Title: Face Recognition in the Thermal Infrared Spectrum

Authors: Pradeep Buddharaju, Ioannis Pavlidis, and Ioannis Kakadiaris

Department of Computer Science, Infrared Imaging Group

Abstract: Face recognition is gaining acceptance as a superior biometric method. It is touchless, highly automated, and most natural since it coincides with the mode of recognition that we as humans employ on our everyday affairs. Most of the research efforts in this area have focused on visible spectrum imaging and geometric feature extraction. Despite progress, certain problems still remain and are due to the very nature of the legacy approaches. Images in the visible band are formed primarily due to relfection. Therefore, they depend on the existence of an external light source, which sometimes may be absent (e.g., nighttime). Imagery formed primarily due to reflection is also very difficult to process because of the strong dependence on incident angle and light variation. Finally, geometric algorithmic approaches have weaknesses, since the facial geometry of the person may change over time due to various reasons (e.g., orthodontics or change of body mass index). They also can be fooled by disguise attempts.

We have a adopted to work in the thermal infrared portion of the electro-magnetic spectrum. In this region images are formed primarily due to emission. Therefore, they do not depend on the existence and intensity of an external light source. They are also less dependent on the incident angle. In terms of algorithmic approach we have adopted a spectral analysis methodology. In contrast to geometric approaches spectral analysis is more resilient to stochastic facial changes as well to disguise attempts. Our algorithm proceeds in four (4) stages: In the first stage we segment the imagery using adaptive fuzzy connectedness segmentation to remove the background. In the second stage we divide the segmented face into its spectral components using a bank of K Gabor filters. We associate K Bessel probabilistic models to these filtered images to obtain 2K Bessel parameters, which constitute the feature vector. In the third step, we short-list high probability subjects by applying the L^2-metric on the Bessel feature vectors. In the fourth and final step, we feed the short-listed set to a Bayesian classifier to find the exact match. Our method introduces two important novelties: the adaptive fuzzy connectedness segmentation and the Bayesian classification steps. In the experiments with the Equinox thermal face database, our method performed better than competing approaches with accuracy scores exceeding 90%. This work is sponsored by an NSF research grant on information assurance.