

## International Journal of Innovative Research in Science, Engineering and Technology

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# Analysis of Casting Surface Using Machine Vision and Digital Image Processing Technique

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**ABSTRACT:** In this work surface analysis is carried out for casted aluminium and cast iron components for detection of various surface defects encountered in castings using machine vision and digital image processing technique. Defect detection involves three stages. First digital image of casting surface are captured using suitable lighting and camera, captured images are processed to reduce noise and enhance its quality. Secondly Region of Interest is selected by thresholding the image. Finally edge finding operation is performed using gray co-occurrence matrix features to detect the surface defects and blob analysis is carried out to extract the boundary features of defected area. Various surface defects can be detected using the proposed method including cracks, cold shut, burrs, shrinkage, blowholes, sand drop, rust and porosity. Two types of lighting system, direct and diffused illumination are used. Reflections are different for different types of metals, some metals like gold, silver, chrome plated are having high specular reflection. In such cases there is need to use different lighting systems.

Edge detection was carried out and edge maps were extracted for defected regions of casting components using Matrox Imaging Library workbench. Blob analysis was carried out for previously processed grayscale filtered image to extract blobs in an image using MATLAB. Good visible defect region boundaries were extracted at different manual thresholding levels.

**KEYWORDS:** Region of Interest, Grey co-occurrence matrix, Edgedetection, Blob analysis

### I. INTRODUCTION

Casting is one of the major manufacturing process till today. Surface defects in the casting reduces the product quality, it can be considered as a threat and which requires proper inspection. Variety of surface defects makes their inspection more complicated, costlier and requires longer time. The most of the casting industries till today depended on manual inspection. The human inspection results in less consistent due to several reasons like variance in expertise, human errors, repeated tasks and this less fit to today's fast automated manufacturing system especially in mass production

Machine vision is a true multi-disciplinary field, encompassing computer science, optics, mechanical engineering, and industrial automation. A Machine vision system combines image capture and processing systems (computer hardware and software) with digital input/output devices (cameras) and computer networks (to store and share the image data). No machine beats human vision for versatility, but other human weaknesses limit their productivity in a manufacturing environment. Boredom, distraction, and fatigue all typically degrade human performance in vision-related factory tasks

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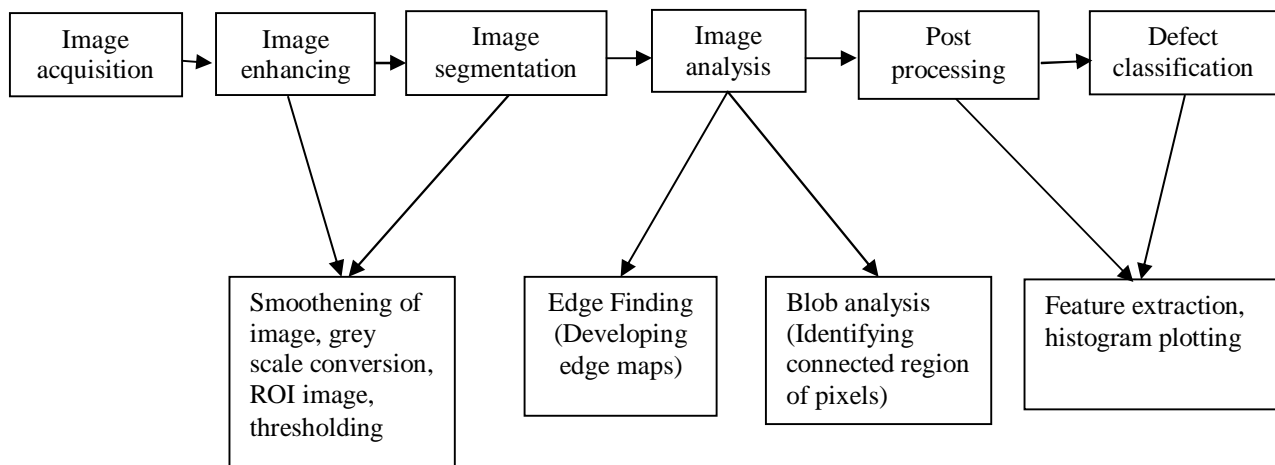
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Vol. 6, Issue 10, October 2017

like inspection, which require high speeds, constant operation and a lot of monotony .Machine vision systems can perform repetitive tasks faster and more accurately, with greater consistency over time than human.

S K Sethi et al .,(1996) developed an automatic surface defect inspection system for casting and welded components. Ajay pal Singh Chauhan et al .,[2] developed machine vision PCB inspection system to detect defects. Subtraction algorithm is used i.e comparing standard PCB image with PCB image to be inspected. Tiwari Priti Ramesh et al.,[3] proposed a method for metal defects detection and their classification using Digital Image Processing Technique. A machine vision system with typical annular and rotating lightning arrangements are used to reveal scratch and lack of machining defects on the surface of brushed parts [4] . M.EL-Agamy et al.,[5] developed an automated vision based inspection system for metals. Artificial neural network is used for classification of surface defects .Inspecting surfaces are compared with matching templates to detect the surface defects. Pinholes in the steel products are difficult to identify because the size of each pinhole is relatively small compared to crack, scratch and scales. Doo-chul Choi et al., [6] developed an algorithm for Pinhole detection in steel slab images using machine vision technique. Chang jiang li et al .,[7] developed an automated vision defect inspection system for curved surfaces with High Specular Reflection .Object is illuminated by four different incidence directions, then the synthetic image is build using those images captured at different angles with diffused illumination technique. Alex kiviong developed a fully functional beta algorithm that was successively tested on real production line using prototype hardware for finding contour and surface defects on cast iron engine components [8]. AL yong-hao and xuke [9] developed an image processing technique to detect corner cracks for steel billets. Snake projection wavelet algorithm is proposed to detect seams in rolling process. Zhang Xue-Wu et al .,[10] proposed an visual inspection system to detect surface defects on highly reflective metals. Methods used in defect detection algorithms are Otsu threshold for image segmentation.

## II. METHODOLOGY



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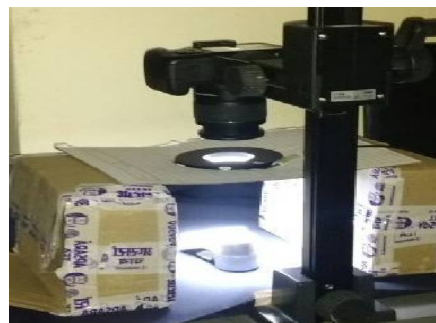
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Vol. 6, Issue 10, October 2017



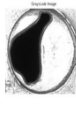
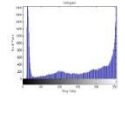

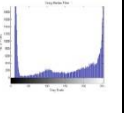
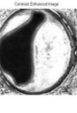
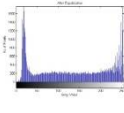
## III. EXPERIMENTATION

**Image Acquisition:** In this work Canon EOS 1200D camera is used to capture colour images. Good images are captured with suitable lighting, camera setup to reduce further processing of images. Sample images are captured using different lighting techniques and the suitable lighting is selected which suits the present application.

Lighting is one of the important part of image acquisition, to get an quality image proper lighting technique has to be used. Different type of material exhibits different surface properties. Some metal surfaces are highly reflective and some are poor reflective for the same input. So depending on the application suitable lighting is necessary. In this work White LED diffused ring light is used with dark field illumination technique to capture the images of components. Images are captured with same focal length and 1:1 aspect ratio is maintained for better contrast for all components.



**Image Processing:** At first ROI image is identified from the original colour image and it is extracted. Then it is converted into grayscale image. Then the noises present in the grayscale image is reduced using median filter. After reducing the noises contrast enhancement is carried out. Histograms are plotted for grayscale image, grayscale filtered image and grayscale contrast enhanced image to obtain intensity information of pixels and it is helpful for further defect analysis. Same procedure is followed to all the casting components. MIL 10.00 and MATLAB R2013a workbenches are used for image processing.

Component	Original Image with ROI	ROI Image	Grayscale Image	Histogram	Filtered Image	Histogram	Contrast enhanced image	Histogram
Bearing Housing								

**Image Analysis:** Image analysis is performed to extract useful information. Pictures, or images, are important sources of information for interpretation and analysis. There are two main types of image processing operations a) Those that enhance or transform an image b) Those that analyse an image (that is, generate a numeric or graphic report that relates specific image information). In the present work edge detection is carried out to find out the geometrical features of defected surfaces regions by extracting the edge maps. Blob analysis is carried out using filtered grayscale image to find the boundary feature of regions of connected pixels of same intensity within an image

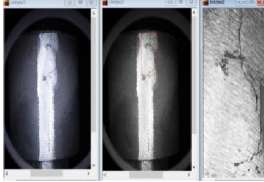
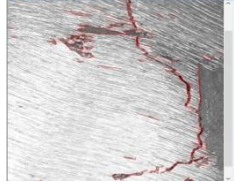
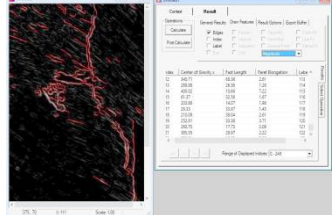
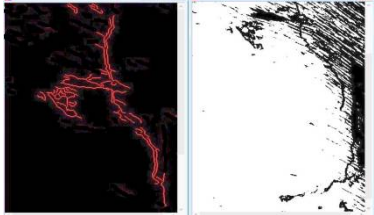
**Edge Detection:** Edges defines a boundary of objects. These can be established from intensity transitions in an image. Well-defined edges come from sharp transitions in value, typically found in highly-contrasted images. Conversely, weak edges come from gradual transitions in value, typically found in smooth images

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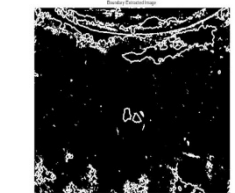
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Vol. 6, Issue 10, October 2017

original image, grayscale image and ROI cropped image	Finding edges on ROI image using manual thresholding and filtering operations	Extraction of edge features	Edge extracted image and Binary image
			

**Blob Analysis:** Blob analysis is used to identify connected regions of pixels within an image, and then calculate selected features of those regions. The regions are commonly known as blobs. Blobs are areas of touching pixels that are in the same logical pixel state. This pixel state is called the foreground state, while the alternate state is called the background state. Manual thresholding is applied on a grayscale filtered image to vary the boundary extractions of region of interest in an image. This operation is done by using the intensity information of pixels as recorded in histogram of filtered grayscale image.

Original Image with ROI	ROI cropped Image	Grayscale Image	Binary Image	Boundary Extracted Image
				

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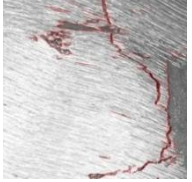
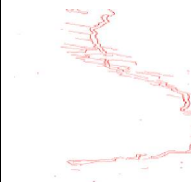
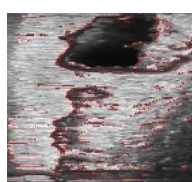

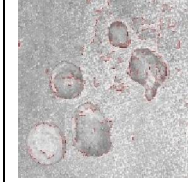




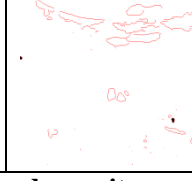
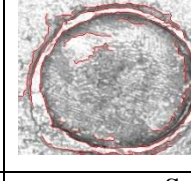
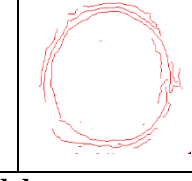
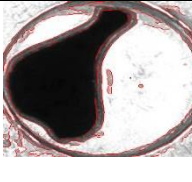
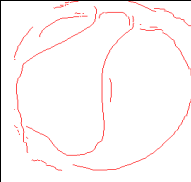

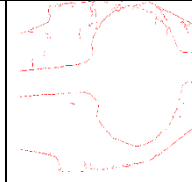
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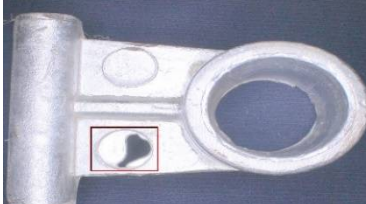
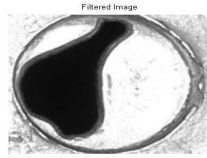

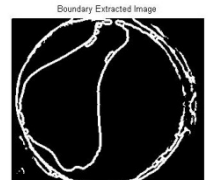
Vol. 6, Issue 10, October 2017

## IV. EXPERIMENTAL RESULTS

The following table shows the source image with defected surface and their extracted edge maps of the components used in this work for defect analysis

Source image with edge map	Extracted Edge map	Source image with edge map	Extracted Edge map	Source image with edge map	Extracted Edge map
					
<b>Surface crack</b>		<b>Shrinkage and sand burn</b>		<b>Blow holes</b>	
					
<b>Porosity defect</b>		<b>Shrinkage and porosity</b>		<b>Sand drop</b>	
					
<b>Cold shut</b>		<b>Burrs</b>			

Blobs are extracted by processing the filtered grayscale image. Defected surface boundaries of different casting defects are revealed at various threshold levels. Using the pixel intensity information from filtered grayscale histogram, manual thresholding levels are applied on binary images. Blob analysis is performed using MATLAB. The following table shows the blob analysis results of various casting components.

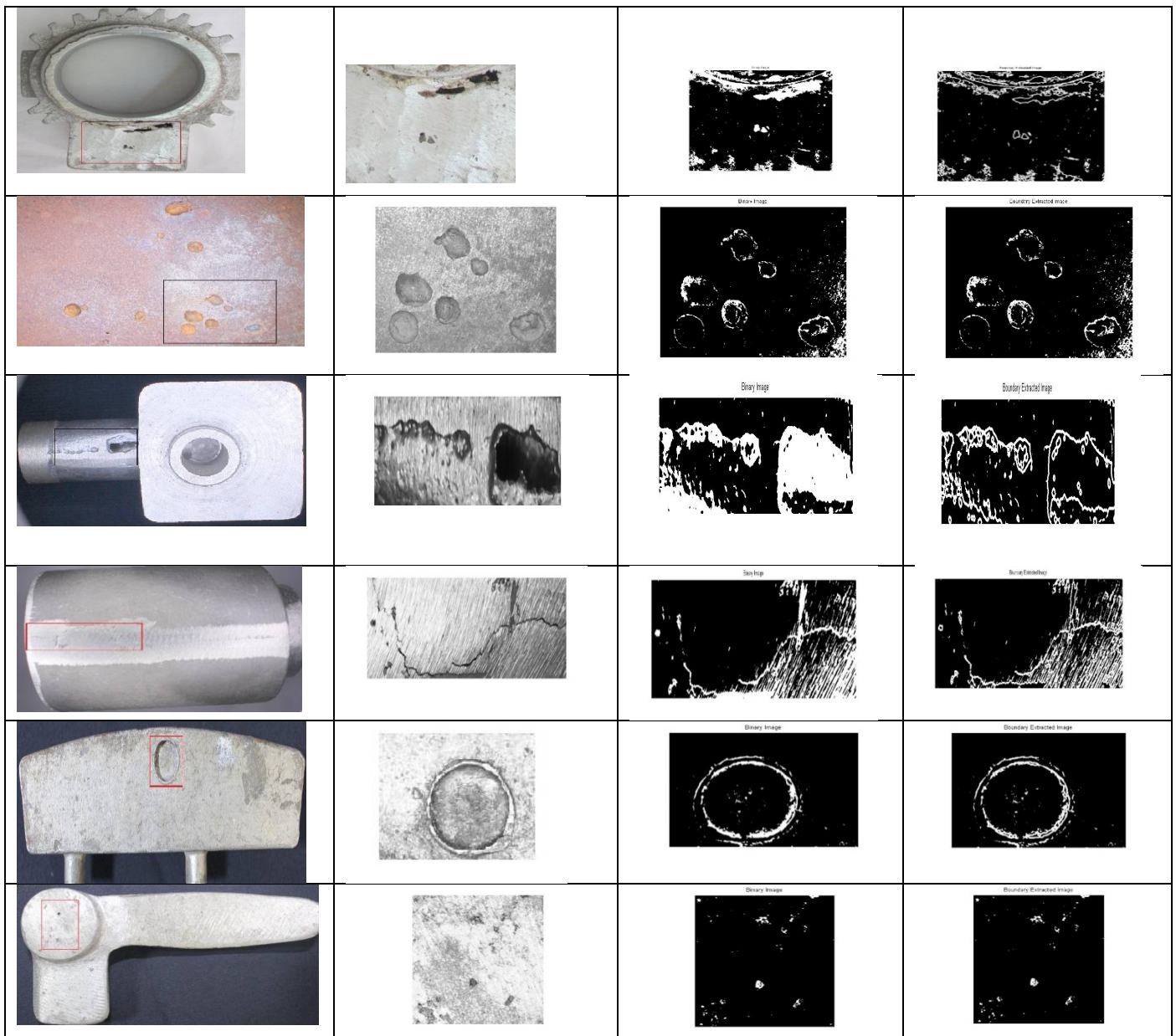
Original Image with ROI	ROI grayscale Image	Binary Image	Boundary Extracted Image
	<small>Filtered Image</small> 	<small>Binary Image</small> 	<small>Boundary Extracted Image</small> 

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Vol. 6, Issue 10, October 2017



## V. CONCLUSIONS

Trails were conducted on various lighting techniques to arrive at suitable lighting for the present to capture good colour images of aluminium and cast iron casted components. The diffused lighting technique was found better to capture good colour images of casting components and good images are successfully captured using LED diffused ring light. Image processing of captured images are carried out for contrast enhancement and noise filtering and histograms of grayscale images, filtered images and contrast enhanced images were plotted for all the components used in this work to study grey intensity distribution along the surface.

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Vol. 6, Issue 10, October 2017

It was found that edge finding is an effective tool for developing the edge maps for surface defects analysis of castings. Edge maps helped to differentiate casting defects so that they can be classified based on image data. In this present work edge maps has been extracted successfully for surface defects like cracks, pinholes, blowholes, burrs, sand drop, shrinkage, sand burn and cold shut.

Blob analysis was carried out for casting components using MATLAB. Filtered grayscale image was used to extract the blobs of defected surface regions. Using the pixels intensity information from histograms manual thresholding values were applied on binary image so that clear boundaries of defected surfaces are extracted successfully. Good visible defect region boundaries were extracted for various casting components at different thresholding levels.

From the above, it is inferred that machine vision and image processing can be successfully applied to analyse surface defects in casting components. Further the variation in image data of defects as observed can be utilized to develop templates for automatic inspection of casted components

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