *parallel micromanipulator*. One of the innovations presented in this design consists of the application of a lever mechanism for the transmission of the movement. The term "micromanipulator" comes from the application for which it is being constructed, which consists of the manipulation of micro-components within a cell of manufacture of mechanical micro pieces. The development of this prototype of micromanipulator has been developed using the platform of computer aided design Unigraphics, in which it was done the geometric modeled of each one of the components and end assembly (CAD), the generation of files for the computer aided manufacture (CAM) of each one of the pieces and the kinematics simulation of the system evaluating different driving schemes.

Keywords: Micromanipulator, Micromechanics, system of aerospace exploration, Unigraphics, CAD, CAE.

1 Introduction

In this work a parallel mechanical system is described that will be part of the system of aerospace exploration QUETZALCOATL
In general a parallel manipulator is defined as a closed kinematics chain, which consist of separated and bonded links that they connect the fixed platform (base platform) with the movable platform (figure 1).

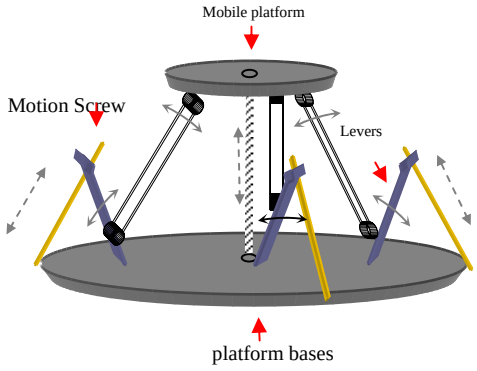


Figure 1. Preliminary design

This type of manipulator presents great advantages compared with the serials manipulators, some of them are: better stability and precision, low weight, capacity to manipulate great loads, movement at high speeds and accelerations. This type of parallel systems has a great number of applications in telemetry, astronomy, in flight simulators and the industry of machines tools, only to mention some. This work proposes a closed mechanical system, designed for its application in the Micromechanics area, specifically in tasks of micro assembly and micro machining. In the field of the micromechanics it is settled down that the term micromachine corresponds not only to the size of the device (which could be of micrometric scale) but also to the size of the components that can machining and/or manipulate [1,9]. For that reason it has been designated to this system with the name of parallel micromanipulator (figure 2).

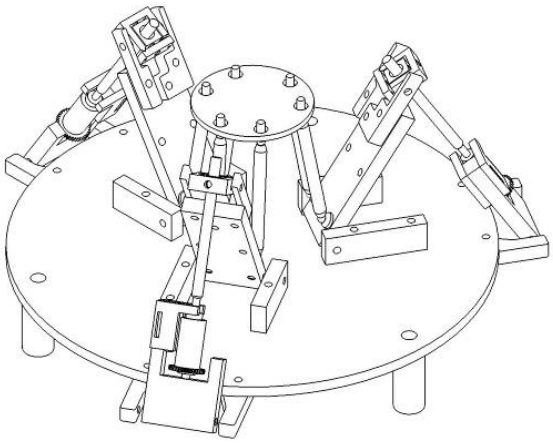


Figure 2. Isometric view of the micromanipulator

2 Micromanipulator design

This micromanipulator is compound of two platforms, one fixed and another movable, which are joined by means of three identical lever mechanisms separated 120 degrees each one, which we will denominate "arms" (figure 3). The fixed platform has a diameter of 200 millimeters and the movable platform has a diameter of 50 millimeters. Each arm is conformed by three links; the first one is a motion screw which is connected to a prismatic bar by means of a “Cardan” joint. This bar is supported in the base platform in such a way that when receiving the transmission of movement that comes from the motion screw describes an oscillating movement that is function of the sense of rotation of the screw. Finally this bar is joined to a pair of parallel cylindrical bars by means of spherical joints, these bars directly transmit the movement to the movable platform and similarly they are joined to this by means of spherical joints. The main reason to use the lever mechanism obeys to the intention to obtain a high resolution in the displacement of the movable platform.

This way by means of independent and complementary displacements of each one of the arms different displacement trajectories of the movable platform can be obtained. The configuration designed for this manipulator considers the integration of basic components for the conformation of the different subassemblies as well as for the final assembly. These components have been designed with the purpose of being able to be made of simple way and by means of the conventional processes of manufacture from common structural members like wall-plates and plates of commercial thicknesses. Similarly the assembly process of this manipulator is a simple task, because it requires the application of elements of standard union like screws and small bullets.

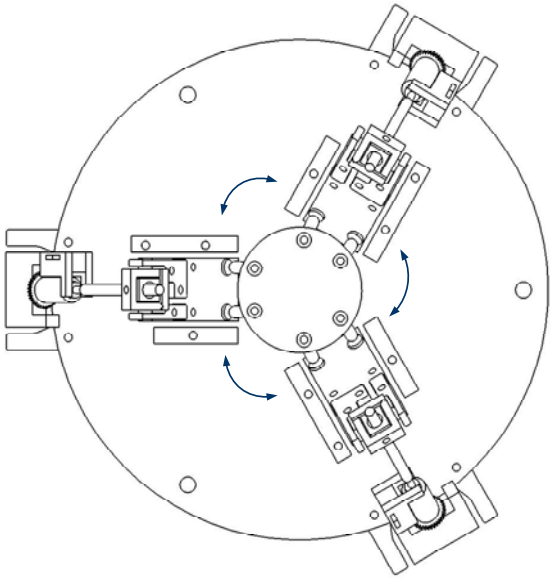
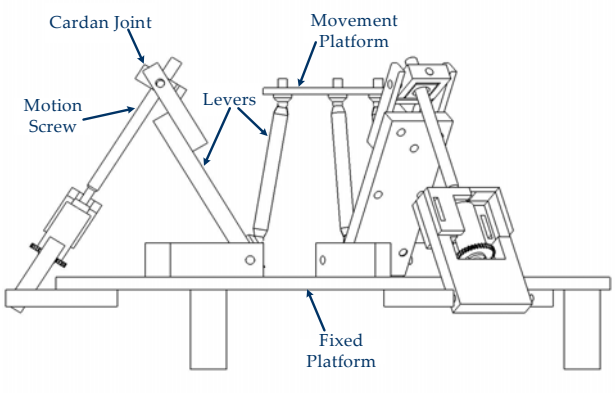


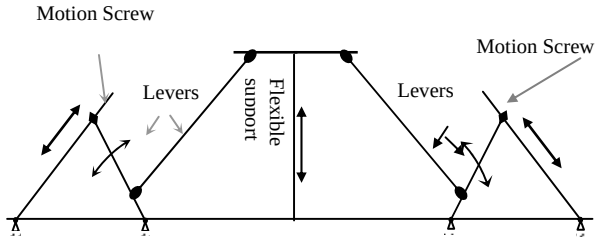
Figure 3 Top view of the micromanipulator

3. Formulation

The scheme of this design is shown in the figure 4; the main structure of the design is conformed by links that are connected between them by means of spherical joints; the integration of a motion screw with one of the links generates a lever mechanism. As it is appraised in the figure, the system is symmetrical, which allows us to predict the movement of the three levers from the analysis of anyone of them. Let us observe that an analysis of movement by each arm can be made, each one contributes with one degree of freedom (DOF), associated to the drive of the motion screw, and as a whole we will obtain three degrees of freedom for this system.



(a) Structure



(b) Skeleton

Figure 4. Diagram in a plane

4 Computer simulation

4.1 CAD (Computer Aided Design)

For the development of this system it has been modeled, in a parallel way, a virtual prototype of the micromanipulator and the design platform used has been *Unigraphics*. It was generated the geometric model of each one of the components and later all components were integrated in the final assembly of the manipulator, see fig. 5.

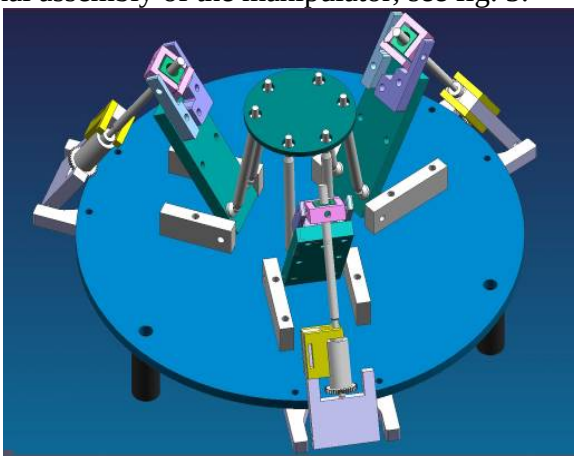


Figure 5. Final Assembly on Unigraphics Platform

4.2 CAE (Computer Aided Engineering)

Once concluded the virtual assembly of the micromanipulator it was generated a kinematics simulation of the movement of the manipulator. In this simulation different schemes of movement of the motion screws were evaluated and it was observed its repercussion in the displacement of the movable platform. These simulations allowed observing the behavior that the prototype will have when it is driven and confirmed that the design was developed with the correct geometric proportions. In the figure 6 is shown an image of the simulation process.

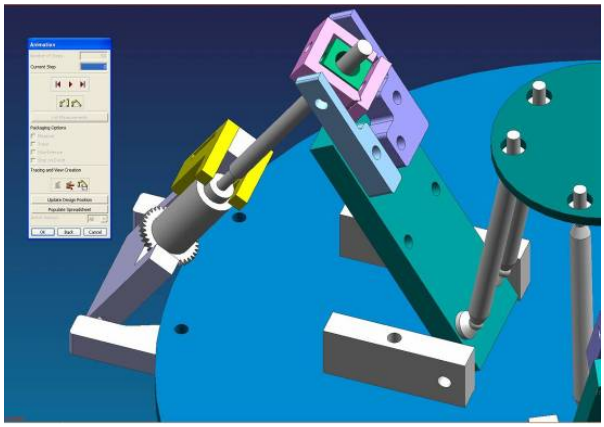


Figure 6. Computer Simulation Process

5 Prototype

Up to now it is counted on the first version of the prototype which was made in aluminum and brass mainly. For its manufacture it was used the information of the virtual model of each one of the components to be made. This information was transferred to numerical control systems (CNC) by means of which it was made the manufacture of the components. In the figure 7 is shown a picture of the prototype in its present state.

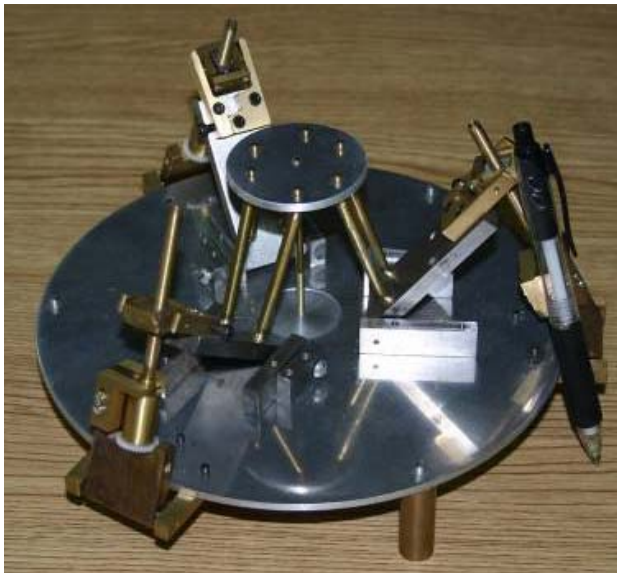


Figure 7 Current state of the prototype.

6 Conclusion

We proposed to use all types of conventional mechanical technologies for producing micromechanical devices. Developing a project applying CAD tools it is a very powerful way of saving time at the moment of the integration of the entire system. Virtual models let to have an excellent pre-visualization of the project that it is being developed so every mistake can be corrected before the beginning of the manufacture and assembly processes.

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