

Originally developed to create pictures of solar system planets and moons, NASA imaging technology has found employment in such diverse areas as medical diagnosis and monitoring, Earth resources survey by remote sensing and quality control in industrial operations. Its further utility is being investigated in a variety of other applications and image processing technology shows promise of becoming one of the most prolific sources of spinoff.

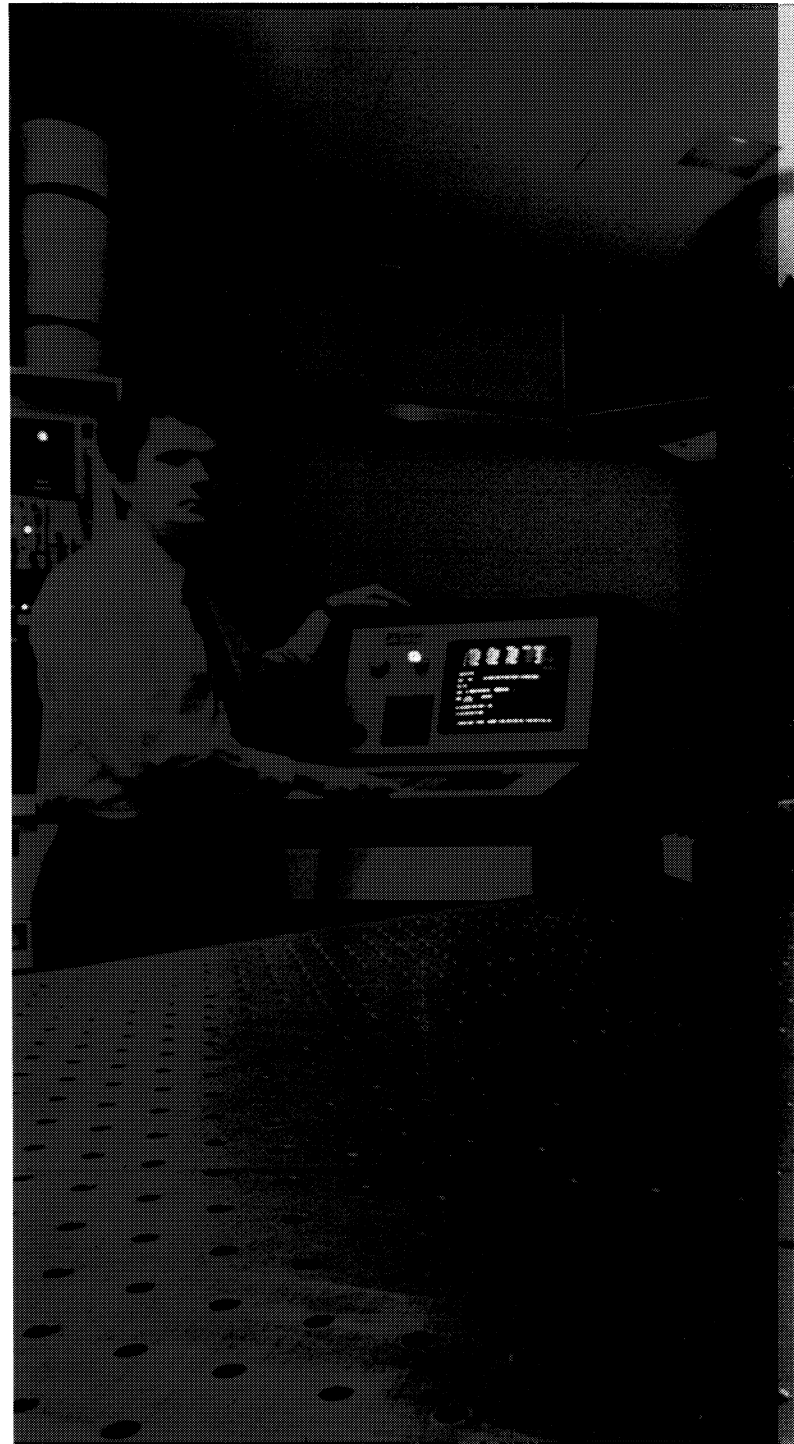
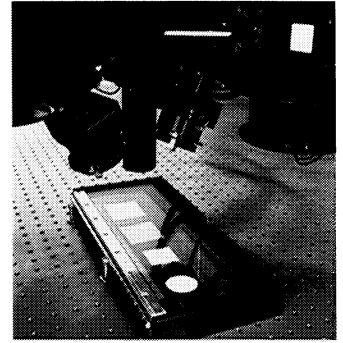
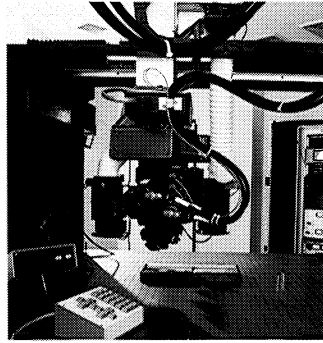
A unique application is a combined hardware/software system called the Charters of Freedom Monitoring System, which will periodically assess the physical condition of the U.S. Constitution, the Declaration of Independence and the Bill of Rights. Although protected in helium-filled glass casings, the documents are subject to damage from light, vibration and humidity, their parchment pages may stretch or split, and ink may fade, flake or wear off.

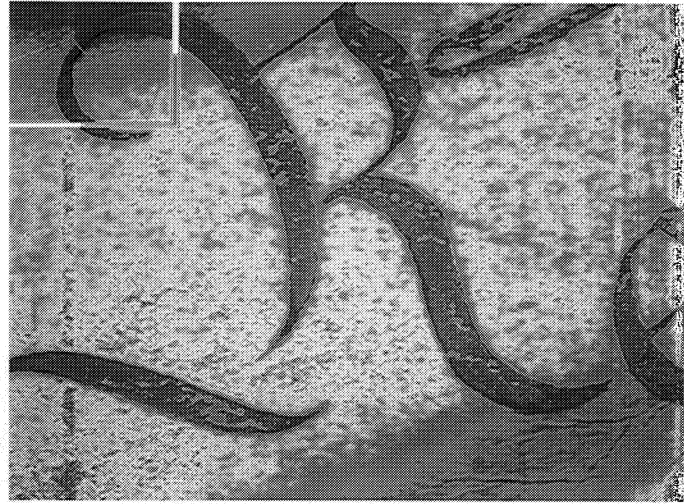
The job of the monitoring system is to image the documents precisely at selected times, then compare each new image to detect as early

as possible any change in the characteristics of the ink or parchment. That will allow National Archives conservators to plan action to halt the deterioration.

The project began in 1982 when the National Archives retained NASA's Jet Propulsion Laboratory (JPL) to develop a systematic method of determining the condition of national archives. JPL conducted studies of concepts based on space imaging technology, in particular a charge-coupled device (CCD) that had been employed in a number of imaging spacecraft, including the new Galileo Jupiter explorer and the Hubble Space Telescope. JPL asked The Perkin-Elmer Corporation, Norwalk, Connecticut, optical systems prime contractor for the Hubble Space Telescope, to apply its optical expertise to development of a precise photometer and to integrate it into a complete document monitoring system. Perkin-Elmer began work in 1984 and delivered the system to the National Archives in 1987.

The photometer is a CCD detector used as the electronic "film" for the system's scanning camera, which mechanically scans the document line by line and acquires a series of images, each representing a one square inch portion of the document. The photometer





is capable of detecting changes in contrast, shape or other indicators of degradation with five to 10 times the sensitivity of the human eye. A Vicom image processing computer receives the data from the photometer, stores and manipulates it, allowing comparison of electronic images over time to detect changes.

The complete monitoring system is shown at upper left. Next to it is a closeup of the camera and a radiometric reflectance target, used to calibrate the photometer's illumination, a green light that provides the essential contrast and does not damage the parchment. The exact intensity of the light is carefully established so that it can be precisely duplicated in every future scanning.

In the center is the system in operation in a darkroom environment. Above is a false color image, a segment of the Constitution that shows (in the red areas) signs of ink flaking that possibly occurred before the document was encased in its protective shield. Below are two supporting units: the taller one is the electronics rack that converts analog data to digital and controls the light

sources, shutter and CCD; the other is an Anorad Automatic III system for positioning the photometer over the document.

The latter, along with the Vicom computer, is among several commercially available components integrated into the system to minimize cost and maintainability.

Perkin-Elmer also developed user friendly software in accordance with JPL's requirement that people without image processing training be able to operate the system. The Charters of Freedom Monitoring System was designed to be maintainable for at least 50 years. Precise control of illumination, positioning, vibration and temperature ensure the repeatability of each image, so that conservators can assume with confidence that changes detected are actually changes in the document and not in the system. ▲

