

Abstract

All tasks for facial analysis, including facial recognition, are initiated with face detection, which embraces precise alignment and augmented modeling of the face. Various factors associated with heterogeneous environmental conditions and imaging settings result in intra-subject diversity and inter-subject resemblance, leading to uncertainties in the recognition process. Different fuzzy sets and systems have proven their potential in managing uncertainty at various levels. Considering its merits, adopting rank-level fusion for face recognition is prudent for improved precision. With the common intention of proposing a more refined approach, the thesis titled “Studies on Face Detection and Recognition from Still and Video Images” encompasses four approaches to facial recognition in which various fuzzy sets are expended in the rank-level fusion involving different feature representations, derived by distinct feature extraction techniques.

The first face recognition methodology entails a general type-2 fuzzy set (GT2 FS) to address intra-class diversity and inter-class resemblance due to environmental conditions and imaging settings. This rank-level fusion framework involves three distinct sets of confidence factors (CFs) from a classifier fed with three different feature representations (vectors) corresponding to the three feature extraction techniques. From each set, the top classes were selected based on the CFs. For each class, a GT2 FS was shaped with feature vectors from the test image and training samples of the respective class. The complement of the type-reduced defuzzified value was regarded as a fuzzy rank. For each class, common to one or more sets, the fuzzy ranks are aggregated by summing them, and then this sum is fused with the complemented mean of the confidence factors to obtain a final score for each class. The test image was recognized based on its final rank.

The second face recognition methodology has taken advantage of an interval type-2 fuzzy set (IT2 FS) that utilizes intra-class face images to generate lower and upper membership functions defining the footprint of uncertainty (FOU) of IT2 FS. Distinct feature vectors derived from different FE techniques for a face image are used to utilize the different underlying discriminant features, which, in turn, address the issues of inter-class similarity. The defuzzified value was used to generate the fuzzy rank for the

class under consideration. The top K classes, which are selected based on the CFs of the classifier, are taken into consideration for the fusion process. For each class, the fuzzy ranks are integrated by summing and fusing with the respective complemented mean of the confidence factors to obtain the final fused rank. If a class does not appear in the top-ordered classes for a feature vector, a penalty is set against it. A facial image is identified based on the final fuzzy rank.

The third methodology employs an interval type-3 fuzzy set (IT3 FS) and multiple feature representations of a facial image to resolve uncertainties arising from intra-class divergence and inter-class similitude due to factors related to imaging and environmental circumstances. Corresponding to the input feature vector, a selected number of classes according to the CFs of the classifier are involved in rank-level fusion. For each class, corresponding training samples were employed to define the secondary membership domain. For each training sample, smaller proximity measures using training samples from all classes were set apart to express the lower and upper membership functions of the scaled Gaussian domain of the FOU of the IT3 FS. Successive direct defuzzifications lead to a crisp value, which is deemed a fuzzy rank for each top-ordered class. We combined these fuzzy ranks judiciously with the respective confidence factors generated by multiple feature vectors to obtain the final rank for that class. The class with the lowest rank was identified as the test-image class.

Another subsequent approach explored a methodology wherein the faces were detected and extracted from an outdoor video clip, and a custom-made face dataset was created. A rank-level fusion mechanism was implemented for facial recognition that uses the probabilities produced by the softmax functions of multiple deep CNN models. The fuzzy ranks are derived for the top-ordered classes from the probabilities produced by the softmax function (termed certainty indices) of the respective deep model by applying a Gaussian distribution function, followed by a complementation operation. Considering three deep CNN models, the complement of the average of the certainty indices is combined with the summation of the fuzzy ranks for each class. A penalty mechanism is implemented for a class not included in the top-ordered classes corresponding to an FV. The class with the lowest final ranking was identified as the test-sample class. All methodologies expounded in this thesis were evaluated on several face databases, such as AT&T, FERET, UMIST, Faces94, and Chokepoint, and demonstrated their pre-eminence over similar related approaches.