Quality Inspection Mechanism for Roll Foam Stickers in the Garment Industry

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Abstract

This paper describes an image processing approach which can be used to inspect the quality of defected sticker tags in the garment industry. The approach involves extraction of features from a quality image and then, matching extracted good key points with the existing other or defected images to express the quality of the defected image based on the percentage of key point matching. Firstly, several descriptor/matcher algorithms are tested to finalize the most suitable descriptor/matcher combination. It is found that SURF/FLANN algorithms show a high degree of accuracy in terms of the speed and the number of matching points. To implement the proposed algorithms, OpenCV on Python platform is used as they have inbuilt functional libraries which support for these powerful matching algorithms. Finally, a set of defected images are tested to compare the effectiveness of the selected pair of descriptor/matcher algorithms. The results show that the degree of defectiveness is proportional to the quality percentage found through the image processing technique.

Keywords: *Defected Image, Image Processing, Quality Inspection, SURF/FLANN*

1. Introduction

The garment industry uses price tag stickers [Figure 1] to provide details about the clothes. These stickers are manufactured in Roll Foam Format. In the local industry, particularly in developing countries, the workers have to manually remove defected stickers from these rollers before they are attached with the clothes.

Figure 1. Price tag stickers in the garment industry

The manual sticker inspection is time consuming task in the local garment industry. An affordable machine which can be customized according to the application would be a good solution for that. This work presents an image processing technique to initiate an automated solution for the quality inspection of garment sticker rollers in the local industry. Here proposed image processing technique must be able to recognize the defective stickers from the sticker rolls .These stickers mainly contain details on the bar code, serial number and the size of the product [Figure 1]. These stickers are in rollers. In each roll there are about 3000 uncounted stickers. Among these stickers, a considerable amount of defective low quality stickers can be identified. The garment industry wants to remove these stickers from the roller before feeding them to the sticker pasting machine.

The quality inspection of images can be executed using feature matching functions by comparing the features of the ideal image (set by the user) and the features of the captured target image. If the target image contains a threshold amount of features that are in the ideal image, the target object is accepted quality wise, else the target object is rejected. Hence in this project, the related work can be mainly categorized in to two parts as,

1. Feature extraction and,
2. Feature matching.

3. Some Literature

Authors in [1] have presented an image detection system based on Log-Polar Transform (LPT) and SIFT algorithms. Unlike other schemes that extract features from the original image, the presented scheme extracts features from the transformed image by LPT. Here, the presented scheme utilizes SIFT to extract geometric-invariant features from the LPT images to achieve greater robustness and resistance to geometric distortion. When given a suspect image, the scheme compares the extracted features from the host LPT image and the suspect LPT image to determine similarity. Their experimental results show that the presented scheme can achieve high recall and precision rates even when the duplicate image is modified and not exactly the same as the host one.

Authors in [2] have proposed a technique using SIFT algorithm to present local features description of binary images. This is more relevant work to this project as garment labels can also be categorized as binary images. The novelty of the proposed algorithm is make use of SIFT for binary image matching by taking the power of Hough Transform (HT) in line detection. HT can be used on any line orientation. Thus, HT investigates lines as criteria for binary image similarity beside SIFT features for local and corner descriptions. Here, their experiments highlight the superiority of this approach for binary images which contains straight lines.

Sometimes, image preprocessing is required to in order to extract desired features from an image. Authors in [3] have proposed a new approach based on image pre-processing to Speeded Up Robust Features (SURF) in target recognition. The proposed image preprocessing method improves the global air-light first by using Retinex algorithm of the original image, then a homomorphic filtering scheme is proposed after db2-type wavelet transform. For the purpose of feature extraction, initially target part is extracted from the original image and is converted into a gray scale image. Then matched by SUFR algorithm. A detailed analysis of the results are compared with the traditional methods that is histogram equalization and the performance of the method proposed in this paper is satisfactory.

Features from Accelerated Segment Test (FAST) based on the circular mask segment test is recognized as a superior feature detector in terms of speed. The radius of the circular mask and the arc length of the segment are the two geometric parameters that affect the speed and the quality of the detector. Binary Robust Invariant Scalable Key points (BRISK) applied FAST directly across all the layers of the scale-space representation of an image without considering the effect of these parameters. Authors in the paper [4], have proposed a new feature detector, Features from Adaptive Accelerated Segment Test (FAAST), to further reduce the computation time, and to improve the quality of the corner response of FAST. To apply this detector across all the layers of the scalespace, the proposed detector applies different mask sizes with their corresponding arch lengths across different layers of the pyramid. The superiority of this algorithm is shown in the Figure 2. Their experimental results on benchmark datasets reveal that the proposed method produces significant improvements in repeatability score by generating more discriminating features that are close to the real corner location.

(a) FAAST Detector (Bike)

(b) FAST9-16 Detector (Bike)

Figure 2. FAAST and FAST9-16 matching example using the reference image and the first image in the Bike test sequence: a detection threshold of 65 and a matching hamming distance threshold of 75 are used. The resulting matches are connected by the green lines showing no clear false positives. The size of the circles denote the scale of the detected key points while the radials denote their orientation.[4]

Authors in the paper [5] have presented a modified feature point descriptor (MBRIEF). It includes adjusting the location coordinates of the pixels in the image patch according to the feature point's main orientation and adopting a new test definition by introducing the adaptive threshold. The results of their experiments show that the method is more robust and more distinctive than the original descriptor BRIEF in case of the obvious changes of the viewpoint. It is rather robust for the translation and rotation of the affine transformation. However, M-BRIEF requires the extra pretreatment of rotating the matching images before computing the descriptor. Thus it has higher cost of time than BRIEF even though the time factor is not important in my project. Moreover, this work is essentially about the two-dimension recognition which is more compatible with my work.

It is important to identify compatible feature extraction algorithm as well as feature matching algorithms for this project. Authors in the paper [6] have dealt with the recognition of printed Oriya script a popular Indian script. Their work is based on the gradient features based approaches for character recognition of printed Oriya script. For this, Histogram of Oriented Gradient (HOG) and Scale Invariant Feature Transform (SIFT) have been used to extract features from each individual character to uniquely identify it. Support Vector Machine (SVM) classifier, Brute Force (BF) Matcher and the Artificial Neural Network (ANN) have been used for efficient recognition. The performance of each approach for character recognition have been presented based on their input parameters and performance metric. lt has been found that when HOG features were classified using ANN, it outperforms over other approaches.

By testing the feature detection with every algorithm, the most accurate one for the quality inspection has to be determined. In the next step, extracted key points and their descriptors are stored to compare the features of the target image. For that most suitable feature matching algorithm has to be identified as similar to the work in [6].

4. Method

The proposed method of image processing and quality inspection consists few steps.

- Selection of the Most Compatible Algorithms for Feature Detection, Extraction and Matching
- Extracting Features of the Ideal Image
- Capturing Features of the Target Image
- Feature Matching
- Quality Inspection

Selection of the most compatible feature-matcher pair

There are higher number of feature detection algorithms (descriptors) than feature matching algorithms. In this work, firstly the Region of Interest (ROI) of a non-defective label is configured. The captured data from the region of interest can be saved as a NumPy array. In order to extract locations of key points in the image, the obtained Numpy array is processed using feature detection algorithms. Computer Vision and Image Processing tool boxes in Matlab provide inbuilt functions to implement some commonly used feature detection algorithms. However it lacks direct functions on feature matching. On the contrary, OpenCV library in Python provides direct access to some fast compatible algorithms on feature matching such as FLANN (Fast Library for Approximate Nearest Neighbors)and BF (Brute Force Matcher). Further we can access feature descriptors such as SIFT(Scale Invariant Feature Transform), SURF (Speeded-Up Robust Features), FAST Algorithm, BRIEF (Binary Robust Independent Elementary Features) and ORB (Oriented FAST and Rotated BRIEF).

To determine the most suitable algorithms which are most appropriate for these label images, firstly different combinations of feature descriptors and matchers are compared as presented in the Table 1. For this comparison, two slightly different images are used as the ideal image and the target image. The algorithm pair which matches a highest number of key points within the shortest period of time is selected as the best combination for this task. The procedure is explained in the next paragraph.

Table 1. Different combinations of feature detection and matching

Detector	SIFT	SIFT	SURF	SURF	ORB	ORB
Matcher	BF	FLANN	BF	FLANN	BF	FLANN

Here we have to find the best pair of feature detector-matcher. For that, a several combination of algorithms are applied to an ideal image [Figure 3] and a target image [Figure 4]. The order of combinations are presented in Table 1. Firstly, a descriptor is able to extract a number of good key points. Then the matcher matches extracted features to the target image. Figure 5 present the performance of the several Descriptor/Matcher combinations. Here the number of good key points the matcher can match, as well as the time duration for the entire operation are recorded. They are presented in the Table 2.

3780*1141

Figure 3:Image (1) for testing of feature detection and matcher combination performance

3750*1064

Figure 4:Image (2) for testing of feature detection and matcher combination performance

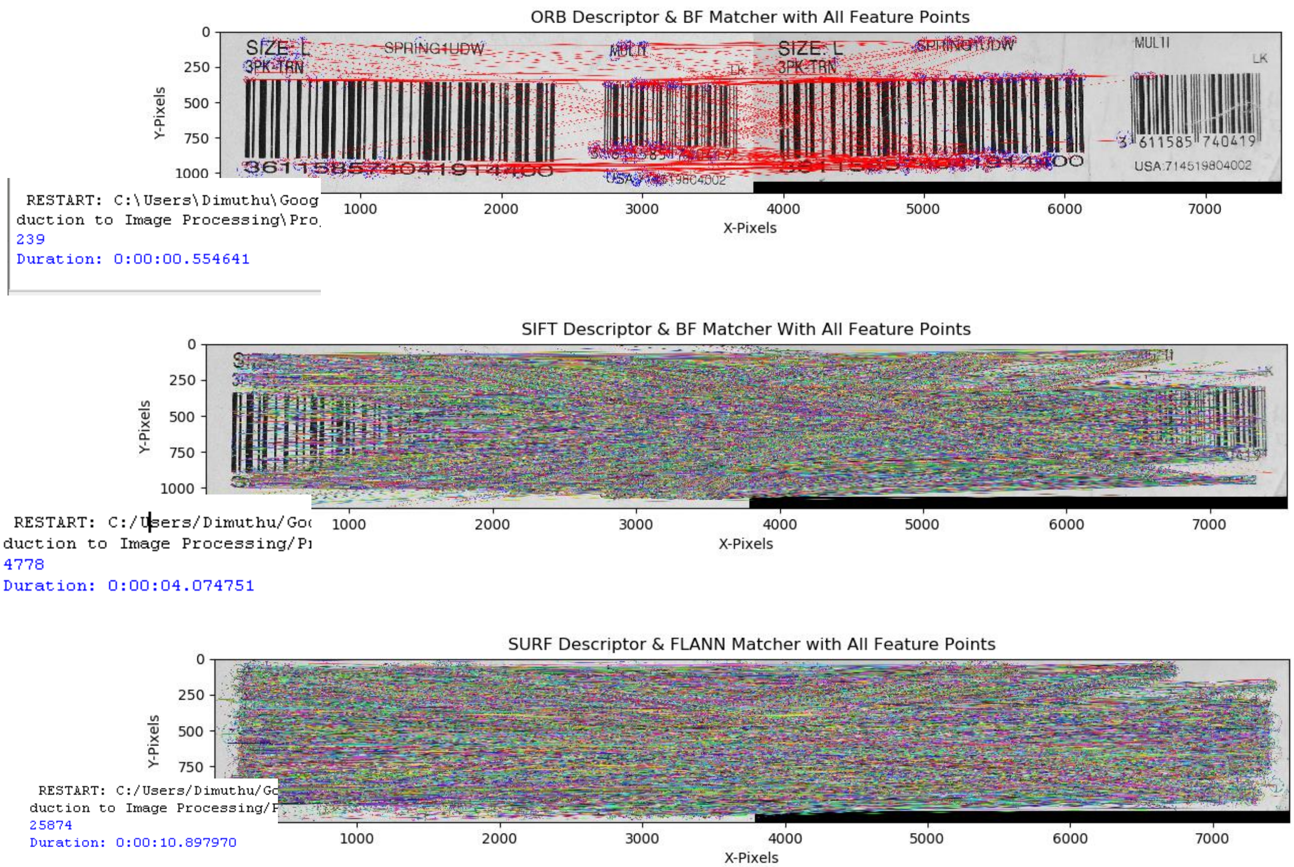

Figure 5. Performance of the ORB/BF, SIFT/BF, SURF/FLANN Feature/Matcher combinations

Table 2: Performance of different combinations of feature detection and matching

Detector Matcher	**SIFT BF**	**SIFT FLANN**	**SURF BF**	**SURF FLANN**	**ORB BF**	**ORB FLANN**
Key points	4778	4778	25874	25874	140	1100
Time (s)	4.131837S	2.917537	20.227068	10.823621	0.546489	6.093
Key-points/Time	1156.38	1637.68	1279.17	**2390.51**	256.18	180.53

From the results in the Table 2, it can be concluded that SURF/FLANN pair detects a high number of key points during a short period of time. Therefore, for the quality comparison of defected images this combination is used.

Mechanism of Feature Matching

Two distinct arrays which consist of a number of key points and their descriptors of ideal image and the target image are separately obtained. These arrays are compared to check whether there is a possible matrix (homography matrix) which represents the transformation matrix of key point locations in the ideal image to the key point locations in the target image. To find the homography matrix, initially, good matching points of the two images are computed using feature matching algorithms. For an example, the BF Matcher takes the descriptor of one feature in first and finds the distance to every individual descriptor of the second set from the taken descriptor of the first data set. After calculating all the distances, the closest distance is returned. Using KNN (K Nearest Neighbor) matching technique of any of the above algorithms"k" best matches for each descriptor from a data set could be obtained.

5. Results and Conclusion

Quality inspection of defected images

The quality inspection is executed by comparing the features of the ideal image (set by the user) and the features of the target image captured. If the target image contains a threshold amount of features that are in the ideal image, the target object is accepted quality wise, else the target object is rejected. The quality percnetage can be numerically presented based on number of good matching points. To comapare the performance and accuracy of the selected Detector/Matcher combination, a set of defected images are used. The defected images shown in Figure 6 shows different degree of defectiveness. While some are highly damaged, some are distorted with artifical noise at different levels.

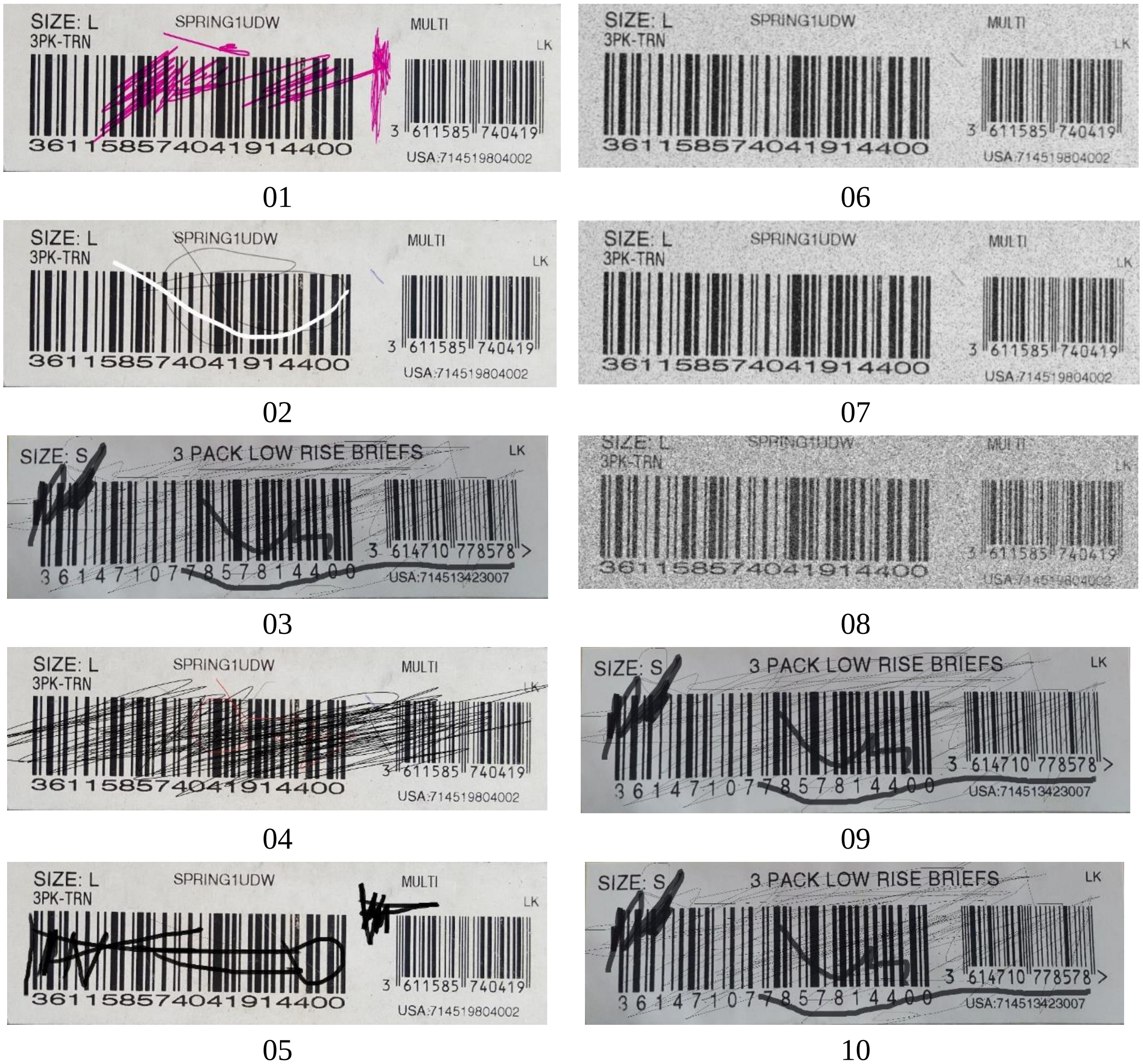

Figure 6. Some defected roll foam stickers in different damaged level

Figure 7 shows the feature matching of different of the ideal image with the defected images 1, 2, 5 and 10. These figure are arranged in a way that the degree of defectiveness increases with the image number, showing low defects in the upper images. Hence, the number of matching feature points should also be decreased when the defectiveness increases as witnessed through Figure 7.

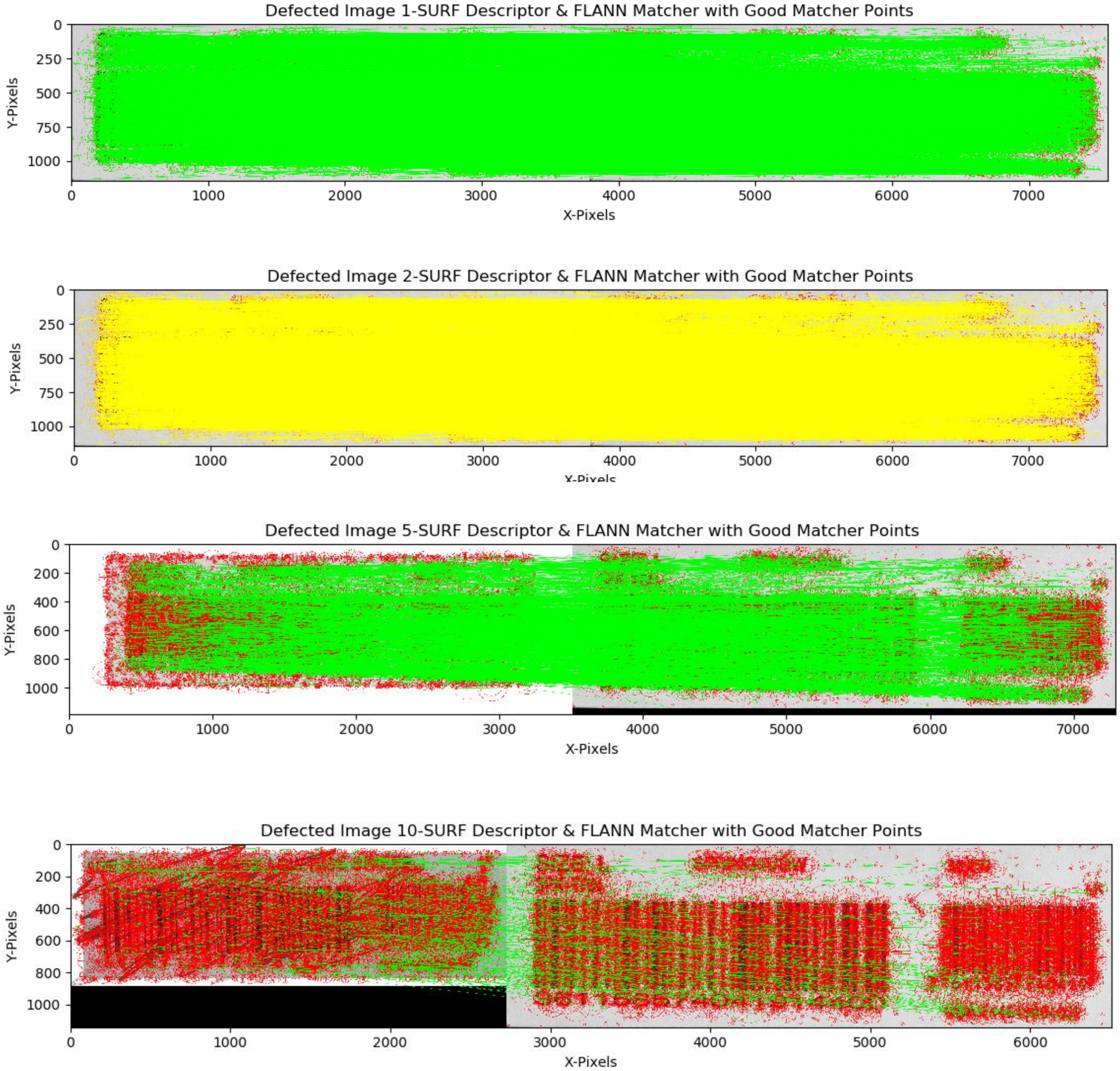

Figure 7. The feature extraction and matching performance by SURF/FLANN combination for the defected images 1, 2, 5, 10.

The quality of the detected match

If a particular frame has a homography matrix with the ideal image the number good matches in the target image detected by the FLANN based KNN matching was used as the numerical measure of the quality of the target. For finding the percentage of quality, the ratio of a number of good matching points in the target image to the number of total key points recorded in the ideal image is considered as presented in the equation (1). We can record the number of key points for all these 10 defected images. Finally with the help of equation (1) we can reveal the quality of image as an expression for the degree of defectiveness.

$$Quality(\%) = \frac{Number\ of\ good\ matching\ points\ in\ target\ image}{Number\ of\ keypoints\ recorded\ in\ ideal\ image} \times 100\% \qquad (1)$$

Table 3. Recorded quality of defected images using SURF/FLANN combination

No	Target Image	Good Matching Points Based on SURF/FLANN	The Image Quality
1	Defected Image 1	20755	80.21 %
2	Defected Image 2	20461	79.07 %
3	Defected Image 3	17810	68.84 %
4	Defected Image 4	9248	35.74 %
5	Defected Image 5	2427	9.4 %
6	Defected Image 6	1173	4.5 %
7	Defected Image 8_Gausian2	796	3.1%
8	Defected Image 7_Gausian1	325	1.25 %
9	Defected Image 9_SaltPeper1	263	1.01 %
10	Defected Image 10_SaltPeper2	229	0.8 %

The results in Table 3 and Figure 7 agree each other. It shows that the degree of defectiveness is proportional to the quality percentage found through the image processing technique. Here the used defected images are not exactly what we find as defected images in the industrial environment. Therefore, it is required to test the algorithm with the real defected images to express the exact accuracy. To conclude, these algorithms can be used in the industrial environment as they deliver relatively fast results. However, associated hardware system must be compatible to achieve the intended outcomes.

7. References

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