Seeing the Unseen

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At a recent tradeshow we were given a printed cardboard (see image 1 below) with a depiction of a masked person. The purpose of this promotional material was to show that by using a near-infrared InGaAs camera the image of a person underneath is visible, driving home the message that this camera could see through material opaque to the human eye. In military situations, for example, seeing through fog is a major advantage over the opponent, but there could be other uses in sensing thin layers under a transparent or semi-transparent top layer.

Promotional card depicting a black plastic layer "mask" over the image of a person.

Looking closer at the picture, we can see a black plastic layer deposited over the printed picture. In the visible range of course the image is the same as the RGB photo, a VNIR hyperspectral scan however reveals that the absorption is starting to diminish past 700 nm.

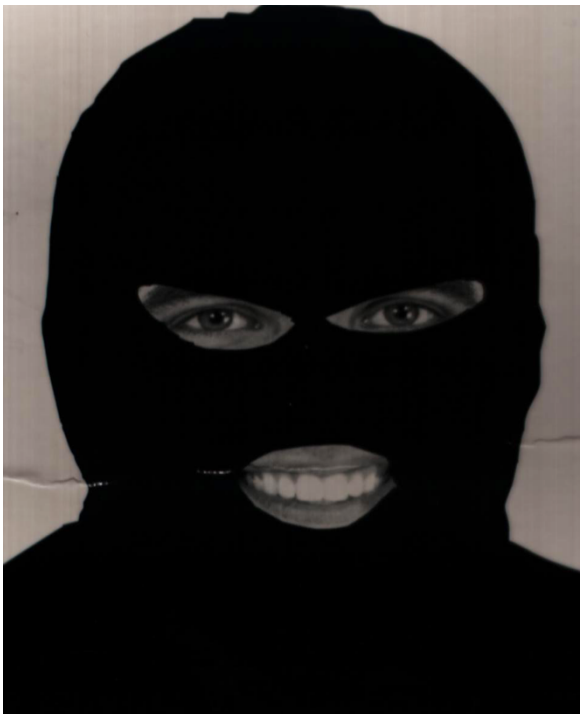


Image as scanned by an FX10 hyperspectral camera in the 400-700 nm range of the VNIR spectrum.

In the 700-1000 nm range the black layer becomes partially transparent. Other materials - such as plant or animal tissues - are also quite transparent, and this is used in the measurement

of blood oxygenation, Raman and other medical optical measurements.

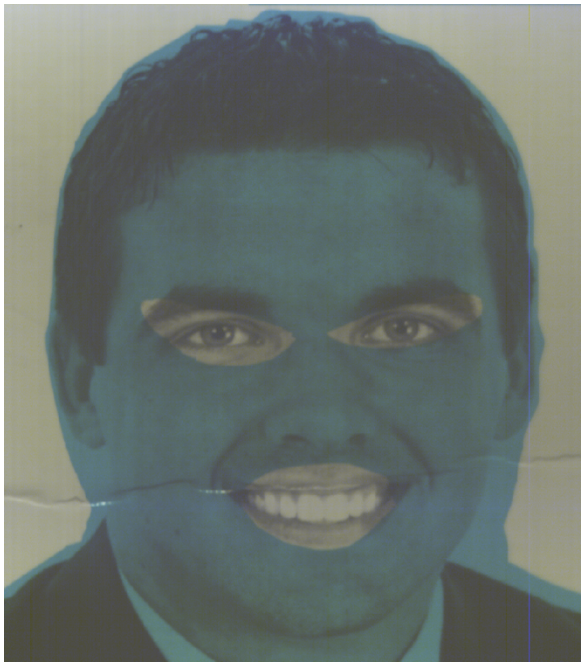
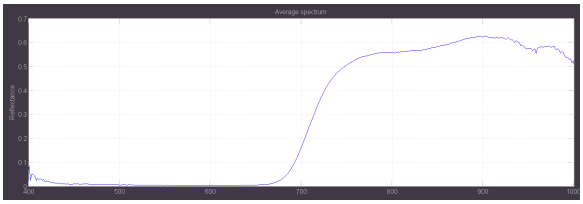


Image as scanned by FX10 hyperspectral camera in the 700-1000 nm range of the VNIR spectrum.

Just as the mentioned demo showed, in the 1000-1700 nm area, the black layer completely disappears. One important note is that not all black layers are transparent in this region. Paints that contain carbon black look the same in the visible but are totally absorbing in the whole visible to near infrared range.

Image as scanned by a SWIR camera in the 1000-2500 nm range of the SWIR spectrum.

As we move further, using a SWIR (1000-2500 nm) hyperspectral camera, the combination bands of the plastic start absorbing again, decreasing the reflectance. In a very thin layer such as was on this picture, the face is still seen but the light is more and more absorbed towards the longer wavelengths as evidenced by the enclosed mid-infrared spectrum.



Reflectance spectrum of the plastic layer in the longer wave near-infrared and mid infrared region.

For the above short investigation the following equipment was used:

- RGB camera: iPhone 10
- VNIR Hyperspectral Camera: FX-10 (400-1000 nm)
- Near-Infrared Camera: FX-17 (900-1700 nm)

- SWIR Camera: Specim Stirling Cooled MCT SWIR-384 (1000-2500 nm)
- Mid-infrared: Varian FTIR with Pike UpIR Reflectance Accessory (7000-400 cm-1