



Creep Measurement Video Extensometer

This automated system measures test-sample creep rates for materials testing.

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Understanding material behavior under load is critical to the efficient and accurate design of advanced aircraft and spacecraft. Technologies such as the one disclosed here allow accurate creep measurements to be taken automatically, reducing error.

Before the present innovation, there was no satisfactory method of accurately measuring the mechanical strain characteristics of materials during deformation at high temperatures inside an inert gas or vacuum chamber. The goal was to develop a non-contact, automated system capable of capturing images that could subsequently be processed to obtain the strain characteristics of these materials during deformation, while maintaining adequate resolution to capture the true deformation response of the material.

The measurement system comprises a high-resolution digital camera, computer, and software that work collectively to interpret the image. The camera captures an image of the specimen prior to beginning the test. The image, containing two fiducial marks at a known distance, is analyzed by the software to determine the relationship between actual

distance and the number of pixels separating the fiducials in the image. This is the basic calibration prior to the beginning of a test.

Once a test is started, images are captured at a predetermined rate and the calibration relationship is used to determine the distance between the fiducials while the specimen is being deformed, by converting the pixel distance between fiducials to the actual separation distance via the predetermined relationship. The separation distance is then used to measure the creep rate, and information important to the analysis of the test is automatically written to a file that can be exported to other analytical software. This system can also be used for tensile and compression testing, but data acquisition rates are limited due to the current state-of-the-art in hardware. Finally, the system has been proven out for testing being conducted at low temperature, high temperature, in air, vacuum, and inert gas environments, on systems that give line-of-sight access either directly or via a chamber viewport.

The software for this technology was written in LabVIEW, C, and VBScript. LabVIEW was used for the majority of

the code (user interface, program control, data storage, etc.). Standard image processing algorithms were written in C for those areas of the code requiring computationally intensive image processing routines (connected components labeling, circular Hough transform, and circularity measurement). VBScript is used to control the cameras and transfer images from the cameras to the PC. The VBScript uses Windows Imaging Acquisition (WIA) to send commands to the cameras and is based on sample code from Microsoft and a script called "Camera Control."

The system, based on an inexpensive, 12-megapixel, digital SLR camera, provides an accuracy that is within 0.0005 in. (12.8 μm). In contrast, the prior art (optical cathetometry) was only accurate to within 0.001 in. (25.4 μm). Hence, increased accuracy was not only achieved, but can be further increased by using even higher-resolution cameras (when available) or increased magnifications where applications permit.

This work was done by Mark Jaster, Mary Vickerman, Santo Padula II, and John Juhas of Glenn Research Center. Further information is contained in a TSP (see page 1). LEW-18578-1

Radius of Curvature Measurement of Large Optics Using Interferometry and Laser Tracker

This method determines the curvature radius of large mirrors.

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The determination of radius of curvature (ROC) of optics typically uses either a phase measuring interferometer on an adjustable stage to determine the position of the ROC and the optics surface under test. Alternatively, a spherometer or a profilometer are used for this measurement.

The difficulty of this approach is that for large optics, translation of the interferometer or optic under test is problematic because of the distance of translation

required and the mass of the optic. Profilometry and spherometry are alternative techniques that can work, but require a profilometer or a measurement of sub-apertures of the optic. The proposed approach allows a measurement of the optic figure simultaneous with the full aperture radius of curvature.

The steps required for this measurement are:

- Alignment of the phase measuring interferometer with the optic under test.

For a spherical optic, a transmission sphere that overfills (faster f#) the optic is used.

- The power is nulled by translating the optic under test (OUT) or the interferometer. At this point, the transmission sphere focus is the radius of curvature of the OUT.
- An adjustable mount near the focus of the transmission sphere has a magnetic nest for placing a laser tracker retro-target. This is a spherical target