ENTROPY BASED IMAGE ANALYSIS USING CORRELATED COLOR, TEXTURE AND MOTION CUES

by

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For my mother

Susan

Certificate

This is to certify that the thesis entitled "**Entropy based Image Analysis using Correlated Color, Texture and Motion Cues**", which is being submitted by **Ms. Seba Susan Rajan** to the Department of Electrical Engineering, Indian Institute of Technology, Delhi, for the award of the degree of **Doctor of Philosophy**, is a record of bonafide research work, carried out by her under my guidance and supervision. The thesis has reached the standards fulfilling the requirements of the regulations regarding the degree. The results contained in the thesis have not been submitted to any other university or institute for the award of any degree or diploma.

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Abstract

This thesis contains an investigation on the statistical integration of correlated color, texture and motion cues for solving various image analysis problems such as color image segmentation, static and dynamic texture recognition, dimensionality reduction of large texture features, color-texture recognition and motion anomaly detection. The statistical tool used by us is the entropy function which is a measure of the amount of uncertainty within a domain. Shannon entropy, which is the most popular entropy, is ideal for the maximum entropy framework. However wherever a certain orderliness exists within a system, the non-extensive entropy proposed in this thesis is found relevant for representing the chaos in the system. The probabilistic non-extensive entropy satisfies all the axioms of a classical entropy function and also is non-additive for the statistically independent case. The non-linearity of its Gaussian information gain ensures that the low probability events lying under the bell of the Gaussian curve contribute high information and the rest of the events are discarded as being non-relevant. It is this clear distinction between the relevant and the non-relevant information that makes the non-extensive entropy successful in our experiments. The task of identifying the correlated visual cues in a computer vision problem and representing it by the entropy descriptor in some manner is the theme of this thesis. We investigate various novel ways of tapping the regularity within image structures using the new entropy, for solving a variety of pattern recognition problems. A detailed experimental analysis is carried out on the benchmark databases for all our results with state of the art comparisons. Our contributions are described in brief. A proposition of a Color Image Segmentation using a novel

Fuzzy Co-Clustering Algorithm is the first contribution, which uses Shannon Entropy as the regulating parameter while minimizing its objective function. The second contribution is a new Non-Extensive Entropy function based on an exponential (Gaussian) Information Gain Function, as the texture descriptor for regular or correlated texture structures. It is extended to Dynamic textures by defining an Auto-Regressive model. A new Mutual Information based on the new non-extensive entropy is the third contribution and it is applied for feature selection and dimensionality reduction, with special application to the facial expression recognition problem using the bulky LBP-TOP features. Next an entirely new set of monochrome texture features is derived from the correlation between local and global differences associated with a pixel. The mean of the Difference based feature set over the image is the texture cue used for classification. The fourth contribution constitutes of exploring the Non-Extensive entropy of the color Difference based texture features for redundancy across R,G,B color planes and a fusion of information across color planes. The fifth contribution is an unsupervised motion anomaly detection algorithm which is implementable in real-time. This is achieved by representing the correlated motion vectors over time using a weighted sum of non-extensive entropies and testing for a spike in entropy in real time. The adaptive monitoring of a crowd in motion is also proposed with the advantage being that no training for ‘normalcy’ and ‘abnormality’ is required.

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