Non Destructive Testing For Detection abnormal Object in The X-Ray Images

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Abstract. The clarification of weaknesses or defects detection in radiographs image is very important especially in medical science and non-destructive testing centers. The pressing need appears to develop the capabilities that serve image processing in several aspects to achieve the desired results and obtain useful information as possible from images. Therefore, it is very important to know the appropriate methods for image processing, especially with poor context radiographs images to improve their clarity and facilitate the interpretation process. In addition to providing important visual information that difficulty of obtaining from its sources noise-free. This research aims to detect non-normal objects that exist in the X-ray image efficiently through the adoption of digital image processing methods. By using the median filter addition to the morphological processes and obtaining satisfactory results. Where the accuracy of the proposed model reached 86.25 and the proposed model was applied to 80 casting images.

Index Terms— X-Ray images, Defect of castings, Median filter, Morphology operators, Non-normal object.

1. Introduction

It can be seen the image contains sub-images sometimes referred to as interest areas and simply called (regions). Factually, this concept reflects images often contain groups consisting of a number of objects that can obtain useful information, each of which can be essentially an important region. In the advanced image processing system, it is possible to apply specific image processing operations to a number of selected areas[1].

General image processing techniques can improve image quality including noise prevention, direction reduction, and edge detection. Several image processing processes can be combined to meet specific needs or obtain important regions that help us obtain information or extract certain important features[2]. With the growing importance of images in people's daily lives. And its use in various fields of medical, engineering, scientific, and even recreational[3].

In industry, analysis and interpretation of x-ray images are frequently required for nondestructive evaluation (NDE). The radiographs of the parts of a component are taken and then examined for any blanks, cracks, or impurities that may cause the component to fail after spreading to the component body[3]. One of the benefits of image processing is the contrast enhancement between the normal surface of the body and the defect to provide the optimum resolution between them.

To the defect detection from the regular structure in casting image, preprocessing step required for getting more homogeneous images, or changing and adjusting the level of gray to improve their contrast. This step is very necessary for the casting images work to highlight(clarity) the place of the defect. Each type of image has a different preprocessing method. So it is necessary to know the appropriate methods for processing each type[4]

The objective of all the X-ray detection projects is to identify abnormal objects and work to detect them efficiently through the adoption of digital image processing methods. The discovery and
clarification of weaknesses in radiographs are very important in medical science and non-destructive testing centers. This indicates the importance of development in the field of image processing to achieve the desired results[5].

Sometimes the images obtained from satellites or traditional and digital cameras lack the problem of contrast and brightness due to the imaging systems and lighting conditions during the image capture. Images may contain different types of noise associated with imaging. The image enhancement objective is to highlight certain image features needed to analyze and extract important data for the image. Enhancement image processing includes many operations such as improved contrast and edge detection, false coloring, noise filtering, illustration, and zoom. It should be noted that the process of improvement itself does not increase the content of the original information in the data, but simply focuses on certain characteristics of the specific picture is important to highlight. Some enhancement techniques include important procedures to improve contrast, eliminate noise, and adjust the grayscale of the image[6].

Image segmentation is the process that divides an image into parts or objects. To maintain the important function or objects it is very important that will be focused on and the implementation of this sub-section depends on the problem being solved. In other words, when the interesting objects in the image are isolated should stop the segmentation. Image threshold techniques are widely used to segment the image[7].

The median filter is a nonlinear digital filtering technology. It is based on the value of the center element of a set pixel values from the filter window, widely used in digital image processing, it preserves the edges of images during noise removal[8].

Morphological processes are known to affect the shape or structure of the body. It is applied to binary images of white and black colors. Morphological processes are widely used in pre-processing or post-processing, like filtering, dilution, pruning, and the possibility of obtaining a description of the shape.

It is significant to know the similarity between the two images and the possibility of detecting the regions that have been changed by matching the pixels of the two images. This is the fundamental decentralization on which both dilation and erosion operations depend.

Both dilation and erosion can be combined into a more complex series of operations. The concepts of opening and closing are the most useful in morphological filtering[1]. The elimination of all pixels in areas that are very small and do not contain the element structure is possible using the process of opening (erosion process followed by dilation). In this case, the structure element is often called a probe name, because it is probing the image looking for small objects to filter out of the image[9]. See figure (1).

![Figure 1. Morphology operators (a) erosion (b) dilation](image-url)
The present paper is organized as follows: Section 2 describes the relevant published research; the proposed six steps and detection algorithms are explained in Section 3; the results are described in Section 4.

2. Relevant Published Research

In 2019 Al-Hameed, W.; Fadel, N presents the researchers used the four-phase system to detect the flawed object in the casting images. In the preprocessing phase, the inference fuzzy system was used to improve the context of the image and to try to present the defective object as much as possible. The second phase is segmentation was used FCM algorithm, And the preparation of the third phase is the extraction of features focus on geometric features and then use the concept of OTDT (optimization threshold decision tree) to classify the objected to the defective or non-defective[10].

In 2016 P.Kanmani, Dr.P.Marikkannu, M.Brindha presents ID3 classifier with association rule mining for solving classification problems of MRI images. Applying median filtering techniques to reducing noise in the first step. Association Rule Mining and Classification used the FP tree algorithm and ID3 classifier was used for predicting. The main goal of this method is to classify the brain images into normal and malignant images[11].

In 2015 Zhiyun Xue and others presented three main components. Firstly, enhance the contrast image and irrelevant regions removed. Addition four features have been extracted( image mode, size of body rate," pyramid of histograms of orientation gradients (PHOG)", and "Contour-Based Shape Feature (CBSF)"). Finally (SVM) was as a classifier to train and test on 8300 chest Xray images[12].

3. The Proposed Method

As mentioned earlier, this research aims to detect the abnormal objects that exist in the X-ray image efficiently depending on digital image processing methods, by using the median filter addition morphological processes(dilation and erosion) and obtaining satisfactory results. Figure (2) illustrates the proposed research steps.
Figure 2. proposed research steps
3.1 Convert image

The first step is to read a PNG image and convert it into a gray image. Radiation images are originally gray and this is a general step.

\[ \text{NewImage}(i, j) = \text{gray(Picture.Point}(i, j)) \]

3.2 Median filter

The median filter filters each pixel in the image with its neighboring neighbors to determine whether the selected pixel represents its circumference or not. The values are first sorted in ascending or descending order, and the pixel value is replaced by the average (intermediate) pixel value. The neighborhood is referred to as the window. The window can contain different shapes 3*3, 5*5, or 7*7 focused on the target pixel. The most important feature of the median filter does not create new unrealistic pixel values. Because the value of the surrounding pixel is the value of one of the pixels is a neighborhood within the selected window. As shown in figure (3). In this research, we used the window 3*3.

It is known that window sizes of a median filter give an influence on removing noise in images, the small window size gives better performance in low noise densities, that images used in this model do not contain dense noise, so used a small window size 3*3. If the images contain a high density of noise, it is best to use a large window size. In addition, it is possible to consider a very small defect as a noise and for this reason we move away from large windows.

![Figure 3. Median filter](image-url)
3.3 Difference image

Extract the difference between two images, namely the gray image and the median filter image.
1. set value of c1=bitmap1.getpixel(i, j) // (gray image)
2. set value of c2= bitmap2.getpixel(i, j) // (median filter image)
3. set value t=c1.R-c2.R
4. new image(i, j)=t

3.4 Convert to binary

The fourth step is to convert the difference image to a binary image with only two colors, namely white and black. The threshold limit used in this step is 128 if the pixel value is between 0 and 127 the pixel value becomes 0, and if the value is greater than 128, then the pixel value becomes 255.
1. If imag(i, j) > 0 And imag(i, j) < 128 Then
2. new image(i,j)=0
3. Else
4. new image(i,j)=255

This step is necessary because the dilation and erosion windows deals with the image pixels depending on the white and black color matching in the morphological processes, so it is necessary to convert image to binary image.

3.5 Morphological processes

The binary image was introduced into the morphological processes. Both dilation and erosion are similar but the difference in the process of erosion turns the pixel into "white" rather than "black".

In this paper, the structure element D is used in the form of a 3 * 3 square matrix. The erosion process moves the structural element across the whole image I and the following actions are taken:
A. There will be no change in the pixel value if the center structure element D is matched with a pixel of "0" in the image, thus moving to the next pixels.
B. the pixel value "1" changes to "0" if one pixel of the window structure element is "0". In other words, the pixel value "1" remains if all the elements of the structure (the entire window) match the pixel values "1" in the original image. It is best described in a series of steps:

\[ \text{Erosion} = I \ominus D \]

The Dilation process is performed by placing the structural element D on the image I and moving it through the image in a twisting-like manner. It is best described in a series of steps:

\[ \text{Dilation} = I \oplus D \]

A. If the origin of the structure element is synchronized with the "0" pixels in the image, there will be no change in the pixel value and therefore moves to the next pixels.
B. If the origin of the structure element (middle element) is synchronized with the pixel "1" in the image, change all pixels to "1" of the image covered by the struck element. In other words, change all the pixels of the window in the image to "1". Show figure (4).
3.6 Combine image

In the last step, the image produced by morphological processes and merged with the original image. After this process the abnormal objects will be shown to us clearly, meaning the x-ray vulnerability is very obvious.

1. set value $c_1$=bitmap1.getpixel(i, j)// original image
2. set value $c_2$=bitmap2.getpixel(i, j)// morphological image
3. set value $t$=$c_1$.R+$c_2$.R
4. new imag(i, j)=$t$

4. Evaluation of A Proposed Method

In the proposed method, we used X-ray images of casting that contain specific defects available in reference [13]. The method of research was applied to the car wheel, noting that the method is very effective in detecting flaws of the type of holes.

In the case of cracks, they give fewer results due to the properties of expansion and corrosion which are not very accurate with cracks. As in case no. 3 in the figure (5).

Depending on the matrix of confusion we can calculate both accuracy, Sensitivity or Recall measures. The accuracy is the most widely-used measure of the proximity of the true value and to know the predictive capability of a model.

Table .1 Confusion Matrix

| predicate  | Regular image | Defect image |
|------------|---------------|--------------|
| Regular image | $TR=35$ | $FD=8$ |
| Defect image | $FR=3$ | $TD=34$ |

Where FR, TR, FD, and TD means are a false regular, true regular, false defect and true defect respectively.

Accuracy = $\frac{(TR+TD)}{(TR+TD+FR+FD)}$

Total number of images $= 80$
Images have defect $= 37$
Regular images $= 43$
8

Correct detection images 69
Incorrect detection images 11
Accuracy = 86.25 %

| I | Image 1 | Image 2 | Image 3 | Image 4 | Image 5 |
|---|---------|---------|---------|---------|---------|
| A |         |         |         |         |         |
| B |         |         |         |         |         |
| C |         |         |         |         |         |
| D |         |         |         |         |         |
| E |         |         |         |         |         |

**Figure 5.** A: Original image, B: Median filter, C: Binary image, D: Dilation process, E: Combine image.

5. Conclusion

The discovery of internal defects in industries is very important, especially as the world is heading to the concept of industrial automation and away from human effort using efficient systems capable of solving the problem of objectivity. This paper presents an effective way to detect abnormal objects in X-ray images through several sequential image processing techniques by using the median filter addition to the morphological processes and obtaining satisfactory results especially flaws detection of holes type. This research aims to clarify the abnormal object so that it is clear without distortion since we have already seen the difference between the original and the final image and thus achieve the desired goal of
discovery. The model gave a good accuracy, especially with holes-type defects, where the accuracy reached 86.25 and the proposed model was applied to 80 casting images.

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