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Guest Editorial

Guest editorial: Special issue on computer vision beyond the visible spectrum

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The Editors

It was three years ago that we had our first special issue in *Computer Vision Beyond the Visibel Spectrum (CVBVS)* in the Machine Vision and Applications journal [1]. At that time, we expected that computer vision research would grow significantly in the nonvisible spectrum, particularly in the biometrics area. This second special issue in the Image and Vision Computing journal comes to verify our expectations. New CVBVS methods and systems in face detection, tracking, and recognition enable identification at a distance under any lighting conditions. As a result, this new technology heralds the migration of human identification screening from access control to surveillance applications. These adavances promise to revolutionize the security industry. Also, methods and systems for defense applications, which is the traditional CVBVS domain, grew more sophisticated and effective. Target detection and recognition in Synthetic Aperture Radar (SAR) imagery is at the very core of these advancements.

All the papers included in this special issue were presented in preliminary form at the IEEE Workshop in Computer Vision Beyond the Visible Spectrum, held in Kauai, Hawaii, on December 14, 2001. The selected papers were a small subset of the total number of papers presented at the Workshop and underwent two rounds of further rigorous review and updates to ensure a high quality outcome.

In the first paper *Face Detection in the Near-IR Spectrum*, J. Dowdall et al. introduce a new face detection method based on the fusion of two near-infrared bands. The resulting phenomenology is such that it allows reliable face detection with simple algorithmic means like integral projection. The authors realized a prototype system based on their method and performed comparative experimental tests with a state-of-the-art visible spectrum face detector. The near-infrared detector exhibited superior performance at various ambient illumination conditions and in the presence of extreme face rotation. This face detection system in combination with a face recognizer is employed on a trial basis for gate control in a practical application.

In the second paper *Tracking Human Faces in Infrared Video*, C.K. Eveland et al. describe a novel face detection and tracking system in thermal infrared. In contrast to the near-infrared face detector proposed by J. Dowdall et al. in the first paper, this system is totally passive. The underlying method has two components: first, a face segmentation scheme that is based on a thermal emission model from the human skin; and second, a *condensation* algorithm that uses the segmentation model for tracking the face over time. The method is characterized by mathematical elegance and is supported by promising experimental results.

The third paper is on *Statistical Hypothesis Pruning for Recognizing Faces from Infrared Images* by A. Srivastava. This paper complements the face detection and tracking methods presented in the first two papers. Recognition is accomplished by hypothesis pruning using spectral decomposition of the observed images and their lower-order statistics. This is another elegant method that is supported by comparative experimental results. The authors used the data sets released by the first two papers, which reinforces the complimentary nature of the approaches towards an infrared identification system.

The fourth paper *Genetic Algorithm Based Feature Selection for Target Detection in SAR Images*, by B. Bhanu and Y. Lin introduces a Genetic Algorithm (GA) approach for target feature selection in SAR imagery. The GA algorithm is driven by a new fitness function based on

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the Minimum Description Length Principle (MDLP). The authors report extensive experimental results that verify the effectiveness of their method for target detection and the superiority of the MDLP fitness criterion versus three traditional fitness functions. The public MSTAR data set was used in the experiments.

Although target detection in SAR is definitely the current technological norm, target detection in the Passive Millimeter Wave (PMMW) spectrum is emerging as an attractive alternative, especially because of its passive nature. In the fifth paper *Automatic Target Segmentation Using PMMW Imagery*, M.R. Stevens et al. propose a model based on Gaussian curvature to characterize a wide range of target types in the MMW spectrum. This model is used to segment targets out of the background. The authors compare the performance of their algorithm to a set of algorithms operating on co-registered laser radar (LADAR) imagery. The comparison shows that the PMMW target detection algorithm produces a lower false alarm rate, illustrating the promise of targeting systems in the MMW spectrum.

In the sixth paper *Target Tracking in Airborne Forward Looking Infrared (FLIR) Imagery*, A. Yilmaz et al. propose a robust approach for target tracking in FLIR images. In comparison to SAR, which is the current modality of choice and MMW, which is the up and coming modality, FLIR is the traditional modality for target detection and tracking. In the proposed method, targets are detected using fuzzy clustering, edge fusion, and local texture energy. The position and the size of the detected targets are then used to initialise the mean-shift tracking algorithm. The authors report excellent experimental performance on the AMCOR FLIR data set.

A very interesting and non-traditional target detection application is the subject of the seventh paper *Generalizations of Morphological Shared Weight Networks Using Choquet Integrals with Applications to Ground Penetrating Radar Based Land Mine Detection by* A.K. Hocaoglu et al. The authors advance the state-of-the-art in image-based land mine detection by replacing conventional morphological filters with Choquet integral-based morphological operations in morphological shared weight neural networks.

The special issue closes with a departure from the biometrics and target reognition technology. In the last paper *Fully Automatic Registration of Multiple 3D Data Sets*, D.F. Huber et al. present a method for multi-view surface matching. The proposed algorithm begins by converting input data into surface meshes, which are pairwise registered using a surface matching engine. Then, a graph optimization method eliminates all the incorrect pairs and enables appropriate transformations to register all the views. The method finds application in 3D digital reproduction of real-world objects out of range imagery. This can be tremendously useful in art preservation and demonstrates the ever-expanding scope of CVBVS technology.

In conclusion, CVBVS research and development will continue to thrive in the biometrics and target detection/recognition area for the foreseeable future. At the same time CVBVS technology is making headway in biomedicine, which we see as the next emerging of CVBVS research. We hope to see many new real-world applications in the future, which will solve significant problems and improve the quality of life.

References

[1] Machine vision and applications 11 (6) (2000).