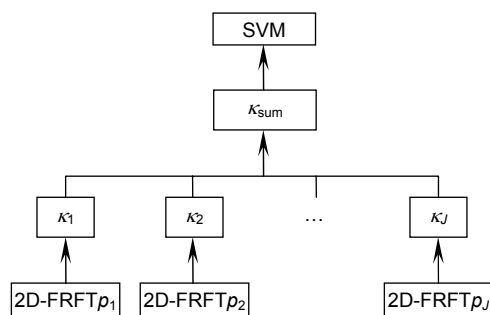# Multiple order fractional Fourier transformation for face recognition based on multiple kernel learning

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The face recognition framework of multiple order FRFT based on multiple kernel learning

Overview: Fractional Fourier transformation (FRFT) is a very useful tool for signal processing and analysis, which can well represent the content of the image by projecting it to the time-frequency planes. The features extracted by 2D-FRFT have shown very promising results for face recognition. However, one problem is encountered when we apply 2D-FRFT tools for recognition problem: it is hard to know that which order of 2D-FRFT (the angle of projection of time-frequency plane) is suitable for the specific task without prior knowledge. The common method is that different orders are experimented and we empirically select the best one. In spirit of multiple kernel learning in machine learning, we discuss the relations between the order selection in 2D-FRFT and kernel selection in multiple kernel learning. Both problems can be considered as an equivalent problem when the features from 2D-FRFT in different orders with the subsequent SVM classifier can be transformed to linear kernels with SVM according to Representer Theorem. By treating the linear kernels over different features from 2D-FRFT with different orders as the input to multiple kernel learning framework, and also by applying support vector machines (SVM) on top of the learned kernels, the weights in the multiple kernel learning framework correspond to the order weights in the fusion of 2D-FRFT features of different orders, we can then update the weights in the multiple kernel learning framework and SVM parameters through alternative optimization. It is proceeding by first learning the parameters of SVM when fixing the parameters of multiple kernel learning, and then updating the parameters of multiple kernel learning by gradient descent algorithm when fixing the parameters of SVM. Learning iterations are stopped until convergence. Therefore, the problem of order selection of 2D-FRFT can be solved by the off-the-shelf algorithms of multiple kernel learning. We apply the proposed algorithm to face recognition task, and the experiments are conducted on the ORL dataset and the extended YaleB dataset. From the results it can be observed that: 1) The performance are improved by combining different 2D-FRFT features in different orders in compared to single order 2D-FRFT features; 2) The performance of different 2D-FRFT order fusion are comparable and even better than other classical features for face recognition, such as Eigenface, LBP and HOG; 3) The learned weights in the multiple kernel learning frameworks can give us clues about the contribution of each order of 2D-FRFT. In a nutshell, the experimental results show the effectiveness of the proposed algorithm.