Testing MEMS-based Accelerometers in GPS Navigation System With a Custom 2-Axis Gimbal

Inertial navigation systems are used in a wide range of products such as robots, automobiles and aircraft as well as home electronics and video game consoles. As we are all familiar from the everyday use of GPS navigation devices in automobiles or smart phones, inertial navigational systems continuously calculate the orientation and velocity of a moving object and provide this data to a computer. For a precise calculation of data, test and calibration of the built-in accelerometer sensors is required at various orientations, usually about two rotational axes, during prototype test or in production.

A Newport customer, that manufactures MEMS-based inertial navigation systems like accelerometers and gyroscopes, is using a customized 2-axis Elevation-Roll gimbal assembly. Built from two, high-precision RV series rotary stages, the inner stage providing roll motion and the outer stage assembly providing elevation, the gimbal is an ideal platform to test and calibrate the MEMS-based accelerometer, allowing orientation of the accelerometer in various positions relative to the direction of earth's gravity.

The MEMS sensor, housed inside an environmental chamber, is rotated about its central axis and then rotated relative to gravity. The required accuracy and repeatability vary depending on the type of sensors.

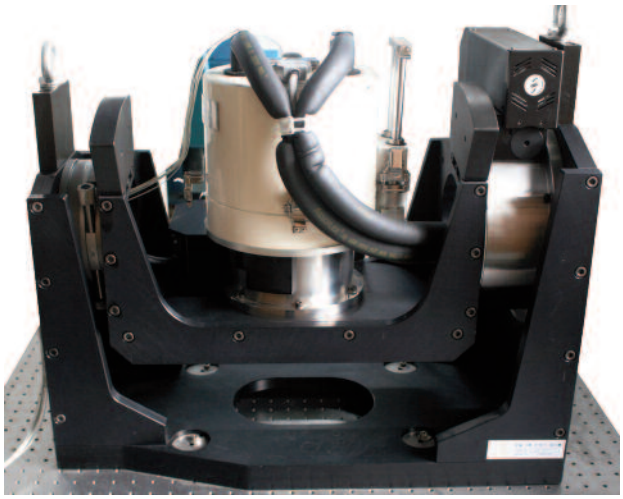

Figure 1: Newport Elevation-Roll gimbal with RV HAHLT stages for MEMS-based accelerometer sensors (Environmental chamber not provided by Newport)

Key Specifications:
Elevation Stage: RV240HAHLT with error mapping
Roll Stage: RV160HAHLT-F with error mapping
Controller: XPS-C2 with (2) XPS-DRV03
· Axis Accuracy: 5 arcsec (0.00139°)
· Axis Min Incremental Motion: 0.0001°
· Axis Repeatability: 0.0002°
· Axis Velocity: 16°/s
· Axis Travel Range(s): ±170°
· System Orthogonality: 100 µrad

Figure 2, 3, 4, and 5 illustrate other gimbal designs that span across different levels of performance and interfaces required for testing a variety of MEMS-based sensors in the industrial marketplace.

Shown in Figure 2, is a high speed direct drive gimbal providing continuous 360° rotation of the azimuth and elevation axes using an integrated slip ring. This recent development expanded Newport's product offering of direct drive rotary stages, high torque brushless servo motors and ultra-high resolution encoders that ensure precise angular motion at high speeds (up to 720 °/s) and acceleration.

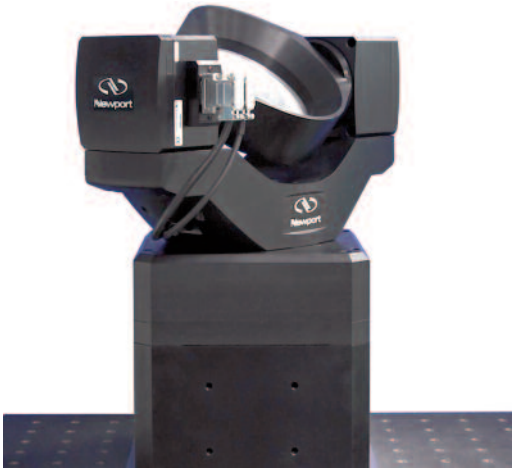

Figure 2: High Speed 2-Axis Motion Simulator

A video of this motion simulator is available online: http://newpor.tc/RGVvideo

Figure 3 shows a multi-axis assembly used by a Newport customer for test and calibration of various automobile sensors. The sensors are used to measure and record a vehicle's angular velocity and acceleration around its vertical axis (yaw), the speed of a tire's rotation and the amount of torque on the steering wheel or gears, all these to maintain stability and reduce vibration.

Figure 3: 11-Axis Motorized System for Calibration of On-Vehicle Safety Sensors

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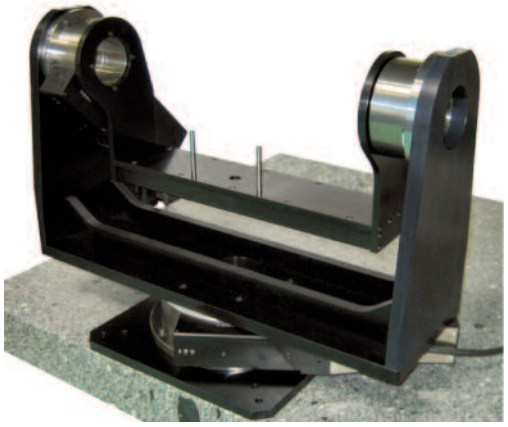

Figure 4: Azimuth Elevation Full Yoke Gimbal

Figure 4 shows an Azimuth-Elevation Gimbal design where an elevation sub-assembly is mounted to an azimuth stage, providing two orthogonal, rotation axes. In this configuration, the sensors are rotated about the elevation axis first and then the azimuth. It is possible to add a Roll axis on the platform and orthogonal to the elevation axis.

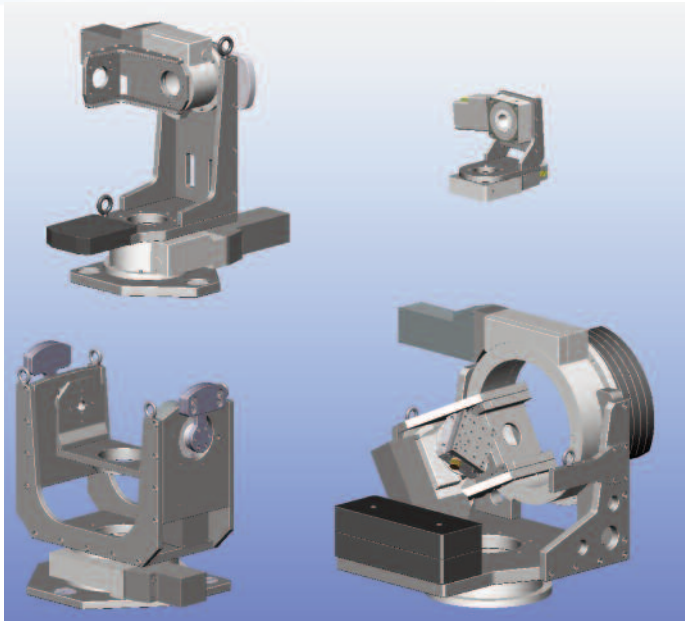

Figure 5: Various Other Newport Gimbal Configurations

Figure 5 shows other gimbal configurations to accommodate different types of payloads and positioning requirements. Configured in either half-yoke or full-yoke designs, in various sizes, Azimuth, Elevation and Roll assemblies are available with Newport RV series and URS series stages. Based on specific sensor requirements, a Newport gimbal system can be customized to meet the needed MIM, repeatability, accuracy, speed and budget.

For questions about Newport motion solutions for test and calibration of MEMS-based sensors, please contact Newport sales and application engineers at tech@newport.com. .

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