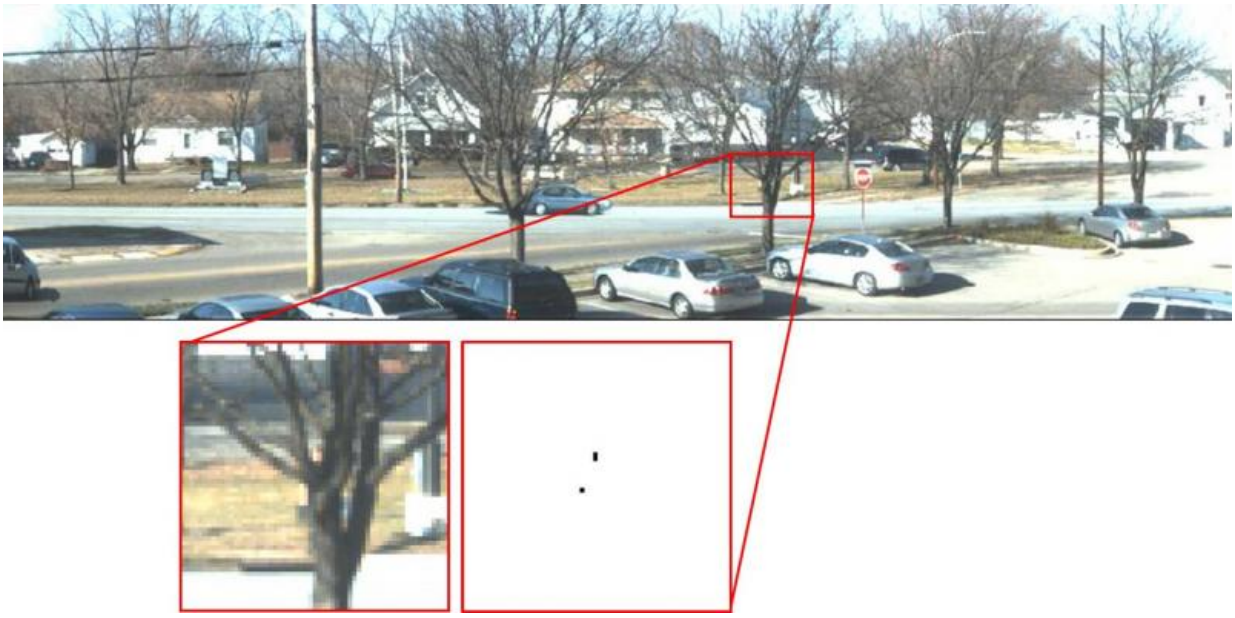
Human skin detection technology for improved security, search and rescue

December 10 2015



The Air Force Institute of Technology's skin detection research is a key element in supporting security and search and rescue operations. Credit: M. Mendenhall/Air Force Institute of Technology (AFIT)

Color-image based systems are excellent at locating people in aerial search and rescue operations, but fall short when it comes to discerning between actual human skin and objects with similar hues. To remedy this, researchers at the Air Force Institute of Technology (AFIT) have developed a novel two-dimensional feature space which uses the spectral

absorption characteristics of melanin, hemoglobin and water to better characterize human skin.

Spectral imaging systems use information from the entire electromagnetic spectrum to provide digital images with much greater information per pixel than traditional cameras. Feature spaces in a spectral imaging system are vectors that numerically represent an object's characteristics. The skin detection approach is described this week in *Applied Optics*, a journal from The Optical Society.

In their work, the AFIT research team used feature spaces to key in on specific constituents of human tissue by using a skin index concerned with how water and melanin's presence in skin manifests at two different wavelengths in the near-infrared region. These changes would cut the overall cost of hyperspectral-based search and rescue systems by a factor of seven.

"The study represents a crossroads between physics and statistical pattern recognition," said Michael J. Mendenhall, assistant professor, Air Force Institute of Technology, Department of Electrical and Computer Engineering, Dayton, Ohio, USA. "The features were designed based on an understanding of the physics behind skin's spectral shape, but in such a way that the features separated skin and non-skin pixels in order to make the pattern recognition portion of the problem more effective."

"After a lot of investigation into spectral properties of false alarm sources, we arrived at a simple observation that skin is more red than green, due to the melanin in darker skin and oxygenated hemoglobin in lighter skin, whereas many of the false alarm sources were more green than red," Mendenhall said.

Many current image recognition programs employ hyperspectral imaging systems, which allow engineers to search for a wide variety of

objects—exoplanets, oil wells, or human skin, to name a few - by looking for specific "fingerprints" in the electromagnetic spectrum. However, the involved image acquisition and post-processing are typically too slow for live search and rescue operations. Additionally, specific air platform requirements and the high cost of acquisition and management—around $700,000—currently puts hyperspectral systems out of reach for search and rescue organizations.

Mendenhall and his colleagues use their skin detection and false alarm suppression feature space to design an application-specific optical system using three framing cameras; their first breadboard system is about 12"x12"x6". Because their skin detection solution can be implemented with less expensive technology capable of live video frame rates, its total price tag would be around $100,000.

Future work for Mendenhall and his colleagues includes investigating the scattering properties of hair in order to characterize pixels as a mix of skin and hair, as well as improving the rates of their system by accounting for skin's specular, or mirror-like, reflection of light.

More information: M. Mendenhall, A. Nunez, R. Martin, "Human skin detection in the visible and near infrared," Applied Optics 54, 10559-10570 (2015) www.osapublishing.org/ao/abstr …m?uri=ao-54-35-10559

Provided by Optical Society of America