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Fault Detection in Bearing Using Digital Image Processing

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Abstract

Bearing defects are a major reason for poor quality and of embarrassment for manufacturers. Inspection processes done on these industries are mostly manual and time consuming. To reduce error on identifying bearing defects requires more automotive and accurate inspection process. Considering this lacking, this research implements a Bearing Defect Recognizer which uses computer vision methodology with the combination of local thresh holding to identify possible defects. The recognizer identifies the bearing defects within economical cost and produces less error prone inspection system in real time. In order to generate data set, primarily the recognizer captures digital bearing images by image acquisition device and converts the RGB images into binary images by restoration process and local threshold techniques. Later, the outputs of the processed image are the area of the faulty portion and compute the possible defective and non –defective bearing as an output.

1. Introduction

All steel industries aim to produce various competitive steel products. The competition enhancement depends mainly on productivity and quality of the steel produced by each industry. In this sector, there have been an enlarge amount of losses due to defective products. Most defects arising in the production process are still detected by human inspection. The work of inspectors is very tedious and time consuming. The identification rate is about 70%. In addition, the effectiveness of visual inspection decreases quickly with fatigue. Digital image processing techniques have been increasingly applied to steel bearing samples for analyzing the product.

As the technological progress is happening the products are now extensively made using steel material which needs to be ultra light weight and modular in nature steel components like bearing, As per industry statistics we have found that bearing are made up of steel material which is prone to various kinds of defects when manufacturing using image processing. Therefore we suggest a fully robust system taking advantage of image processing techniques (Image segmentation, Non smooth corner detection etc) must be explored to build an economical solution to provide Total Quality Management in manufacturing units which would allow an eco-system of continuous monitoring and improvement there by reducing the cost.

This paper is organized into Section I includes Introduction, Section II Related work, Section III Model Presentation, Section IV Results and Section V Conclusion and future work.

2. Related work done

IZZET Y O¨ NEL, K BURAK DALCI and I˙BRAHIM SENOL investigates the application of induction motor stator current signature analysis (MCSA) using Park's transform for the detection of rolling element bearing damages in three-phase induction motor. The paper first discusses bearing faults and Park's transform, and then gives a brief overview of the radial basis function (RBF) neural networks algorithm. Finally, system information and the experimental results are presented.

Deng Seir Due to the high demands for productivity and quality of bearing and the shortage of traditional detection methods, this paper proposes an automatic detection system based on machine vision technique. The detection system uses digital image processing technology to process the images collected by CCD camera and finish identification for the surfaces of bearing quickly and accurately. Firstly, least squares fitting and annulus scan are used to locate the bearing and the regions which will be detected. Secondly, contrast enhancement and low-pass filtering are used to improve the quality of images. Next, object inspection is applied to determine whether defects exist. Finally, the shape feature is used to finish recognition of defects.

Se Ho Choi This paper presents a real-time defect detection algorithm for high-speed steel bar in coil. Because the target speed is very high, proposed algorithm should process quickly the large volumes of image for real-time processing. Therefore, defect detection algorithm should satisfy two conflicting requirements of reducing the processing time and improving the efficiency of defect detection. To enhance performance of detection, edge preserving method is suggested for noise reduction of target image. Finally, experiment results show that the proposed algorithm guarantees the condition of the real-time processing and accuracy of detection.

3. Model Presentation

The system design of bearing defect recognizer, which mentioned into this paper, is illustrated in Fig. 1. The proposed system can be a competitive model for recognizing bearing defects in real world. Base on the research, the proposed system design is separated into two parts. The first part of our research processes the images to calculate the thresholding values of different bearings. The second part calculates the number of bearing balls and third part checks whether the bearing defective or non-defective.

(a) Processing Input Using Computer vision methodology:

In our recognition system, the original digital (RGB) image is converted into gray scale image through noise removing and filtering techniques (restoration process). As image processing is costly, for this reason, adaptive median filter algorithm has been used as spatial filtering for minimizing time complexity and maximizing performance. After restoration processing, we calculate threshold value of gray scale image. In our proposed system, the most important key point is the decision tree processing in order to achieve the threshold value. As we know that there have been different types of colour bearing images and also different types of defects in bearing, so local thresholding was used based on decision tree process. We have identified the threshold value (T) at greater than 120 and less than 60. Due to different threshold values to different pattern of faults of bearing, we generalize a specific threshold value (t) for all types of bearing. Base on the threshold value achieved from the decision tree, gray scale image is converted into binary image using local thresholding technique.

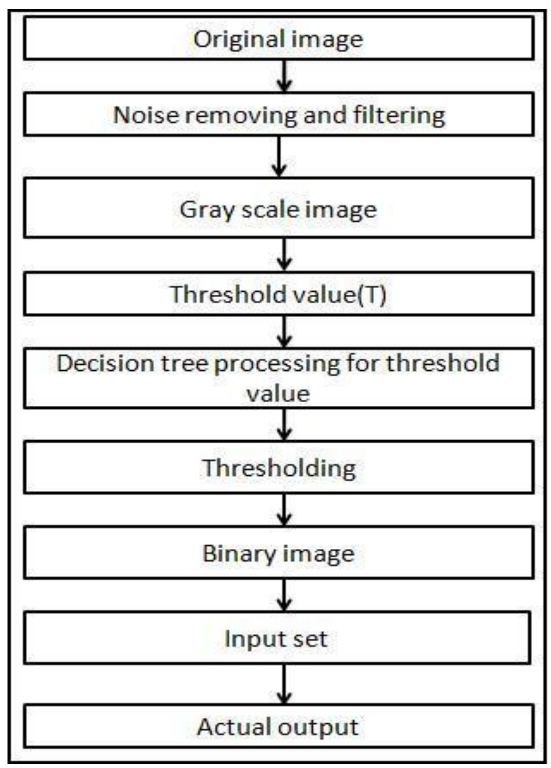

Figure 1. System Design of Textile Defect Recognizer

(b) Ball counting algorithm of bearing

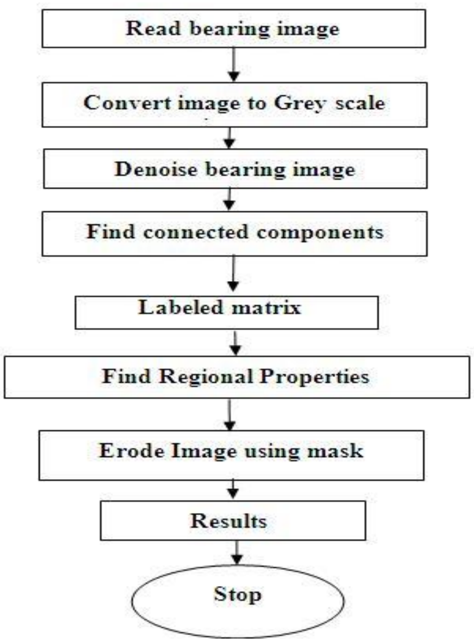

Figure 2. Flow chart for Calculating balls of bearing

The steps for ball calculating algorithm of plastic bearing are as follows:-

1. The input image is read by using imread function.

2. The algorithm can be tested for gray scale and a colour image by appropriately using functions such as is gray function.

3. Denoise the bearing image for removing the small dirt particles.

4. Find the connected components of the bearing image .Pixels are connected if their edges touch. This means that a pair of adjoining pixels is part of the same object only if they are both on and are connected along the horizontal or vertical direction.

5. Generate the labelled matrix.

6. Extract regional properties of the bearing image.

7. Erode image.

8. Results.

(c). Algorithm for purposed work

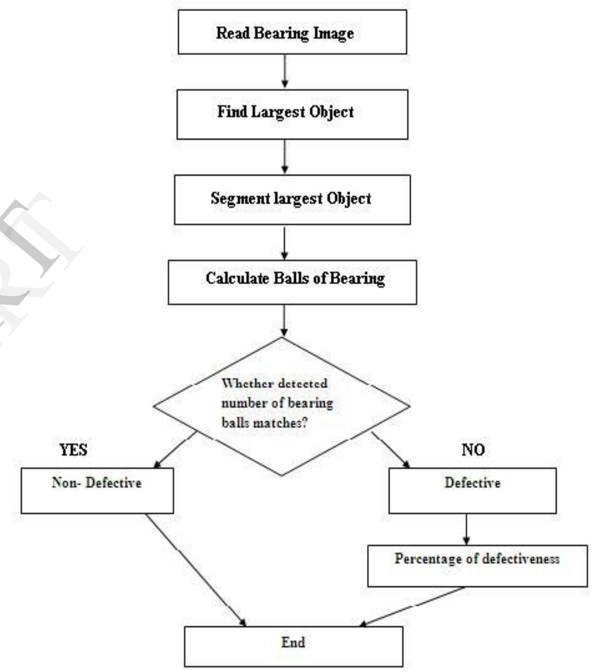

Figure 3. Flow chart of the purposed method

The proposed algorithm is mentioned as follows:-

1. The input image is read by using imread function.

2. The algorithm can be tested for gray scale by appropriately using functions.

3. Denoising -Noise is the result of errors in the image acquisition process that result in pixel values that do not reflect the true intensities of the real scene.

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4. Segment largest object i.e. bearing image.

5. Calculate the labels i.e. number of balls of bearing.

6. If the number of ball match with the subscribe number then the bearing is non-defective, otherwise the bearing is defected.

4. RESULTS

To see the qualitatively as well as quantitatively performance of the proposed algorithm, some experiments are conducted on several coloured and gray scale images. The effectiveness of the approach has been justified using different images. The results are computed qualitatively (visually) as well as quantitatively using quality measures.

The following figures are the screenshots of the proposed work which shows the different images which consists of original images and output bearing images.

Figure 6.Original bearing image

This is the RGB image of the original bearing which is used as an input.

Here the number of the gray values in the value was 255 which have been reduced to 35 with segmentation process.

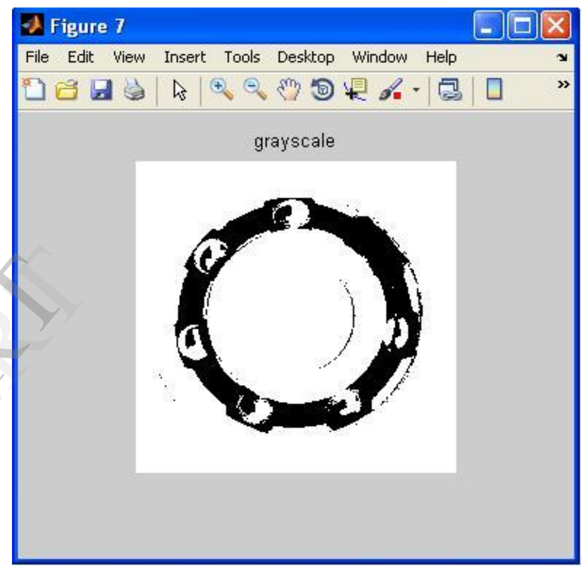

Figure 7.Grey scale image

The bearing images have been converted into black by using the complement code for increasing the visibility.

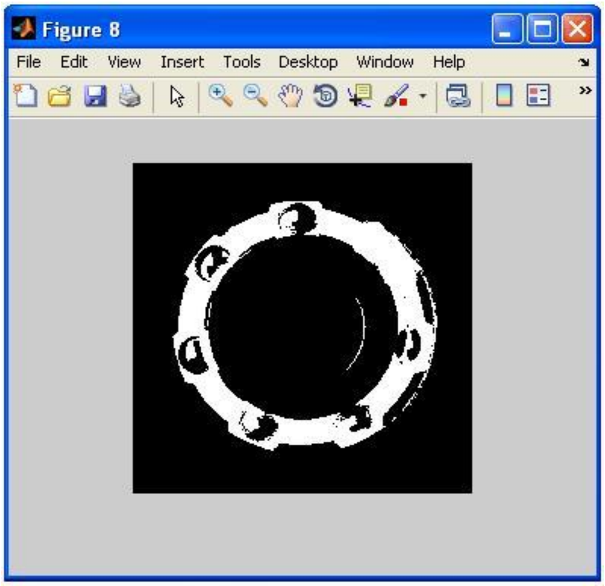

Figure 8.Binary image

The above figure image shows the binary image for increasing the visibility with respect to the surface.

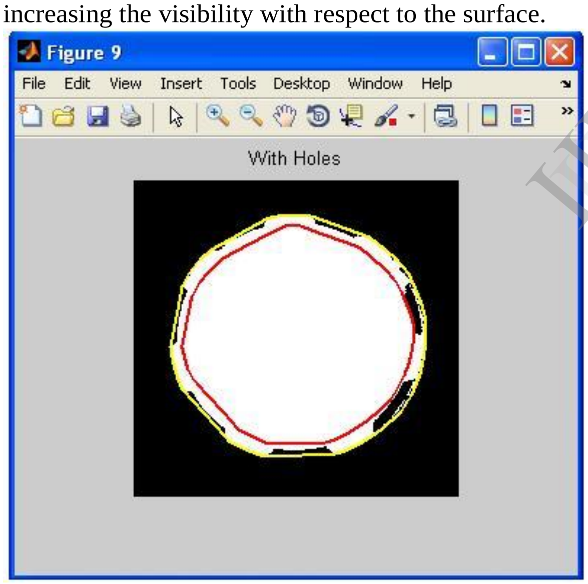

Figure 9.Circumference of bearing

The above image shows the step of a ball calculating algorithm where it identify where it identify the outer as well as inner circumference of ball based on Ball counting algorithm.

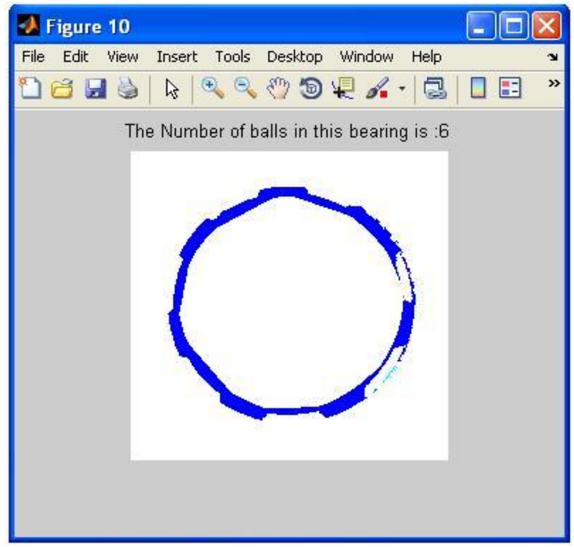

Figure 10.Count number of ball's

The above image count the number of ball's of the bearing image for checking whether the number of ball's are same as that of the subscribe number. If the number of ball matches with the subscribe number then the bearing in non - defective otherwise it is defected.

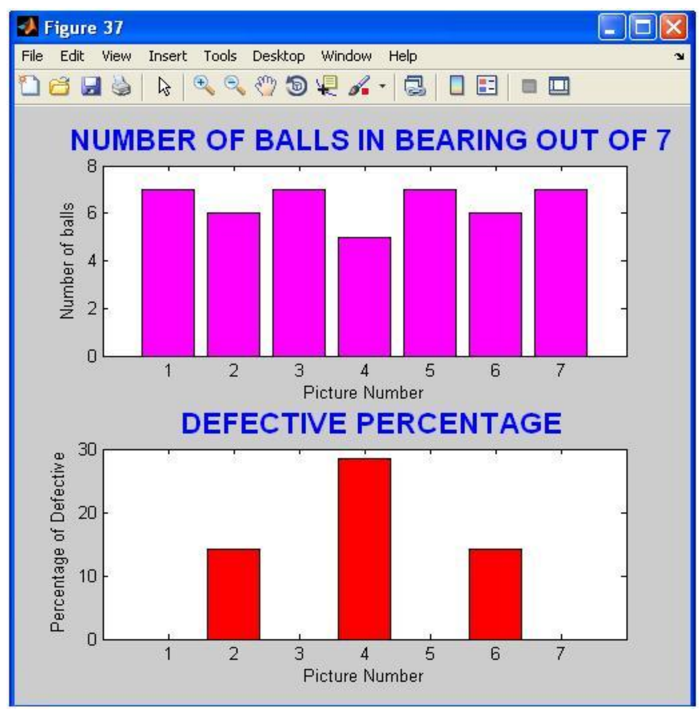

Figure 37. Comparison of different defective and non-defective bearing images

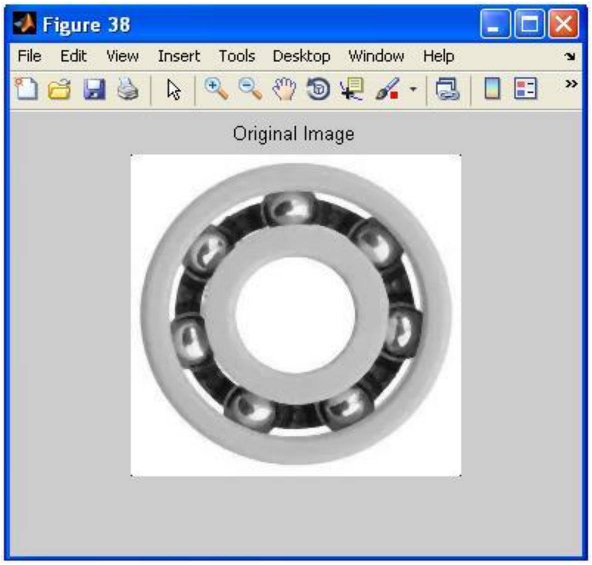

Figure38.Original image

This figure shows an RGB image of the original plastic bearing which is used to make industrial products like robotics

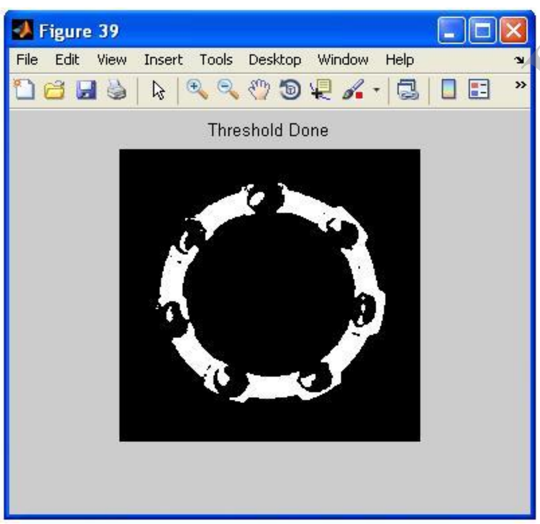

Figure39.Defected bearing

The above image basically shows the location of the defect after running the defect identifier algorithm based on thresholding.

5. Conclusion and Future Scope

Firstly, in this paper we have been able to detect defective bearings which have specific number of balls.If the number of ball's are deformed or more or less than the subscribe number than the bearing is defective in nature and therefore the bearing is useless.
After conducting the above procedure for defect detection we suggest that in future we must take advantage of some machine learning algorithms for making defects detecting more reliable and robust. There are number of future possibilities for improving the performance of these detection algorithms like usage of machine algorithms which help to identify the defective parts as these occur over a period of time. They increase their accuracy based on the updated parameter set and scenario machine algorithm like Support Vector Machine, K-NN and neural network can be used.

6. Acknowledgement

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7. References

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