

Newport Hexapod with Image Derotator Brings Innovative Metrology Tools to Industrial Manufacturing

The Newport HXP1000 Hexapod enables precise positioning and alignment for analysis of in-plane and out-of-plane vibrations and deflections of rotating machinery parts.

Every rotating part in a machine generates vibration due to a small imperfection of machine components. Measurement and analysis of vibration are important as a small amount of power transmitted from rotational vibration can produce undesirable effects in manufacturing processes. In order for engineers to identify and diagnose faults of components such as roller bearing or turbine engines, various electro-optical solutions are emerging to study the dynamic behaviour of rotating machinery.



Figure 1: Optomechanical image derotator assembly on Newport HXP1000 (Courtesy of Universitat Hannover)

A team of scientists at the Universitat Hannover in Germany developed a unique method for determining the in-plane and the out-of-plane vibrations and deflections of rotating objects. The setup consists of an opto-mechanical image derotator, combined with a high speed camera and a scanning Laser-Doppler-Vibrometer (LDV), mounted on a Newport HXP1000 Hexapod 6-Axis Parallel Kinematic Positioning System (shown in Figure 1). The image derotator allows obtaining a stationary image of rotating objects, and non-contact measurements of vibration and deflection are made in a coordinate system fixed to the rotating object. In order to achieve an optimal derotated image, one of the key requirements is to have the same rotation axis for both the rotating object and the image derotator (Figure 2). Newport's HXP1000 series hexapod helps meet the requirement with a precise positioning and alignment of the image derotator, creating an innovative metrology tool for rotating machinery parts.

Working Principle of the Derotator

As illustrated in the Figure 2, the main component of the derotator is a metallic reflector prism. As the prism is rotated, an image passing through will rotate at

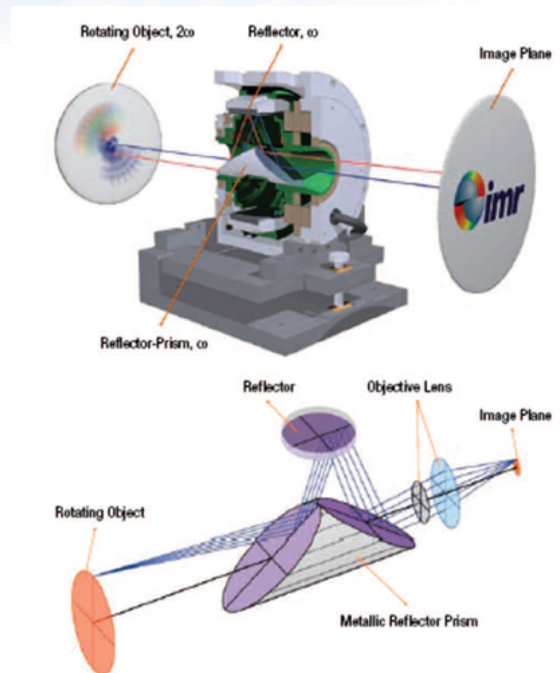


Figure 2: Configuration of a prismatic reflector (Courtesy of Universitat Hannover)

twice the rotation speed of the prism. The prism is used to eliminate the optical path through the glass and avoid aberrations or light polarization. To optimize the derotated image, the optical axis of the prism, the rotary axes of its drive and the object must be identical, and the prism must rotate with half the rotational speed of the rotating object. The reflector prism is located at the center of a hollow-shafted torque motor, and the speed of the motor is controlled by a cascade control implemented in Matlab xPC Target software, ensuring the rotational speed of the derotator and the object amount to a ratio of 2:1.

After initial alignments of the optical and rotary axes are completed with the Hexapod, images taken from a high speed camera are analyzed, and commands are sent to an HXP1000-ELEC controller to further adjust the position. This entire alignment process is automated, using a LabVIEW program.

Newport HXP1000 Hexapod

Newport's HXP1000 6-axis Hexapod is a parallel kinematic motion device that provides six degrees of freedom: X, Y, Z, pitch, roll and yaw. The user definable coordinate systems allow setting a virtual pivot point for the image derotator, thus allowing synchronization of the derotator with rotating objects. The work coordinate system of the Hexapod, which is relocated to match the coordinate system fixed to the rotating object, helps avoid the need for complex external coordinate transformation in the programmed software, while the tool coordinate system, which is fixed to the carriage and moves with the Hexapod, allows lateral and

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angular movements relative to the mounting base of the derotator sub-assembly. The maximum of 5000N centered load capacity and 100N/ μm rigidity provide a rigid, stable platform to support heavy weight of the derotator sub-assembly and ensures good imaging quality of the objects rotating at a high speed. The compact, integrated 6-axis positioner design provides highly accurate, repeatable movements without deflection or accumulation of individual axis errors.

The Newport HXP1000 with image derotator has been rigorously tested and developed by the researchers in Hannover, and provides a unique metrology solution to a wide variety of industrial applications, including vibration and deformation measurements of fast rotating components, analysis of fracture mechanics on rotating disc-shaped tools, thermographic investigation of wear processes in rotation systems and acoustic investigations of automobile tires. With the expanded offering of the HXP series Hexapod, Newport motion continues to help researchers develop advanced techniques in various testing and metrology of high precision machinery.



Figure 3: A photo of Newport HXP1000-MECA

For additional information, please contact Newport applications and sales engineers at tech@newport.com.