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Generating Hierarchical Dictionary in Parametric Eigenspaces

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The technique of three dimensional object recognition and the pose estimation from a two dimensional image has wide applications ranging from visual inspection to autonomous navigation, and has been studied by many reserchs.

Visual learning methods are reserched, which takes a large set of brightness images by varying its pose and learns many images, and recognizes three dimensional object by two dimensional matching of the input image of the target object and many images learned in the actual environment. Visual learning methods are based on two dimensional matching of images. So visual learning methods have a defect that images of the object are very easy to be affected by the place to take pictures of the objects in the actual environment, but has an advantage for three dimensional object recognition in the actual environment, because visual learning methods need not extract the topological features from the images of the object.

In visual learning methods, parametric eigenspaces method proposed is two demensinal matching based on image compression. So the image set is compressed using the Karhunen-Loeve transform to obtain a low-dimensinal subspace, and matching can be done in the low-dimensional subspace. So this method can store three dimensional object as images set in small memory capacity, and can recognize three dimensinal object in real time. For this reason, many applications has been studied.

But, the dictionary in the parametric eigenspace method is necessary to store many image sets of all objects to be recognized varying its pose and illumination derection, and so on. So the dictionary needs enormous memory capacity. And in recognition stage, the parametric eigenspace method need to match input image to all image sets in the dictionary, therefore, needs enormous time in matching. So, for practical use, memory capacity in dictionary and matching computations in recogniton in parametric eigenspace method need to be reduced more.

This research proposes generating hierarchical dictionary in parametric eigenspaces in order to reduce the memory capacity in the dictionary and matching computations in recognition in parametric eigenspace method. To put it concretely, this research reduces the memory capacity in the dictionary by thinning out for the image sets varying continuously the pose, and reduces the matching computations in recognition by generating hierarchical dictionary.

This research proposes the classification of image sets in the closed curved line, because the images of target object to be recognized are distributed around the closed curved line, for the dictionary in the parametric eigenspaces method constructs the closed curved line in the parametric eigenspaces following object rotation. By classifying images in the closed curved line, classified image sets are made of the images that are neighboring to each other in viewpoints, and can include images not existed in the dictionary to some degree. Further, this method proposes the optimum classification of images in the sense of distinction and minimum square in the closed curved line as the method to classify images in dictionary so as to separate images well. Then, the classified images has only images neighboring to each other in viewpoints and similar to each other in eigenspaces. So classified images can be represented by one image, and can reduce memory capacity in the dictionary by representing a few images instead of many images.

This method constructs hierarchical dictionary by classifying the classified images in the closed curved line reflexively. In this way, by generating the tree for the dictionary from the root to leaves, we can recognize with efficient matching, lowering pose errors based on the coarse-to-fine strategy in the recognition stage.

We examined whether this method can reduce the memory capacity in the dictionary and the matching computations in the recognition by our recognition experiment using the hierarchical dictionary in the parametric eigenspaces that is constructed by this method. When we finish classification of image set whose variance in the class is small to some degree, then we can reduce images which construct the dictionary more than not hierarchical dictionary in Parametric Eigenspaces, and can reduce the memory capacity. And we can recognize with efficient matching, lowering pose errors. This means the hierarchical dictionary in the parametric eigenspaces is effective in reducing the memory capacity in the dictionary and matching computations in recognition .

However, this method constructs eigenspace not considering topology of viewpoints, but classifies images to construct hierarchical dictionary in parametric eigenspaces considering topology of viewpoints. The problem is that we need construct eigenspaces considering the topology of viewpoints.