4-10

Fuzzy models in feature extraction: some prerequesites and trends of development

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The study of image analysis and processing enables us to show various sources of uncertainty, inaccuracy and fuzziness in data and knowledge related to these processes, such as:

1) input image variability depending on the angle of view, light, brightness and some other factors (for instance, any image is marked by uncertainty and fuzziness due to the differences in brightness levels);
2) inexactitude in representing the image in a feature space induced by a priori uncertainty of image classes, their intersections and the absence of one-to-one correspondence between feature space and image class space;
3) systematic classification error;
4) scene context influence (often some additional information associated with a scene context may be of primary concern, for example, the presence of other objects, their positions etc.).

So the use of fuzzy techniques in image sciences is required. Each vague (MxN)-image with k-levels may be seen as a finite set of fuzzy singletons where membership values give some levels of brightness regarding to a basic level. As a result of our analysis, the following ways and strategies of implementing fuzzy concepts and models in image sciences are considered.

1. Image processing is made by using conventional (non-fuzzy) techniques, and an obtained classification is corrected by means of

fuzzy expert system (including fuzzy production rules or/and fuzzy frames).

2. The existing algorithms of cluster analysis and image processing, such as c-means algorithm, thresholding, region growing algorithm, are fuzzily extended with the use of fuzzy sets or fuzzy measures (possibility/necessity measures).

3. Generalized contrast intensification operators and measures (indices) of fuzziness (entropies of fuzzy sets) are used to decrease the image ambiguity in the edge detection algorithms. Here the entropy measures may be used to specify image quality, to validate the contrast intensification operators or to improve the techniques of contrast enhancement. Another promising way is to train fuzzy neural networks for edge detection.

4. The development of special (image-sciences-oriented) branches of fuzzy mathematics, such as fuzzy geometry of space and fuzzy topology, is of particular interest. Specifically, it means the introduction of special fuzzy features in the framework of determining global and local features in image processing problems. We may cite as examples of fuzzy geometric objects fuzzy point, fuzzy line, fuzzy polygon, and as fuzzy global features fuzzy area, fuzzy perimeter etc. The study is performed, how to apply such fuzzy geometric properties in describing ill-defined regions and extracting objects. The comparison of some ordinary and fuzzy image analysis algorithms is made, and main advantages of fuzzy techniques are discussed.