DELTA TAU
Data Systems, Inc.

AI-Hexapod Parallel Kinematic Robot controlled by the UMAC System

NANOMETER PRECISION ROBOTICS

In this application several technologies are combined to control this tool. These technologies are:

1) Delta Tau Data Systems UMAC System
2) Delta Tau Data Systems PMAC HMI Software
3) ALIO Industries Hexapod parallel kinematic robot
4) Nanomotion motors

UMAC System

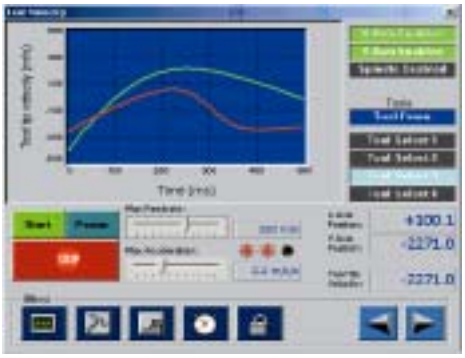
The UMAC (Universal Motion and Automation Controller) is a modular PMAC system built with a set of 3U-format Eurocards. The configuration of any UMAC system starts with the selection of the Turbo PMAC CPU and continues with the addition of the necessary axes boards, I/O boards, communication interfaces (USB, Ethernet, etc.) and any other interface boards selected from the rich variety of available accessories. Accessory boards allow, for example, to interface with virtually any kind of feedback sensor or to implement almost any kind of communication method with the host computer or external devices.

The Turbo PMAC motion controller inside the UMAC System provides the necessary structure to enable the user to easily implement and execute complex kinematic calculations. Kinematic calculations are required when there is a non-linear mathematical relationship between the tool-tip coordinates and the matching positions of the actuators (joints) of the mechanism, typical in non-Cartesian geometries.

This capability permits the motion for the machine to be programmed in the natural coordinates of the tool-tip, usually Cartesian coordinates, whatever the underlying geometry of the machine. The forward-kinematic calculations use the joint positions as input, and convert them to tool-tip coordinates.

The computational power of the DSP-based Turbo PMAC motion controller allows the fast and accurate Inverse Kinematics calculations for 6-axis, and therefore there is no need for an external PC computer.

PMAC HMI



The PMAC HMI software is used in this case to provide the user interface for starting, pausing and stopping the demo and also for displaying positions and trajectories in a customized screen. The computer does not perform any motion calculations, which are instead executed inside the UMAC System, and it is used only to display information and to provide a control panel.

PMAC HMI allows creating a custom operator interface display using a comprehensive suite of ActiveX graphical control objects such as buttons, indicators, stripcharts, bargraphs, gauges, sliders and many more. The interface can be enhanced with unlimited sophistication using the fully integrated *Visual Basic for Applications* development and runtime environment. Communications with the UMAC system is based on PCOMM32, which delivers a reliable link. PMAC HMI is a powerful, flexible and robust world-class operator interface design tool for the PMAC motion controller.

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Hexapod Parallel Kinematic Robot

ALIO Industries patent pending 3 and 6 degrees of freedom parallel kinematic robotic manipulator was designed for demanding nanometer precision applications. Applications in fiber optics, semiconductor, medical, pharmaceutical and micro machining are just some of the uses. Parallel kinematics increase repeatability and performance over stacked stage serial kinematic approaches.

- Parallel kinematics are very rigid platforms that can easily withstand fiber bonding reactive forces or manipulating laser optics
- Increased repeatability over stacked stage serial kinematic structures
- Simplified programming with tool center point (TCP)
- Ability to rotate TCP repeatability about a virtual point in space
- Coordinated 6-axis of motion at TCP
- System resolution versus summation of individual stage resolutions
- Virtual elimination of stacked stage cosine and sine errors
- High-resolution 10 nm non-contact encoders for exceptional repeatability
- Precision cross roller bearings assure high accuracy with long life
- CE compliant components and assemblies
- Class 10 clean room compatible
- Optional D.C. mode for 1 nm resolutions

Nanomotion Linear Piezo Servomotors

The Nanomotion linear piezo servomotors provide high speeds with fast settling time and no servo dither. This contributes to the high-precision nanometer resolution of this system.

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Parallel Kinematic Robot Specifications

Model	AI-Hexapod	AI-Tripod
Work Envelope	40 mm cube	25 mm vertical
Resolution	10 nm	10 nm
Repeatability	50 nm	50 nm servo
Repeatability	10 nm D.C. Mode	10 nm D.C. Mode
Maximum Speed	110 mm/sec	110 mm/sec
Payload	0.8 kg @ tool plate	0.5 kg @tool plate
Motion	6 degrees of freedom	3 degrees of freedom