Reduction of Defect Misclassification of Electronic Board Using Multiple SVM Classifiers

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ABSTRACT

This paper proposes a new method to improve the classification accuracy by multiple class classification using multiple SVM. The proposed approach classifies the true and pseudo defects by adding features to decrease the incorrect classification. This approach consists of two steps. First, detect the straight line by Hough Transform to the inspection image and condition is judged with the gradient. More than 80% of AOI images consist of images with the margin line between base part and lead line part which has the same direction. When detected line directions are almost the same directions, shifted image of inspection image is generated and used as the reference image. In case of different directions of detected lines (this case holds for less than 20% of AOI images), reference image is generated manually. After the reference image is prepared, the difference is taken between the inspection image and reference image. This leads to extract the defect candidate region with high accuracy and features are extracted to judge the defect and foreign material. Second, selected features are learned with multiple SVM and classified into the class. When the result has the multiple same voting counts to the same class, the judgment is treated as the difficult class for the classification. It is shown that the proposed approach gives efficient classification with the higher classification accuracy than the previous approaches through the real experiment.

Keywords: Candidate, Defect Classification, Extraction of Defect, Multiple Class Classification, Support Vector Machine

INTRODUCTION

Basically, Printed Circuit Board (PCB) is a piece of phenolic or glass epoxy board with copper clad on one or both sides. The portion of copper that are not needed are etched off, leaving ‘printed’ circuits which connects the components. It is used to mechanically support and electrically connect electronic components using conductive pathways, or traces,
etched from copper sheets and laminated onto a non-conductive substrate. PCBs are rugged, inexpensive and highly reliable and so it is used in virtually all but the simplest commercially produced electronic devices.

In recent years, the demand of electronic devices with more compact design and more sophisticated functions has forced the PCBs to become smaller and denser with circuits and components. As it is crucial part of electronic device it needs to be properly investigated before get launched. Automatic inspection systems are used for this purpose but due to more complexity in circuits, PCB inspections are now more problematic. This problem leads to new challenges in developing advanced automatic visual inspection systems for PCB.

Automatic Optical Inspection (AOI) has been commonly used to inspect defects in Printed circuit board during the manufacturing process. An AOI system generally uses methods which detects the defects by scanning the PCB board and analyzing it. AOI uses methods like Local Feature matching, image Skeletonization and morphological image comparison to detect defects and has been very successful in detecting defects in most of the cases but production problems like oxidation, dust, contamination and poor reflecting materials leads to most inevitable false alarms. To reduce the false alarms is the concern of this paper.

Previous approach (Tanaka, Hotta, Iga, & Nakamura, 2007) classifies the defects using neural network and Rau and Wu (2005) proposes a method to classify the defects using the intensity at the pixels around the defects region. These approaches classify the defect under the condition that kinds of the defects are previously known. There are some defects whose recognitions are difficult even with the visual inspection. These defects cause the problem. The problem includes the case of misjudgment where a true defect is recognized as a pseudo defect and it is included in the products as a result. Kondo (Kondo, Kikuchi, Hotta, Shibuya, & Maeda, 2009) has been proposed for the distinction of defect classification by determining the features at random. Kondo, Kikuchi, Hotta, Shibuya, and Maeda (2009) classifies the kinds of defect with selecting the appropriate features with classifiers, but there are still incorrect classification cases where a true defect is classified into a pseudo defect.

Approaches to extract the defect candidate region are proposed in Onishi, Sasa, Nagai, and Tatsumi (2003) Maeda, Ono, Makoto, Kubota, and Nakatani (1997), and Numada, and Koshimizu (2007). Onishi (Onishi, Sasa, Nagai, & Tatsumi, 2003) prepares two images of test image and reference image of mask pattern and takes difference image by logical AND. Maeda (Maeda, Ono, Makoto, Kubota, & Nakatani, 1997) propose IR image matching and Mahalanobis distance, respectively.

Other classification approaches include Wakabayashi (Wakabayashi, Tsuruoka, Kimura, & Miyake, 1995) using PCA, Ishii (Ishii, Ueda, Maeda, & Murase, 1998) using variance inside and outside classes, Amabe (Amabe, & Nagao, 2006) using Genetic Algorithm, Roh (Roh, Yoon, Ryu, & Oh 2001) using Neural Network. Another approach to remove incorrect classification of true defect is proposed in Iwahori (Iwahori, Futamura, & Adachi, 2011; Iwahori, Kumar, Nakagawa, & Bhuyan, 2012), where histogram for each defect and evaluating equation are introduced. It is noted that these approaches generate the reference images which are used to detect defect region manually. This paper generates the reference image automatically for around 80% data of AOI images using line detection by Hough Transform. Appropriate determination of threshold can detect the defect region with high accuracy. The paper also proposes the approach to judge the defect of electronic board and foreign material attached on the board with reducing the number of misclassification. Multiple SVM is used to achieve the multiple classification with increasing the features, therefore it is performed to improve the accuracy of classification.
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