

## **3D in focus: Microscopy of paintings using a Hirox KH-8700 digital microscope mounted on a MOPAS mobile XYZ stand system**

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Optical microscopes on a regular microscopic stand are suitable for observation of small objects like paint fragments but not for non-destructive painting studies. Therefore, a vertical as well as a horizontal stand system was developed for mounting the Hirox KH-8700 3-D digital microscope. The microscope block is attached to a motorized linear bar that allows movement of the microscope with micrometer steps in X and Y directions. The lens system of the microscope itself is mounted on a block that is equipped with accurate motors for submicron movement in the Z direction (50 nm steps). Long-distance zoom lenses (13 cm working distance) for magnifications up to 48× allow the attachment of several lighting adapters and give enough room for restoration under the microscope. The unique Hirox rotary mirror attachment makes it possible to view the surface under different angles over 360°. Furthermore, a revolving lens system (1 cm working distance) with zoom magnifications from 35× up to 2500× makes it possible to easily change objectives without losing the point of interest, while avoiding any risk of damage to the painting. The system is equipped with cold high-intensity LED lighting (5700 K color temperature) with 30,000 hours lifetime. The camera can record pictures up to 58 million pixels in one field of view or videos in full HD. Photos are created in focus at high magnification using the submicrometric Z-movement to obtain a sharp, accurate 3-D picture that can be further inspected. Profiles over interesting areas can be drawn in the 3-D software to create vertically and horizontally calibrated profile-data measurements. The authors have applied this system in a number of museum settings in Europe for study of the impasto paint of Van Gogh, paint loss and damage on two Vermeer paintings, investigation of retouches and aged paints on the Van Eyck altar piece, efflorescence of paintings by Munch, impastos and dripping paints on Riopelle paintings, the aged surface of Rothko paintings and reactivity in paints on works by Cuno Amiet, among others. Paint surface morphology of varnished paintings was studied without reflections, using light manipulation or polarization. Varnishes have been inspected, and their thickness was measured with the motorized Z-axis. It is expected that this technology will be useful for examination and documentation of the paintings technique and present condition of paintings, and initial experiments have been done to perform and monitor cleaning operations with solvents in real time. Paintings are often sent to exhibitions elsewhere after careful examination by the responsible conservator. With the Hirox-MOPAS system it is possible to measure and image critical cracked areas in great detail before sending and after return. Museum visitors will have the opportunity to view the painting surface in much more detail on an iPad when Hirox photos and videos elucidating the artist's technique are made available online in the museum. The Hirox-MOPAS system empowers the eye of the art historian, conservator and art scientist.