B104 PTM—A New Way to Image Surfaces

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The attendee will learn about and see a demonstration of a new photographic method to image surfaces in very fine detail.

As a way to create critically clear images of surfaces, Tom Malzbender and Dan Gelb of the HewlettPackard Laboratories developed polynomial Texture Mapping (PTM). Its initial purpose was to enhance computer graphics, but it was soon used by archeologists to render eroded clay cuneiform tablets legible. That success has inspired inquiries from other fields such as dermatology and engineering. The purpose of this presentation is to describe the method to forensic scientists in hopes that more applications may be discovered. Like many innovations, PTM is basically a simple idea. Light striking a surface at an angle will reveal texture on that surface. Light coming from different angles and directions will disclose different parts of the texture. In PTM the light sources are precisely placed to cover a lighting hemisphere. The point sources impinge from near the horizon to near vertical and from all points of the compass. Mathematically, one needs at least six lights, with more lights providing more detail. The current prototype has fifty light sources. The PTM prototype currently in use consists of a hemisphere about a meter in diameter. This dome sits on a table and the subject object is placed underneath. An opening at the top gives access to a digital camera. The light sources are electronic camera flashes arranged around the hemisphere. A black cloth is placed around the base of the unit when it is in use to exclude extraneous light. A computer program activates each camera flash individually and a digital image is downloaded to the computer. With this procedure, 50 images of a static object are acquired under 50 separate lighting conditions. These images are then digitally processed into a PTM. PTM software then allows the user to vary the light source continuously to any location. Multiple light sources may be interactively established to highlight certain features. Light source positions not physically achievable may also be simulated yielding renderings that often reveal more information than may be seen with the human eye directly. Additionally, one may change not only light source direction, but also reflectance properties of the material itself. For instance, a clay object may be made to look metallic, and the extra specular reflections introduced are often helpful in the recovery of surface inscriptions or details. All of the manipulations are electronic. PTM is completely nondestructive to the surface it is imaging. PTM has been tested on indented writing on paper. It does not work as well as the existing electrostatic instruments currently in use, but it will work on substrates where those instruments perform poorly. Thick notebooks and paper previously processed for fingerprints which yield poor results with IMED and ESDA may respond well to PTM. PTM has also been used with excellent results to recover a shoe print in soil. Is PTM of use to forensic scientists? The authors would very much like input from the audience, so please bear in mind these limitations:

- The subject must be small enough to fit under the dome.
- Only one prototype currently exists. It can be taken out of the laboratory, but has limited portability. A portable model could be devised with enough demand.
- The surface must be fairly flat, although some curvature is permissible.
- The HP R&D staff is a bit squeamish. PTM is a brilliant solution; help find a problem for it.

PTM, Imaging, Polynomial Texture Mapping

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