Development of Methods to Judge the Reusability of Hardware Using Rust Pictures

Background

In recent years, each electric power company has enhanced its effective use of the existing equipment and rationalization of maintenance checks. The evaluation of whether hardware that has been corroded with rust can be reused, has been carried out by the human eye based on the judgment of a sample color pallet photograph. However, the pallet can represent only limited states of rust, therefore the judgment depends on human expertise, and human evaluation tend to vary. In order to solve these problems, a database of rust pictures, which attaches judgment labels, is constructed and maintained and a system which can carry out an appraisal of reusability is developed by using this enriched database.

Objectives

To develop an efficient construction technique of a rust picture database which attaches judgment labels; and to verify the accuracy of the reuse judgment system which is based on the rust picture database, for the crossarms of power distribution poles.

Principal Results

1. Construction technique of a picture database with a judgment labels

A construction technique for an efficient rust picture database with the following features was developed using Support Vector Machine (SVM) - a pattern classification method.

(1) In the case of attaching judgment labels to non-judged image data, the labels are automatically estimated by SVM, which ascertains the optimal discriminant hyper-plane. However, pictures with a low reliability of automatic labeling are judged by human eyes. By this iterative process, the discriminant hyper-plane becomes even more optimal and will be able to perform more accurate classifications without a lot of pictures that have had judgment labels attached by a human expert (see figure 1).

(2) The developed method was applied to U.S. postal code numbers for handwritten number recognition, and the effect was evaluated. When our developed method was applied to 3,747 pictures of the numbers 0, 1, and 2 for “judgment label attachment”, the “right judgment label attachment” was able to be performed to all 3,747 pictures with only 166 human-judged pictures (see table 1). This is about only 5% of the cost if a human had had to make “judgment label attachments” to all 3,747 pictures.

2. Verification of reuse judgment accuracy

The reuse judgment accuracy of the developed method was verified using the crossarm pictures obtained in joint research with the Chubu Electric Power Co., Inc.

(1) When pictures (400 sheets), which consist of “reuse” and “retirement” pictures, were classified by our developed method, the average classification accuracy was 89%.

(2) When pictures (600 sheets), which consist of “reuse” and “retirement” and “reuse after plating” pictures, were classified by our method, the average classification accuracy was 71%.

Future Developments

The testing system for the reuse judgment for crossarms will be further developed, and a field test will be performed. Moreover, with regard to the construction technique of an efficient picture database with judgment labeling, the required automation technique of parameter tuning will be developed.

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Reference

M. Yamana, et.al., 2003, “Effective database construction method based on human and computer interaction for equipment maintenance”, Technical Report R00032 (in Japanese)

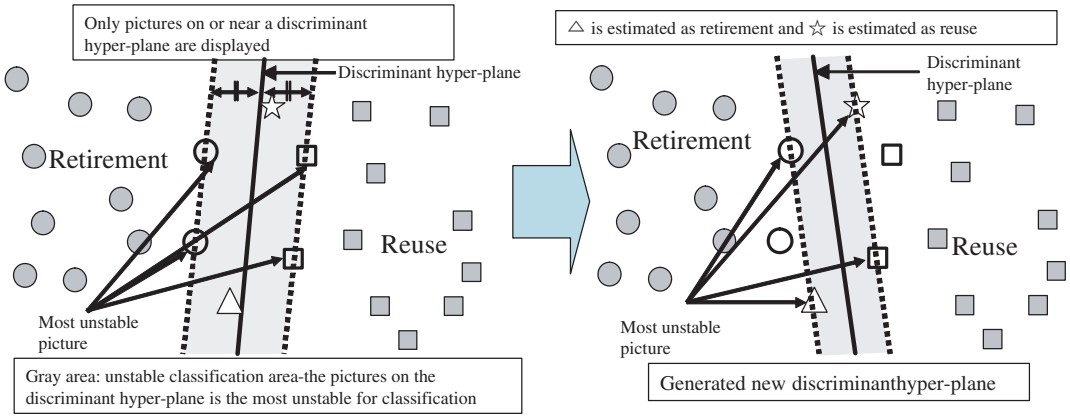

Fig.1 Displayed pictures to human experts to attach correct labels

Table 1 Comparison of cost for attachment judgment labels

	Proposed method	H.W.S.
Number of required pictures	166 ± 5 pictures	3,747 pictures(all)
Relative cost ratio	0.044	1
Required time to classify 100,000 pictures (10sec./sheet)	12.3 hours	278 hours
Required working days to classify 100,000 pictures	1.8 days	40 days

Reuse | Reuse after plating | Retirement

Fig.2 Examples of rust pictures on crossarm

Table 2 Classification accuracy for two-class test data

Classification accuracy		
Total(averaged)	Reuse	Retirement
89%	86%	91%

Table 3 Classification accuracy for three-class test data

Classification accuracy			
Total(averaged)	Reuse	Retirement	Reuse after plating
71%	78%	78%	58%