PROFILOMETRY

2008 Award Winner

APPLICATION NOTE V3V-011

Optical profilometry, or capturing the three-dimensional topography of a surface, is demonstrated using TSI's volumetric 3-component velocimetry (V3V™) camera coupled with digital white light illumination.

Figure 1 shows an illuminated headform. The inset shows the projection set-up. A pattern of dots with density greater than $10^3/cm^2$ was projected onto the headform using a digital projector. Several dot patterns were tested and a final projection pattern was selected that provided the best image recovery.

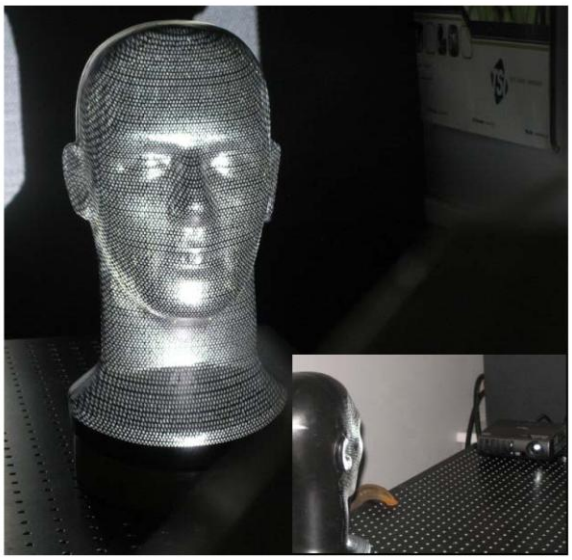

Figure 1: White light illuminated headform.

An image of the illuminated headform was captured using the V3V camera. The resulting point cloud yielded over 50,000 distinct (x,y,z) point locations. Denser point clouds of static surfaces can be obtained by adding the data from multiple images. Commercial software was used to recover the 3-D surface of the headform.

Figure 2 shows a single recovered 3-D image displayed from several points of view, with color indicating surface height. It is important to emphasize that all of these perspectives were generated from a single data set captured by the V3V camera.

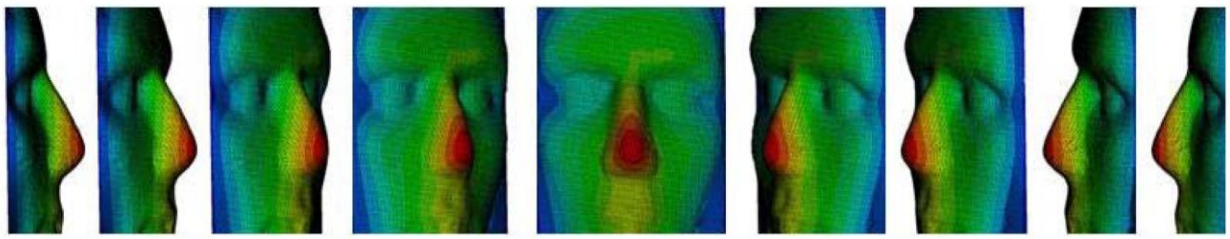

Figure 2: A single recovered 3-D image of the headform shown from nine different points of view.

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Currently, the V3V system is configured to capture individual, ~12 megapixel images in a volume that is approximately 100 mm × 120 mm × 50 mm, with a potential resolution of <0.02 mm in the x-y plane and <0.10 mm in the z plane. The camera operates at 15 Hz, so it is also capable of performing surface mapping on moving as well as static systems.

It is expected that V3V will find use in a wide array of applications. Dynamic surface mapping has applications in fields such as profilometry, reconstructive or cosmetic surgery, sports imaging, industrial imaging, animation and 3-D gaming, just to name a few. Closer to the fluid mechanics field, dynamic surface mapping is expected to be used for applications such as erosion measurements or tracking biological or model surfaces that give rise to or participate in fluid motion.

It is important to stress that surface variations smaller than a fraction of a millimeter can be detected and measured. The state of the art in facial animation, for example, has subjects posing with 10's of manually applied dots in order to capture the essence of static facial expressions. In contrast, V3V is capable of dynamically capturing the information from 10's of thousands of dots from a projection illuminated face, a potential revolution in the field.

UNDERSTANDING, ACCELERATED

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