Retraction

Retraction: Defect Detection of Industrial Products Using Image Segmentation and Saliency (J. Phys.: Conf. Ser. 1916 012165)

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This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

IOP Publishing respectfully requests that readers consider all work within this volume potentially unreliable, as the volume has not been through a credible peer review process.

IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1
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Defect Detection of Industrial Products Using Image Segmentation and Saliency

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Abstract. The manufacturing industries have been searching and developing new solutions to increase the product quality and to decrease the time taken and costs of production. Defect detection methodologies consume much time in manufacturing and manual inspections for quality enhancement. The existing systems cannot handle the data other than the trained ones as they followed the comparison process with the dataset which is of more time consuming and lack of effective depth representation. In the proposed system, multi scale saliency defect detection algorithm is implemented to obtain the boundaries and range of defect in the surface of industrial products. The defect in the products can be detected using pre-processing defect image with color channels, detecting uneven illumination and post processing the defect image thereby splitting out the defect part from original image with edge detection and contours. Hence the output will be of more robust and accurate comparing to the existing systems.

Keywords: Defect detection, image processing, manual inspections, saliency detection, supervised production.

1. Introduction
Defect detection is the most discussed topic that should be considered as unique problems related to the field of artificial vision. Digital image processing issues primarily comes from explicit activities in which specialists attempt to copy or substitute human vision and choice systems with artificial techniques. The general purpose of reproducing human vision is to recognize and classify a subject: these two objectives are in every case carefully binded together. Quality control is a pivotal viewpoint in the modern creation line. Contingent upon the technique utilized to distinguish a deformity on a surface/volume, quality control procedures can be named destructive or non-destructive, Non-destructive testing's (NDTs) target observing a part to identify an imperfection without extricating samples from it, or forever harming it. Among them, the visual-based methodology for defect recognition is a non-measurable process with variable and subjective results. Defect detection is one of the important applications of inspecting the optical visibility of industrial products. Due to the increasing demand for automation in manufacturing industry, defect detection can be found in most of the manufacturing sectors. Although the output products from different sectors have variety of characteristics, the way to find the uneven illumination for the defect products from one sector might...
be useful for manufacturers from other sectors. In this paper, rather than summing up all the visual preparing philosophies, it is centered on the particular arrangements that are unequivocally identified with visual processing methods and, specifically, on visual inspection techniques for surfaces in industrial applications. The following section includes an explanation of the proposed methodology and obtained results are included in the experimental results and the future scope is discussed in the conclusion.

2. Literature Survey
The methodologies proposed earlier and the problems faced with their researches are discussed below. [1] has demonstrated the boundaries-based application for analyzing the performance. At the hour of composing the system was just algorithm intended for defect identification. This methodology order seven deformities such as short, missing opening etc. The problem in this methodology, is that it does not have many stages included and those involved are segmentation, windowing, defect detection, pattern assignment, normalization and classification. [2] determined a few strategies to identify the defects in the ceramic tiles. As the yield, they demonstrated the intensity adjusted or histogram equalized picture. Yet, their framework isn't mechanized which is a lot of essential in the manufacturing process. Again their proposed strategy is operation redundant since they apply their second part on each test picture to recognize different kinds of defects. In addition, their proposed technique is very tedious. [3] proposed a strategy that classify defect utilizing neural network. This algorithm portions the pictures into essential primitive patterns. [4] worried about the issue of programmed assessment of ceramic tiles utilizing computer vision. The paper includes the strategies for pinhole and break identifiers for plane tiles dependent on a bunch of separable line filters, through finished tile break indicator dependent on the wigner distribution and a novel conjoint spatial-spatial frequency portrayal of surface, [5] to a color texture tile defect detection algorithm used for the processing which searches for the irregularities around both chromatic and structural properties of texture tiles.

The strategies are computerized visual investigation system where they just show the defects making them clear to distinguish the defects found on image. [6] introduced an ongoing defect identification strategy for high-speed bar in coil. To upgrade the presentation of the detection they utilized edge protecting technique for noise reduction, to isolate pictures with various gray levels they utilized the laplacian filter and after the working that they utilized twofold thresholding to binarize the picture. In any case, the significant disadvantage of their process is that their strategy won't discover the orientation of the edge due to their utilizing of laplacian filter, as per which will be required for the defect of ceramic tiles. The method utilizing the laplacian channel malfunctions for corner and bends [7]. Such types of techniques can be actualized on the bare PCB to distinguish and to aggregate PCB defects. The significant constraint of this calculation is that the proposed calculation is created to work with binary pictures only, though the yield from the cameras is in gray scale format. Consequently, to improve the calculation, undesirable noise ought to be considered. Since the proposed algorithm right now, is simply ready to isolate 14 sorts of defects into five groups. [8] did improvement in their work by ordering seven groups. This is finished by joining image processing algorithm and the segmentation algorithm.

Most of the pictures are fragmented into four patterns and afterward created five new pictures for each pair of segmented reference and test pictures prepared and in these manner 20 new pictures delivered. Out of which, seven pictures were useful for defect classification. For example, in [9], a single CNN model was developed to showcase the irregular images and spots in welding, glass panel etc. Many deep CNN models have also been proposed to enhance the working and implementation, such as Faster R-CNN [10], SSD [11], YOLO [12]. The visual-based methodology for defect detection is perhaps the most well-known systems in industry. Nonetheless, the customary visual investigation is a non-measurable process with variable and emotional results. Subsequently other automatic defect detection frameworks were created with requesting prerequisites in view of the
intricacy and uniqueness of a particular issue to tackle. [13] Be that as it may, such a framework relies upon the material properties of the surfaces and on their environmental conditions[14]. The below methodology is designed to solve the earlier discrepancies faced in the defect detection methods and also to find the boundaries with the region of defect and perimeter of the defected region of all products in the manufacturing industry. [15] By using the multi scale saliency defect detection algorithm, Fabric defect can also be detected with region of defect in the short span of time with greater accuracy and minimal human interventions.

3. Methodology

An image processing-based system that uses saliency feature detection is proposed to overcome the problems of defect detection of industrial products. The steps mentioned in figure 1 are collectively used for surface defect detection in industrial applications which produces high detection accuracy than the traditional methods acquired by the manufacturing industries for examining defects.

A defect image is loaded as input which is default RGB format. The given input is processed using CLAHE (Contrast Limited Adaptive Histogram Equalization) technique to adjust the contrast and to enhance the defect image in order to view the color channels in detail. The loaded defect image is transferred from default format to ‘l’, ‘a’, ‘b’ channels which is a multiaxes color system indicating L for amount of lightning, A, B for image color code dimensions. The CLAHE technique is demonstrated for each color channels and after applying, the channels are again merged and brought back to their original RGB color space. Then the Alpha and Gamma channels are determined for the defect image to enhance the visual effects and quality of the input. The Gamma channel is used to determine the lumiance of each pixel. Different cameras or video recorder devices do not correctly capture luminance of each pixel thereby gamma correction technique is used to correct the luminance and brightness level.

As the image is enhanced, the defect part in the image can be identified using some of the techniques like Mean shift filtering, histogram and back projection. Mean shift filtering is used to
convert the enhanced image into a rough texture to obtain the part of defect. Back projection is used to identify the region of interest for the areas of saliency in the defect image. Histogram and its objects are used for color and smoothness enhancement of the defect region. After these processes, the defect part is kept for denoising to reduce the unwanted pixels in the image. Then image post processing is done to obtain the boundaries of defect from the region of interest captured in the industrial product defect image.

3.1. Multi Scale Saliency Defect Detection Algorithm

3.1.1. Input. Defect image of Industrial product

3.1.2. Algorithm.
- Read the defect image for detecting and marking the boundaries of defect.
- Store the color code converted from RGB to LAB to lab.
- Set ‘l’, ‘a’, ‘b’ for the CLAHE applied color channels for the defect image.
- Set brightness, contrast and shadow to 0 and calculate the highlight of the defect image.
- Calculate alpha and gamma channels by $\alpha = \frac{\text{highlight} - \text{shadow}}{255}$ and $\gamma = \text{shadow}$.
- Calculate focus of defect image $f = 131 \times \frac{\text{contrast} + 127}{127 \times (131 - \text{contrast})}$.
- Calculate histogram object and normalize using back projection for determining saliency.
- The histogram value is calculated based on color codes from 0 to 1 with source and target levels.
- Saliency for defect image is calculated with the source and target of histogram objects.

3.1.3. Output. Converting the defect image from lab to original format, the region of interest of defect is identified. The objects are equalized and the region of interest is marked according to the saliency determined. Finally, salout image is displayed with the defects highlighted from the original image is shown in figure 6 and 7.

The steps to determine the boundaries of defect are illustrated in figure 2.

3.2. Image Pre-processing
Pre-processing is the initial step for most of the image processing algorithm. The captured image
contains different noises. The removal of the noise after the image pre-processing is necessary task. In this system, median shift filtering is used to eliminate noise. Median filter eliminates the salt and pepper noise effectively because it appear like a black and white dots. In median filter processing, the kernel having size of N x N is used as a median mask and it is applied over an image. The median of the mask values are assigned to the middle element of the mask.

3.3. Saliency Detection
Saliency detection is the way toward applying the processing techniques and detection algorithms to consequently find the unevenly illuminated parts i.e., easily notable areas of a picture as mentioned in figure 3. The main thing is to detect the parts that are visible as an uneven illumination on the surface such as any color code errors, uneven surface of the object, uneven edges over the image and color variations across the products. These parts are detected after the pre-processing step and identified as defect detection of the products.

![Figure 3. Uneven illumination detection example](image)

Saliency recognition is given to numerous parts of detection and picture handling, however a portion of a well known utilizations of saliency includes:

- **Object’s detection** - Rather than comprehensively applying a sliding window and image pyramid, just apply our (computationally costly) detection algorithm to the most notable, intriguing areas of a picture well on the way to contain an object.
- **Advertising and marketing** - Design logos and ads that “pop” and “stand out” to the system from a quick view of how would the image look like.
- **Robotics** - Design robots with visual systems that are similar to own system.

3.4. Image Decomposition
Image decomposition is the most demonstrated image processing techniques in the field of error detection and computational photography since it tends to be applied to different territories, for example, picture smoothing, detail upgrade, picture abstraction, and high-dynamic-range pressure. The principle objective of image decomposition is to effectively isolate structure from figure 4 by safeguarding edge-like construction segments and eliminating fine scale details without earlier data.

![Figure 4. Image decomposition splitting shading and reflectance images from the defect image.](image)

3.5. Image Denoising
Image denoising It is an irregular variety of brightness or color information data in pictures and an unwanted result of picture that make it difficult to see the ideal data. Image denoising is the procedure of eliminating noise or distortions from a picture as figure 5. There are tremendous scopes of utilization, for example, obscured pictures can be clarified.

Figure 5. Noisy image vs. Denoised image.

3.6. Image Post Processing
Contours detection is a process that can be clarified just as a curve joining all the continuous points (alongside the limit), having same tone or intensity. The contours are a helpful apparatus for shape examination and object discovery and acknowledgment. An edge is a point in a picture where there is a sharp change in the pixel color value which doesn't make it persistent in nature and some of the time makes it difficult to decide the shape of the object. Shapes can do a level more than "just" distinguish edges. The algorithm does to be sure discover edges of pictures yet additionally places them in a chain of importance. This implies that you can demand external boundaries of items identified in your image.

4. Experimental Results
The software specifications used are Python language with Python IDE or Spyder having the libraries such as numpy, matplot and opencv. Some of the hardware requirements are processor with core i3 having the RAM of at least 4 GB with the hard disk capacity of 160GB and a graphics card of 1 GB. The multi scale saliency defect detection algorithm is mainly implemented to get the boundaries of the defect from the industrial products. The defect image is enhanced to get the accurate pixels of the image in order to overcome the noise and increase the contrast. The Gamma channel is used to determine the luminance of each pixel for a particular image. Gamma channel is also used to adjust the image's luminance has the value between 0 and 1.

Output_luminance = gammaCorrectionFunction[input_luminance]

4.1. Saliency Detection
The initial result of the defect detection can be obtained as the saliency out by highlighting the uneven illumination from the input image as the part from figure 6 and 7. The uneven illumination of the defect image can be of any color code errors or uneven edges or unwanted objects over the surface of the product. The detected parts are well differentiated from the original image of the industrial products with the region of interest.

Figure 6. Normal image and saliency output of input 1.
4.2. Boundaries of Saliency

The detected defect part is post processed to obtain the clear boundaries with the edges of the defect image as figure 8 and 9. The decomposition is made to detect the accurate edges in the defect part and they are marked in the original defect image for better comparison with the salient part. The perimeter of fault is determined to identify the size of the defect and how serious the defect in the industrial products as shown in the figure 10.

Figure 7. Normal image and saliency output of input 2.

Figure 8. Detection of boundaries and output image of input 1.

Figure 9. Detection of boundaries and output of input 2.

Figure 10. Calculated Perimeter with the boundary of defect for (1) and (2).
5. Conclusion
In this paper, a multi-scale Saliency defect detection algorithm and projection techniques for the
detection of defect from the industrial products is proposed. To identify objects from the picture,
explicit edge discovery methods can be utilized by thinking about the impact of external environment.
Pre-processing step requires contrast stretching which is satisfied by histogram adjustment. A few
strategies for recognition of article give better outcomes yet burn-through additional time which isn't
acceptable in real time environment. Whereas using saliency feature detection, smoothness
enhancement, noise reduction, detection of uneven illumination from the defect industrial products can
be done in less time with more accuracy. For detecting defect(s) in corner, more effort is required as
compared to detecting other defects and this can be overcome in future researches.

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