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Texture based image recognition using deep neural networks

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Texture is a coherent property which belongs to a surface of an object or a region. It carries important information on the structural arrangements and distributions of primitive patterns in the formulation of surface appearance. Texture analysis is one of the key aspects of image recognition and image processing. In human perception of natural scenes, image texture is efficiently processed to give an accurate understanding of the image regions. However, optimal texture feature extraction to discriminate many texture classes artificially is a challenging problem in computer vision. The choice of traditional texture features for texture classification is subjective and highly application dependent with lower generalization to other image textures. Therefore, here we suggested a more generalized Deep Neural Networks (DNN) based approach which can address the optimal texture feature extraction problem. Instead of heuristically selecting an existing texture feature extraction method or a feature selection process, here the hidden layers inside the deep neural network architecture automatically perform those functions without user intervention to give the best texture discriminating performances.

Two commonly used image texture datasets are employed for classification experiments, namely Brodatz and CURet. From each dataset, a total number of images of 5000 and 620 from 10 classes were employed respectively. These texture images include rotation and scale variations in the texture. To acquire more descriptive features, Unwrapped Image Vector (UIV) of the input texture image was considered first. The proposed DNN which comprises several hidden layers can automatically extract the best texture features spanning from micro to macro scale, without losing useful information which usually happens in the traditional subjective texture feature extraction. Furthermore, intensity histogram (IH) and reduced image vectors using Principal Component Analysis (PCA) are also incorporated by the proposed DNN in order to increase the performance. A regularized cost function for DNN was used to avoid over fitting. The experiments were performed on a laptop with Intel dual core 2.20 GHz processors and 4GB RAM with MatLab 2015 environment operating on a 64bit Windows operating system.

DNN achieves more superior classification results than the Artificial Neural Network (ANN) which generally consists of one hidden layer. Moreover, the best classification accuracies are acquired when PCA is used. The Dimension reduction by PCA yields a smaller network with less number of hidden units which performs efficiently due to reduced computational power. The results on Brodatz dataset showed that with a DNN of two hidden layers, an average accuracy of 98.70±0.97% could be achieved while the ANN only gives 87.22±8.02% for the same dataset. The classification results on CURet dataset showed that DNN obtains an average accuracy of 97.60±3.51% while the ANN only achieves 77.41±3.24% test accuracy. Therefore, using DNN, traditional subjective feature extraction and selection can be avoided and better classification accuracies can be obtained in a direct automated manner.