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DETERMINING BEARING DEFECTS WITH DIGITAL IMAGE PROCESSING

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Abstract:

A major cause of poor quality and embarrassing situations for manufacturers are bearing flaws. The majority of the inspection procedures used in these businesses are laborious and manual. More thorough and accurate inspection procedures are needed to improve bearing defect identification accuracy. In order to detect potential defects, this research constructs a Bearing Defect Recognizer that combines local threshold holding with computer vision technology. The recognizer produces a less error-prone inspection method in real time and efficiently finds bearing problems. Primarily, the recognizer uses an image acquisition device to acquire digital bearing images and then transforms the RGB images into binary images using local threshold approaches and restoration processes. The area of the defective section and a computation of the potential defective and non-defective bearing are later outputs of the processed image. The results of the experiments demonstrate the proposed approach's sensitivity and dependability in identifying missing bearing balls as well as faults on the inner and outer races of bearings. The current system has a 94% accuracy rate.

Keywords: Defect detection; Image processing; Computer vision; Thresholding; Counting number of defects

I. Introduction:

All steel industries strive to create a variety of steel products that are competitive. The productivity and quality of the steel produced by each industry determine how much the competition is enhanced. There have been significant losses in this industry as a result of defective items. The majority of production-related flaws are still found via hand inspection. Inspectors' task is exceedingly time-consuming and tedious. About 70% of the population can be identified. Additionally, as one gets tired, visual inspection loses efficiency quickly. Steel bearing samples are increasingly being examined using digital image processing techniques.

As technology advances, steel is increasingly used to manufacture items, especially those that require ultra-lightweight and modular steel components like bearings. According to industry statistics, we have discovered that when bearings are manufactured utilising image processing, the steel material used in their construction is susceptible to a variety of problems. Therefore, we advise exploring a fully reliable system that makes use of image processing techniques (such as image segmentation and non-smooth corner detection) in order to develop a cost-effective Total

Quality Management system for manufacturing units that would enable an eco-system of continuous monitoring and improvement while also lowering 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.

II. Related Work Done:

Yonel, Izzet, and Dalci, K. The application of induction motor stator current signature analysis (MCSA) using Park's transform for the detection of rolling element bearing defects in three-phase induction motor is being studied by I BrahimSenol. The radial basis function (RBF) neural networks algorithm is briefly described after the publication initially covers bearing defects and Park's transform. The experimental findings and system details are then provided. DG SEIR This research suggests an autonomous detection system based on machine vision approach in response to the rising expectations for productivity and bearing quality as well as the dearth of conventional detection methods. The detecting system processes the images captured by the CCD camera using digital image processing technology to quickly and precisely identify the bearing surface types. First, the bearing and the regions that will be detected are located using least squares fitting and annulus scanning. Second, to raise the quality of images, low-pass filtering and contrast enhancement are employed. The next step is to apply object inspection to find any flaws. The shape feature is then employed to complete the defect recognition process.

Ho Choi Se A real-time flaw identification technique for high-speed steel bar in coil is presented in this paper. The proposed algorithm should process the massive quantities of images for real-time processing swiftly because the desired speed is very high. As a result, the defect detection algorithm should meet the two competing demands of cutting down on processing time and enhancing fault detection effectiveness. Edge-preserving techniques are recommended for target image noise reduction to improve detection performance. Finally, the results of the experiments demonstrate that the suggested algorithm ensures the accuracy of detection and the real-time processing requirement.

III. Model Presentation:

Fig. 1 depicts the system design of the bearing fault recognizer presented in this paper. The suggested system may serve as a viable competitive model for identifying bearing flaws in the real world. The proposed system design is divided into two components based on the research. The photos are processed in the first section of our study in order to determine the thresholding values for various bearings. The second section determines the quantity of bearing balls, the third section determines the outside race faults, the fourth section determines the inner race flaws, and the fifth section determines whether the bearing is defective or not.

The original digital (RGB) image is transformed into a grayscale image in our recognition system using noise removal and filtering techniques (restoration process) [13]. We determine the grayscale image's threshold value. The decision tree processing in our suggested system is the most crucial element for achieving the threshold value. Local thresholding based on decision tree technique was utilised because it was known that there were several types of colour bearing images and various sorts of bearing flaws. The threshold value (T) has been determined to be greater than 120 and lower than 60. We generalise a particular threshold value (t) for all forms of bearing because different threshold values correspond to distinct patterns of bearing defects. A local thresholding approach is used to convert a grayscale image into a binary image based on the threshold value obtained from the decision tree.

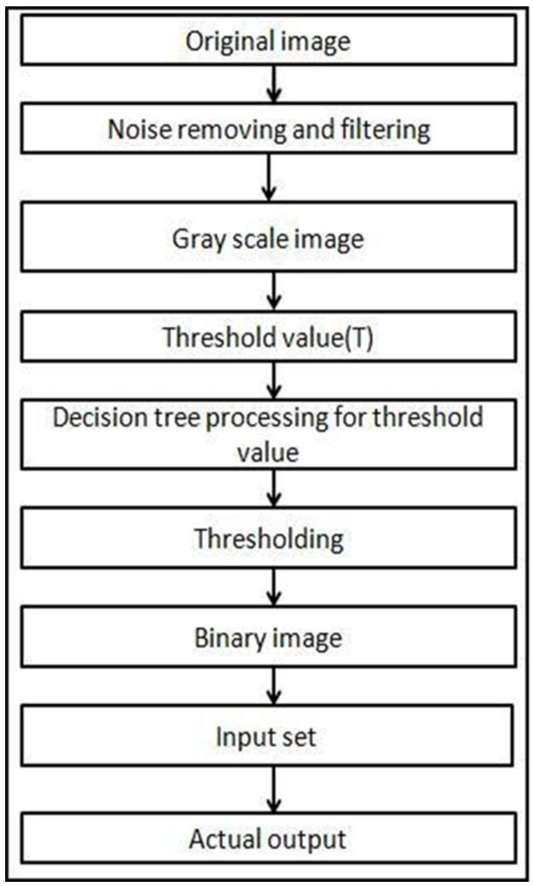

Fig. 1 System Design of Steel Defect Recognizer

Algorithm for purposed work:

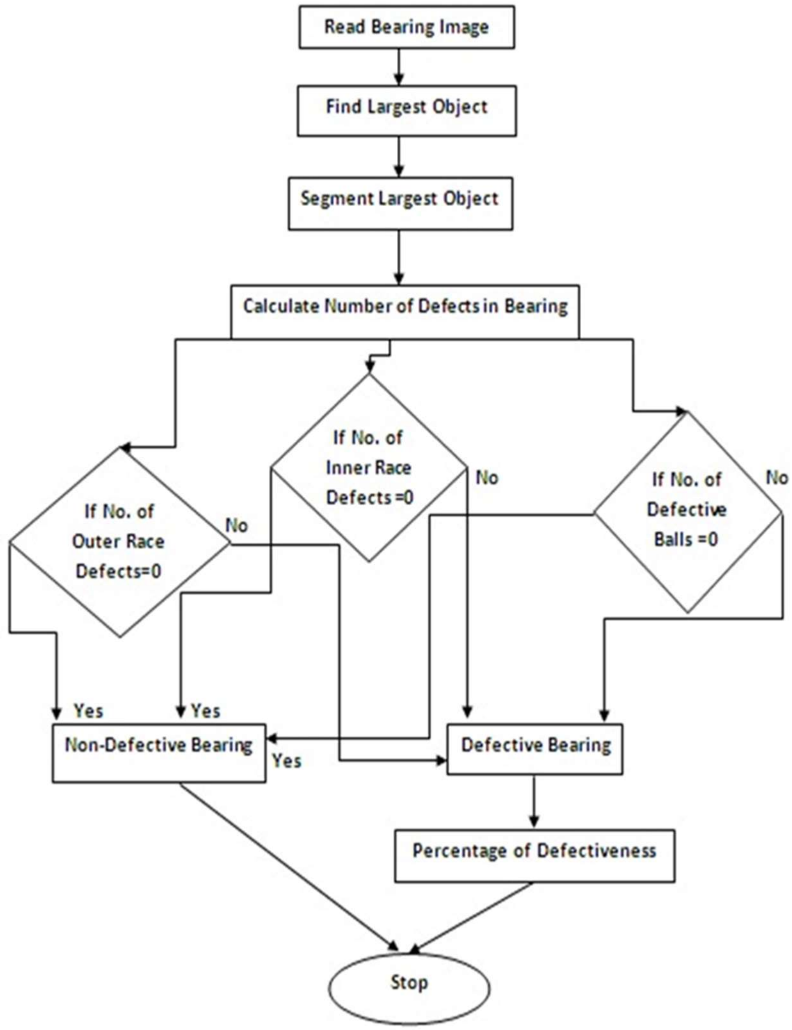

Fig. 2 Flow chart of the purposed method

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.
4. Segment largest object i.e. bearing image.
5. Calculate number of defects in bearing i.e. number of outer race defects, number of inner race defects and number of defective balls of bearing.

6. If the number of defects are zero then the bearing is non-defective, otherwise the bearing is defected

IV. Results:

Experiments are run on a variety of coloured and grayscale images to assess how well the suggested algorithm performs numerically and qualitatively. Utilising various visuals, the approach's efficacy has been supported. Using quality metrics, the results are computed both numerically and qualitatively (visually).

The screenshots of the suggested work that demonstrate the various photographs, including original images and output carrying images, are shown in the ensuing figures.

Fig. 3 Original bearing image 1

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

Fig. 4 Grey Scale Bearing Image 1

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

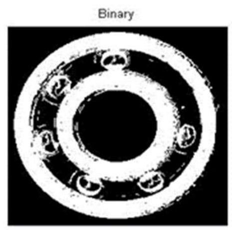

Fig. 5 Binary Bearing image 1

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

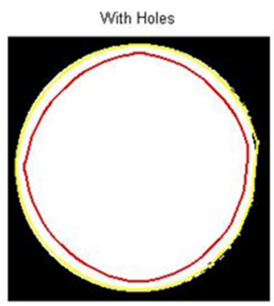

Fig. 6 Circumference of Bearing Image 1

The above image shows the step of a balls calculating algorithm where it identify where the outer as well as inner circumference of balls based on dummy scan algorithm.

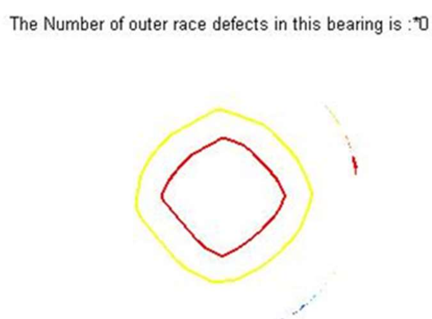

Fig. 7 Number of outer race defects in Bearing Image 1

The above image count the number of defects in the outer race of bearing. If number of defects in the outer race of bearing is non-zero then the bearing is defected.

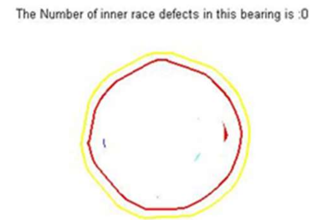

Fig. 8 Number of inner race defects in Bearing Image 1

The above image count the number of defects in the inner race of bearing. If number of defects in the inner race of bearing is non-zero then the bearing is defected.

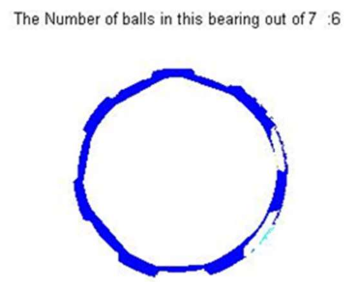

Fig. 9 Count Number of Balls of Bearing Image 1

The above image count the number of balls of the bearing image for checking whether the number of balls are same as that of the subscribe number. If the number of balls does not match with the subscribe number then the bearing is defected.

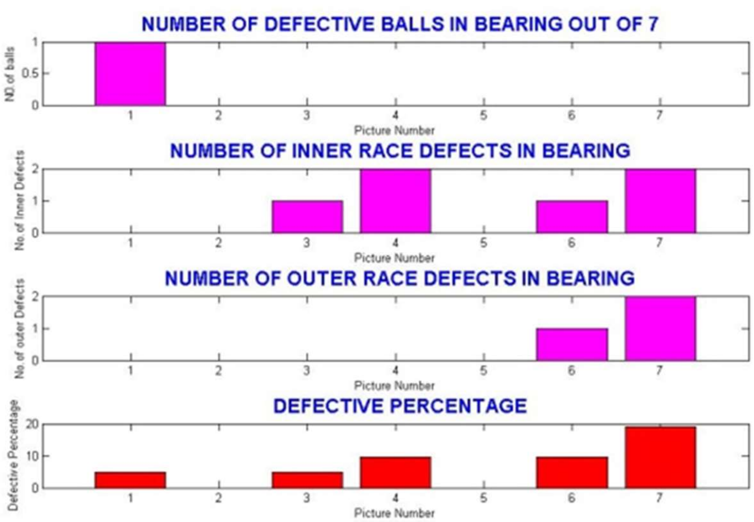

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Fig. 10 Comparison Graph of 7 Examples of Defective & Non-defective Bearing Images

The above image shows the comparison graph of 7 examples of defective & non-defective bearing images.

The following table 4.1 shows the summarizing results.

Table 4.1 Results

Number of defective balls in bearing out of 7		
Value	Count	Percent
0	6	85.71%
1	1	14.29%
Number of inner race defects in bearing		
Value	Count	Percent
0	3	42.86%
1	2	28.57%
2	2	28.57%
Number of outer race defects in bearing		
Value	Count	Percent
0	5	71.43%
1	1	14.29%
2	1	14.29%
Defective percentage		
Value	Count	Percent
0	2	28.57%
4.7619	2	28.57%
9.52381	2	28.57%
19.0476	1	14.29%

V. Conclusion and Future Scope:

First off, we were able to identify faulty bearings with a certain amount of balls in this study. The bearing is flawed by nature and is consequently unusable if the number of balls is deformed, exceeds, or falls below the subscribed number.

After carrying out the aforementioned flaw identification technique, we advise that in the future we should make use of some machine learning algorithms to strengthen and increase the reliability of fault detection. Future prospects for enhancing the effectiveness of these detection methods include the use of computer algorithms that assist in identifying the problematic pieces as they develop over time. Based on the updated parameter set, they become more accurate, and algorithms for scenario machines like Support Vector Machine, K-NN, and neural networks can be utilised.

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