

論文の内容の要旨

論文題目 Empirical Orthogonal Decomposition and Euclidean
Embeddings for Image Feature Extraction

(経験的直交分解とユークリッド埋め込みに基づく画像特
徴抽出)

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For the practical use of image recognition technology, it is necessary that not only the recognition method demonstrates high accuracy but also the method is efficient and the theoretical property of the method is well understood. As a feature that satisfies such property, we propose a novel framework that applies the orthogonal decomposition of the kernel with the distribution estimated from input data as a feature vector and Euclidean embedding of bag of local features in low-dimensional Euclidean space. Then we combine our framework with the existing effective approach that first extracts local features densely, then summarizes the local features into one global feature considering the feature value and position in the image, and finally outputs the category of the image from the global feature. Since we can get the feature vector as an approximation of the kernel function, we can analyze the classification performance with the kernel approximation performance. Also, we can effectively approximate the kernel function using data information. Thus we can obtain informative feature even when the dimension is small. Our Euclidean embedding enables us to exploit prior knowledge in feature extraction and handle the feature vector easily. In this work, we apply our feature extraction method based on orthogonal decomposition to local feature extraction, feature encoding, and feature pooling and propose a novel method in each module. For local feature extraction, we apply our method to convolutional kernel between local image patches that summarizes the nonlinear similarity between pixels considering the pixel position in the patch and propose a patch feature that is effective even with the small feature dimension. For feature encoding, we apply our

method for covariance encoding and propose a feature method with small feature dimension even when the input feature dimension is large. For feature pooling, we propose a framework that regards bag of local features from one image as a function from image plane to feature space and regards feature pooling as an orthogonal projection in function space. With this idea, we can see the bag of local features as a point in function space and thus we can apply our method to construct a novel feature pooling method. Experimental results using standard image recognition datasets show that the proposed method demonstrates compact and effective image feature. Thus, the proposed method not only has good theoretical property but also is efficient for practical use.