Configuration assistant for vision-based inspection

Nowadays, vision-based inspection systems are present in many stages of the industrial manufacturing process. Versatile vision systems are used to accommodate the broad range of inspection requirements but limitations appear due to the time-consuming system setup performed at each production change. This work aims at providing a configuration assistant that helps to quicken the lengthy manual system setup.

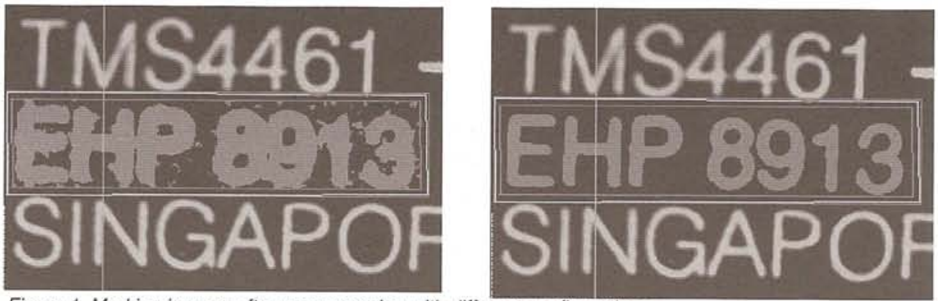

Figure 1. Marking images after preprocessing with different configurations.

A versatile visual inspection system possesses a certain number of *measurement methods* (e.g. dimensions, positions, similarities, …) and some associated *treatments* (e.g. decision, storage, alerts, …). Some of them can be selected for customizing the system for a specific inspection task. This selection, called the *visible configuration,* is usually rather straightforward. Selecting the *hidden configuration*, which consists of a set of parameters that tune the selected methods and treatments for the custom application, is more difficult however. Choosing a good set of parameters is often a lengthy, tedious process during which the operator empirically tries to tune various dependant variables. The goal of the assistant presented here is to provide hidden configurations automatically.

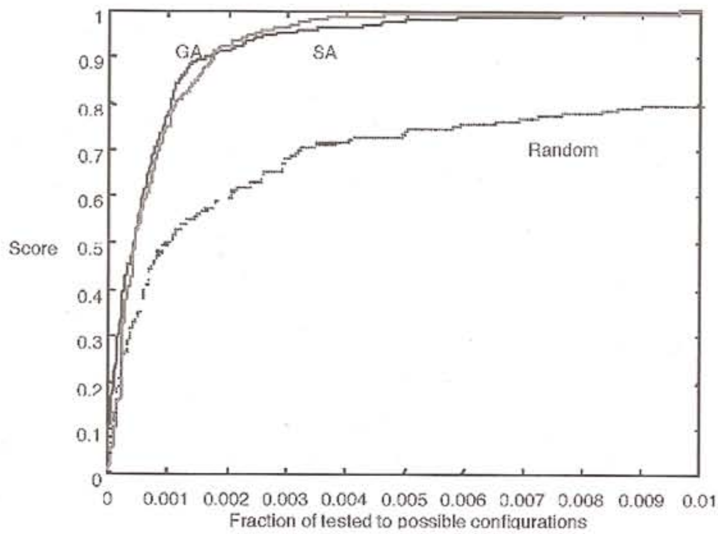

Figure 2. Averaged score over 100 trials .

A first aspect of the assistant concerns the performance rating of a specific hidden configuration. In essence, it uses a performance function and applies to a set of images *S* obtained from good and bad objects to be inspected. The performance function *F* takes positive values only when the inspection system performs without mistakes on *S* and has a magnitude that increases with the confidence in the decision.

A second aspect concerns the hidden configuration selection. It proceeds by maximizing *F* with a search over permitted ranges for the parameters. The search requires smart and robust heuristics because the configuration space is typically high dimensional, and also because the performance function is unpredictable. Specifically, a simulated annealing algorithm and a genetic algorithm are considered for this task. The search is iterated until a stopping criterion (time limit, minimal F-value) is satisfied. Upon termination, it delivers the optimal configuration characterized by a set of parameters, as well as the associated F-value that provides information about its quality.

One application is to aid in the inspection process of markings found on top of molded integrated circuits. This process faces frequent change in the circuits to be inspected and also large variations in the marking type and quality. Thus, system setup is essential and frequent. The application-visible configuration system uses various methods that generate two measurements and end up with a single accept/reject decision. The choice of a well-suited performance function has been studied and is described in Reference 1.The hidden configuration consists of as many as eight parameters: two thresholds for the decision, two thresholds for binarizing the image, three morphological parameters and one positional parameter. Figure 1 shows an example of an integrated circuit marking after preprocessing. The left image reflects the effect of a bad hidden configuration whereas a good one is reflected in the right image.

In this example, there are approximately 1013 possible hidden configurations! The huge size of the configuration space clearly rules out an exhaustive search. A search with intelligent methods, however, was shown to reliably find a near-optimal configuration within a short time. Indeed, it requires only a small fraction of the time that would be necessary to try all configurations exhaustively (typically less than 1% in this application). Figure 2 shows the averaged score (normalized *F*-value) of configurations obtained with two search heuristics, namely a genetic algorithm (GA) and simulated annealing (SA), after a given number of trials (end criterion). For comparison, a curve representing a pure random search method is also given. Although all methods will eventually find the best configuration as a consequence of monotonicity of the score function, genetic and simulated annealing methods have been shown to be very efficient in terms of the average time needed

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to reach a score.

The developed assistant derives great benefit from its ability to provide near-optimal solutions in a short period of time. Activated in association with a learning set of example circuits, it quickly delivers near-optimal solutions that are selected for production inspection. An additional benefit of the proposed configuration assistant is the availability of a score value, which gives a hint of its confidence in the configuration.

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Reference

1. O.Hüsser and H. Hügli, *A configuration assistant for versatile vision-based inspection systems*, **Proc. SPIE 3966,** pp. 259-269, February 2000.

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