4.5.21. USE OF DATA FUSION THEORY FOR IMPROVING RELIABILITY OF X-RAY CASTINGS INSPECTION

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X-ray imaging is a well established technique for castings inspection. An automatic defect detection and recognition software is necessary for implementing a fully automated inspection system. The main issue of such a software is to detect all true defects, while avoiding any false alarm. The Intelligent System for Automated Radioscopy (ISAR) is a software developed at Fraunhofer EZRT, which has an excellent performance in terms of true defects detection. Our work is devoted to the improvement of the ISAR system in terms of reduction of the false alarms rate.

The proposed method is based on Dempster-Shafer theory, also called Evidence theory, commonly used in the field of data fusion. After segmentation of the radioscopic image, a set of detected objects is available, each of which to be classified either as a false alarm or as a true defect. A feature extraction step allows to get an array of parameters for each object (area, contrast, elongation, …). A total of 11 features has been selected, where each feature is considered as a source of information. Goal of the data fusion approach is the determination of the feature combination optimally classifying all potential defects. For that reason, all features have been combined by pairs, triples and the whole together using the Dempster rule of combination. Statistical combinations using mean and median values were also carried out.

Before combining the features, it is necessary to translate them into a common value space, which is called a mass function in the Evidence theory. An automatic algorithm for attribution of masses for each feature value has been developed and implemented, based on the histogram of the feature and the usage of fuzzy sets.

Two databases were constructed for learning and validation of our approach, containing about 300 objects each. Each object was classified manually as true defect or as false defect. This manual decision was considered as reference for our classifier.

Very good results were obtained on the validation database. Several combinations of features are better than the actual ISAR system in terms of number of true defects correctly classified and also in terms of number of false alarms correctly classified. The best combination for true defects correctly classifies 99.1% of the true defects, instead of 97.8% for ISAR. The best combination for false alarms correctly classifies 98.4% of the false alarms, instead of 72.3% for ISAR. The best result for classification of both classes is 98.2% of true defects and 90% of false alarms.

The main advantage of our method is that it is not a “black box”, and all the approach is completely mastered and its operation and interpretation is very simple. Moreover, no expert supervision is required and there is no limitation on the number of features. Our method can also serve to select the useful features for a given inspection task, by choosing the adequate features combination.