A hexapod is a robotic manipulator capable of moving a payload in all six degrees of freedom: lateral, longitudinal, and vertical translations as well as roll, pitch, and yaw rotations. Motions can be made simultaneously in multiple axes or independently in a single axis while preventing movement in the others. A hexapod's parallel actuator arrangement provides high load capacity, stiffness, and accuracy compared to other robotic manipulator architectures. Product models are distinguished by their actuation, sensing, control system, payload capacity, range, resolution, and bandwidth. Hexapod applications are generally divided into three primary categories: precise positioning, motion simulation, and vibration isolation.

Hexapods are needed for a wide variety of uses. They can allow a payload, such as an optic or laser source, to be precisely aligned and oriented relative to another object even as thermal or other forms of drift continually create misalignment. They can simulate road conditions for a vehicle suspension system eliminating costly field testing. Hexapods can also isolate payloads, including cameras or sensitive measurement instruments, from ground vibrations or aircraft jitter that would otherwise result in image blur, measurement errors, or potential damage. Other motion control devices can generally only provide positioning, motion simulation, or vibration isolation in one or two degrees of freedom, but hexapods are the ideal solution when multiple degree of freedom motion is required.
HEXAPODS

APPLICATIONS

- Alignment of telescope optics
- Space vehicle docking system
- Munitions loading
- Assembly line positioning
- Surgical systems
- End effector for serial manipulators

MOTION SIMULATION

- Flight simulators
- Missile tracker simulations
- Automotive suspension system testing
- Simultaneous multi-axis vibration testing
- Disturbance sources
- Motion theater rides

VIBRATION ISOLATION

- Camera image stabilization
- Weapons stabilization
- Optical jitter isolation
- Protection for fragile items during shipping
- Isolation of industrial machinery
- Isolation of sensitive measurement equipment

WHY USE A MOOG HEXAPOD?

- We have the ability to modify our standard hexapods to meet specific customer requirements. We make the hexapod match the application rather than trying to make the application match the hexapod.
- Leveraging off of our heritage designs, we also build custom hexapods to fit unique applications.
- We are well-versed with many types of actuation: electromechanical, electromagnetic, piezoelectric, hydraulic, and pneumatic.
- We have experience with extreme environmental conditions: clean room, vacuum, cryogenic, cryovac, and outdoor use.
- Our intuitive and easy-to-use graphical user interface allows the pivot point to move to any desired location.
- Training, installation support, and continued service support is provided as needed.

HEXAPOD FEATURES

A hexapod consists of six legs or struts arranged in parallel between a stationary base and a moving platform, and each leg is comprised of a linear actuator, one or more sensors, and joints at both ends. A controller is needed to receive and interpret sensor signals and send coordinated commands to the actuator drives to generate the desired payload motion or position. An operator typically interacts with a graphical user interface on a laptop or PC to supply commands to a hexapod and monitor its status.

- Actuators, sensors, and endjoints that are optimized for the application
- Strut geometry and mechanical interface customizable per application
- Real time controller with 2 kHz sampling rate
- Web browser graphical user interface
- Standard libraries for multi-axis control
- Calculates kinematics in real time

- XML-RPC communication between host and target for simple system integration
- Real time data logging
- Options for automated operation and acceptance of remote commands
- Completely passive units available for vibration isolation
- Options for vacuum compatibility on most hexapods

STANDARD AND CUSTOM SYSTEMS

Most of Moog's standard hexapods are for small payloads, but we have delivered systems ranging in size from 130 mm to 3 m, with load capacities between 0.5 and 15,000 kg. Moog also builds octopods and reduced degree of freedom hexapod and monitor its status.

- Motion theater rides
- Disturbance sources
- Simultaneous multi-axis vibration testing
- Other external commands

HEXAPOD SYSTEM: TYPICAL ELEMENTS

- Sensor Conditioning
- Actuator Drive
- Transducer Interface
- Other external commands
- Graphical User Interface

PERFORMANCE SPECIFICATIONS

<table>
<thead>
<tr>
<th>Purpose</th>
<th>HexaPod</th>
<th>HexaPod</th>
<th>HexaPod</th>
<th>HexaPod</th>
<th>HexaPod</th>
<th>HexaPod</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motion Simulation</td>
<td>HexaPod</td>
<td>HexaPod</td>
<td>HexaPod</td>
<td>HexaPod</td>
<td>HexaPod</td>
<td>HexaPod</td>
</tr>
<tr>
<td>Model</td>
<td>HX-M350</td>
<td>HX-M350</td>
<td>HX-P350</td>
<td>HX-P500</td>
<td>HX-V100</td>
<td>HX-V500</td>
</tr>
<tr>
<td>Power</td>
<td>40 W</td>
<td>400 W</td>
<td>100 W</td>
<td>1.5 kW</td>
<td>0.5 kW</td>
<td>2 kW</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1 µm</td>
<td>0.1 µm</td>
<td>0.1 µm</td>
<td>0.1 µm</td>
<td>0.1 µm</td>
<td>0.1 µm</td>
</tr>
<tr>
<td>Range</td>
<td>±20 kg</td>
<td>±20 kg</td>
<td>±20 kg</td>
<td>±20 kg</td>
<td>±20 kg</td>
<td>±20 kg</td>
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RANGE

<table>
<thead>
<tr>
<th>Model</th>
<th>HX-M350</th>
<th>HX-M350</th>
<th>HX-P350</th>
<th>HX-P500</th>
<th>HX-V100</th>
<th>HX-V500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>330 mm</td>
<td>330 mm</td>
<td>635 mm</td>
<td>815 mm</td>
<td>260 mm</td>
<td>600 mm</td>
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<tr>
<td>Diameter</td>
<td>364 mm</td>
<td>914 mm</td>
<td>915 mm</td>
<td>1850 mm</td>
<td>215 mm</td>
<td>1875 mm</td>
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</table>

RESOLUTION

<table>
<thead>
<tr>
<th>Model</th>
<th>HX-M350</th>
<th>HX-M350</th>
<th>HX-P350</th>
<th>HX-P500</th>
<th>HX-V100</th>
<th>HX-V500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>150 Hz</td>
<td>200 Hz</td>
<td>10 Hz</td>
<td>&lt; 1 Hz</td>
<td>250 Hz</td>
<td>NA</td>
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<tr>
<td>Suspension Freq</td>
<td>NA</td>
<td>NA</td>
<td>&gt; 30 Hz</td>
<td>&gt; 40 Hz</td>
<td>&gt; 30 Hz</td>
<td>&lt; 3 Hz</td>
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<tr>
<td>Test Payload Mass</td>
<td>3 kg</td>
<td>30 kg</td>
<td>20 kg</td>
<td>650 kg</td>
<td>2 kg</td>
<td>90 kg</td>
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</table>

POWER

<table>
<thead>
<tr>
<th>Model</th>
<th>HX-M350</th>
<th>HX-M350</th>
<th>HX-P350</th>
<th>HX-P500</th>
<th>HX-V100</th>
<th>HX-V500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standby Power</td>
<td>360 W</td>
<td>350 W</td>
<td>200 W</td>
<td>0 W</td>
<td>40 W</td>
<td>50 W</td>
</tr>
<tr>
<td>Peak Power</td>
<td>1.5 kW</td>
<td>3 kW</td>
<td>1.25 kW</td>
<td>0.5 kW</td>
<td>60 W</td>
<td>1.5 kW</td>
</tr>
</tbody>
</table>

EM- electromagnetic, MS- motor-driven screw, PZ- piezoelectric, PN- pneumatic.