Steel Surface Defects Detection and Classification

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Abstract. In computer vision applications, the surface defect classification is one of the important issues. In this work, we propose a new framework. The advantage of our framework is that to get many features using SIFT for an image and good classification performance according to our strategy. Experimental results on comparison with the different kernels functions for c-SVM classifier demonstrate the effectiveness of the proposed method on steel surface defect detection and classification.

Keywords: Support Vector Machines, surface defect detection, iron error classification.

1 Introduction

Unshaped object classification is one of the difficult tasks in computer vision and pattern recognition application. Recently, many computer vision algorithms are used for detecting the failure in industrial environment. There are several works that detect and classify steel surface defects. The [4] classified the defects in rolled steel surface using several image processing algorithm and self-organizing map (SOM). Some works [7] and [8] have been employed in a wide range of real world problems using SVM. Several recent studies [3], [5] have reported that the SVM generally are capable of delivering higher performance in terms of classification accuracy than the other data classification algorithms. This paper is organized as follows. In section 2, we introduce our classification system with feature extractor and SVM. In Section 3, we detail all experiments results. Finally, we have some conclusions in Section 4.

2 Defects Detection using SIFT

D. G. Lowe describes a method [1] for extracting distinctive invariant features from images that can be used to perform reliable matching between different views of an object or scene.

SIFT is effective for defect detection. It detects feature points exactly instead of rough regions. When SIFT has fixed parameters, one problem occurs that many descriptors are detected in some images, but very few descriptors are detected in other image. Therefore, we have configured the parameters for number of SIFT descriptors.
manually that will be different for each class examples. After detecting enough number of points, we need to remove outliers and overlapped points. In this case, we made a decision focused on the center of the distribution of points and removed overlapped points and the points that locate far from center dense part.

3 Defects Classification

**Support Vector Machines** (SVM) map input vector to a higher dimensional space where a maximal separating hyperplane is constructed. Two parallel hyperplanes are constructed on each side of the hyperplane that separate the data. The separating hyperplane maximizes the distance between the two parallel hyperplane [3].

**Proposed Voting Strategy**

Our proposed framework has 2 steps. First step is that non-rectangle shaped ROI Detection and Feature Extraction using SIFT. The second step is the classification using SVM. In Figure 1, we have shown our classification diagram. In our task we need to classify four classes. Therefore, we use four SVMs with one –versus – all strategy. Each SVM trains the input feature vectors with different labels (the solid lines are indicates that the input features are trained with label 1, then dashed lines are indicates that input features are trained with label -1).

![Fig. 1. The diagram of our proposed voting strategy for 4 classes.](image)

For a given test image, we can get a lot of feature points. Then, we test each feature points with same label, then, the classifier output a label for each feature points. Among outputs of four SVMs, we vote the highest percent result. Through taking vote we achieve the good results.

4 Experimental results

The experimental results show the classification accuracy in different kernels function with different parameter values for SVM. In this experiment, we divided the data with training–test ratio is 70% and 30% by feature vectors.

![Fig. 2. The a) Dark field-Black Line type defects, b) Dark field – Line Scab type defects, c) LS Black Line type defects and d) LS Scratch type defects.](image)
Classification accuracy

We have shown several examples of the experimental results with different kernels as linear, polynomial and RBF, different parameters in Table 1.

<table>
<thead>
<tr>
<th>Parameters (kernel)</th>
<th>class1</th>
<th>class2</th>
<th>class3</th>
<th>class4</th>
</tr>
</thead>
<tbody>
<tr>
<td>c =1 (Linear)</td>
<td>90.91</td>
<td>70.59</td>
<td>81.75</td>
<td>71.72</td>
</tr>
<tr>
<td>c=1,d=2, g=1/128  (Polynomial)</td>
<td>92.11</td>
<td>67.92</td>
<td>81.75</td>
<td>70.29</td>
</tr>
<tr>
<td>d=2, c=3, g=0.06 (Polynomial)</td>
<td>94.74</td>
<td>79.25</td>
<td>83.21</td>
<td>70.29</td>
</tr>
<tr>
<td>c=1000, g=1/128(RBF)</td>
<td>93.42</td>
<td>79.25</td>
<td>86.86</td>
<td>72.28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th># of training images</th>
<th>Class1</th>
<th>Class2</th>
<th>Class3</th>
<th>Class4</th>
</tr>
</thead>
<tbody>
<tr>
<td># of testing images</td>
<td>4</td>
<td>13</td>
<td>17</td>
<td>6</td>
</tr>
<tr>
<td>Total images</td>
<td>6</td>
<td>17</td>
<td>25</td>
<td>23</td>
</tr>
</tbody>
</table>

Testing Performance 100%(2) 100%(4) 100%(8) 82%(14)

5 Conclusion

In this paper, we demonstrate a new framework for steel surface defect detection and classification. One main approach is to detect non-rectangular ROI and many feature vectors from an input image using SIFT. The second thing is that adopting SVM classifiers work in voting strategies among many features for an input test image. The experimental results show that our proposed method is reasonable. One problem was we don’t have enough samples for each class.

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References