

A New Research on Identify Defects in Stainless Steel Plate Using Image Processing

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Abstract— Quality management is very challenging in the production of steel plates. Identifying the defects in surface of steel plates is highly challenging and plays a vital role in high percentage and in quality control process also. In most of the production fields, only manual way of checking the defects is done. Due to which the following constraints are faced. Less efficiency, increase in production cost etc.. In industries, an automated technique which provides better detection, recognition and classification as well is used. Image processing identifies the defect and classifies using MATLAB.

Keywords: Defect detection, classification, recognition, MATLAB.

I. INTRODUCTION

In the current scenario a method which is used to enhance an image and gives us the informative contents by processing the input image is Image processing. In Image processing an image is an input, and output will be a digital image or datas associated with that image. Image Processing system usually includes images as two dimensional one and apply some processing methods to the image. The image processing do not restrict itself to certain area which should be studied but can also be analyzed.

The Images which are generally taken for analyze is from image sensors from satellites. Processing is usually done with the help of computers to manipulation raw data to get a digital images. Since the raw data will have flaws in it, should be processed to get originality of information. The general steps involved in image processing are Pre-processing, image enhancement and display, data extraction.

In today's, scenario, automation is done for various stages of manufacturing process. In metal production fields the manual way of visualizing for defects is done. Defects are of two types, with irregularity and change in orientation. Two cases are different but concept wise same approaches. First one shows defects in structure but in some regions sudden irregularity, the second one is change in the orientation. Two methods are similar in the approach that for different kind of patterns and defects it can be applied. Manual checking needs prior knowledge. Most probably, it is not in particular only about surface defects. In any detection methods for example, detection of edges, changes occur. In production fields, failure of machine happens for various reasons. An automated method to identify the defects as an alternative can be used.

II. LITERATURE REVIEW

The surface defects for four kinds of steel defects in the industrial applications were investigated. They are holes, scratches, coil break and rust. The experimental result gave high accuracy in the corresponding defects and the advantageous factor is the usage of 250 steel defect sample images for testing[1]. The accuracy of defect detection using methods like GLCM, Gabor wavelet, Gaussian filter segmentation method and combination of these methods give relatively less accuracy. Hence a new method implementing the Gabor filter bank was created for the reference and test images.[2]. The study on the two classes of stainless steel plates and three groups of defects formed on them was made. Based on this scale invariant feature transform (SIFT) or speed up robust features (SURF) descriptors, the classification is done based on the artificial neural networks (ANN). The results of the experiments show that the usage of class of invariance SIFT or SURF gives the high accuracy of the defects[3]. An efficient approach for detection and classification of defects on a stainless steel plate is like The defects are located and segmentation is done using the morphological operations. The GLCM attributes and geometrical attributes are extracted in order to characterize the defective region, back propagation neural network is used. The proposed system has been able to detect the defects in real time successfully[4]. A method to detect the defects on the stainless steel plates using SIFT for the defective region detection and also extracting the features. The classification method used is Scalar vector machine. The SVM can be able to generate many features for training the classifier from a few images[5]. The edge information of cold-roll steel sheets has been detected and investigated by using the digital image processing toolbox of the software MATLAB, defects detection of cold-roll steel surface based on MATLAB has a quite satisfying performance[6]. They have presented a survey for identifying the clustering algorithms which can be used for the image segmentation. In this they explained that with the clustering one can perform the image segmentation in a very efficient manner. Clustering algorithm on which they focused in this survey are from both the categories i.e. supervised and unsupervised manner. They mentioned that clustering the image segmentation process still needs some improved technology for the feature extraction because large database used cause variation in feature representation. The unsupervised algorithms are suffering from inefficiency problem due to this they require

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a serious computational efforts for image segmentation[7]. A Visual Inspection System to detect and classify rolled steel defects using methods like Computer Vision techniques and Artificial Neural Network. Defects like welding, clamp and identification hole were classified using Hough Transform[8]. In Future, the segmentation process will be done based on an effective segmentation approach for effective partitioning a defect region from other parts[9]. In this paper an approach is suggested to detect the location of defect on the surface of steel sheet by using Gabor Wavelet and variance. Values of partial images are inspected both normalized and non-normalized in the limit of [0, 1]. Altogether, the amount of correct detection of defective regions is improved in this approach with respect to other approaches[10]. In this a surface detection algorithm for hot rolled steel plates is being developed. The algorithm integrates undecimated wavelet transform, mathematical morphology and radon transform. It determined the positions of defects by maximum modulus of inter-scale correlation coefficients at first, and then classifies the defects by prior knowledge about defects. The algorithm were tested with 563 samples. Experimental results show that the algorithm is not sensitive to scales, water marks and uneven illumination, and the recognition rate is up to 90.23%[11]. Pre-processing operations on the image such as image enhancement, noise reduction and edge detection[12]. A new segmentation of color image is proposed based on granular computing clustering algorithm. The segmentation experimental results shown that (1) GrCC segmentation is a quick segmentation compared with Kmeans and FCM segmentations, (2) GrCC segmentation is better than Kmeans and FCM from the aspects of GCE, VI, and RI. (3) Loss of entropy only is a numerical measure for the segmentation of color image without the corresponding human segmentation[14].

III. EXISTING SYSTEM

A best estimation algorithm is used that estimates the mean with low dependent on the values of a numerical distribution which produces a more accurate estimate of the mean. The high and low values which are outlined can be replaced with closer value to the mean, so that the estimate value is slightly moved towards the mean. The formula used for k-winsorized mean is

$$\bar{y}_{wk} = \frac{1}{n} \{ (k+1)y_{(k+1)} + \sum_{i=k+2}^{n-k-1} y_{(i)} + (k+1)y_{(n-k)} \}$$

Consider 10 ordered samples

X1, X2,X3,X4,X5,X6,X7,X8,X9,X10

Where

X1- smallest, X2- Largest of the sample

10% of winsorized sample refers to trimming of one samples on either sides

X1, X2,X3,X4,X5,X6,X7,X8,X9,X10

10% of trimming refers to (10 number of samples X 0.1) = 1 (sample to be trimmed on each side)

In order to overcome the disadvantages of K-Winsorized mean a modified version of the existing K-Winsorized mean is being proposed.

Advantage of modified K-Winsored mean is, Smaller sample sizes might compel you to use less trimming. The

winsorized mean uses more information from the distribution or sample than the median. The winsorized mean of a sample is unlikely to produce an unbiased estimator for either the mean or the median. Modified Winsorized Mean or equal to median is a reasonable estimate of central tendency or mean for almost all statistical models has better resistant against outliers. Values obtained using Winsorized mean are very closer now duplicate X2 and X9 twice

X2,X2,X3,X4,X5,X6,X7,X8,X9,X9
 Then Winsorized Mean=
 (X2+X2+X3+X4+X5+X6+X7+X8+X9+X9)/10

IV. PROPOSED SYSTEM

In our proposed system we de-noise the image using the nonlinear filter called modified k-winsorized mean.

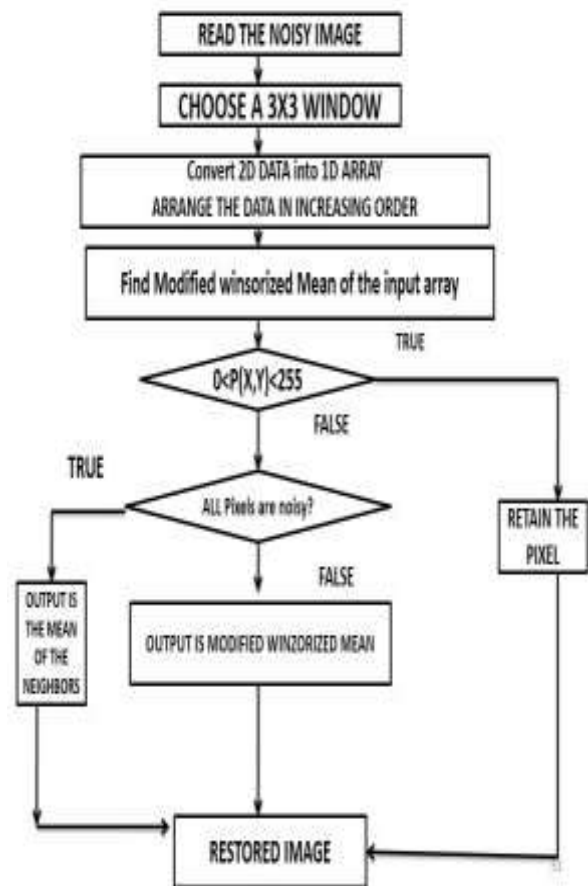


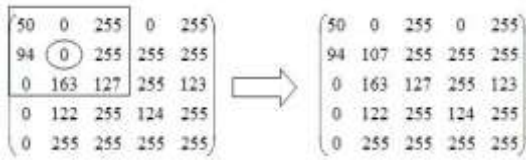
Fig 1 Flowchart of Proposed System

There are 3 different cases for the calculation of the winsorized mean. They are:

1. Processing pixel is noisy
2. All the pixels considered are noisy
3. Processing pixel is not noisy

4.1 Case 1

Processing pixel is noisy



Unsorted array: 50 94 0 0 0 163 255 255 127

Sorted array: 0 0 0 50 94 127 163 255 255

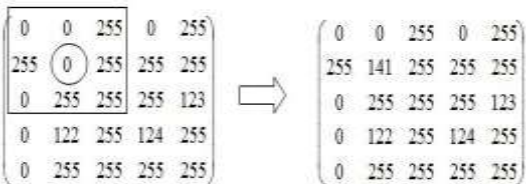
Trimmed Array: 50 94 127 163

Modified Winsorized Mean:

$$(50 + 50 + 94 + 127 + 163 + 163) / 6 = 107$$

4.2 Case 2

All the pixels considered are noisy



Processed pixel is noisy that is "0"

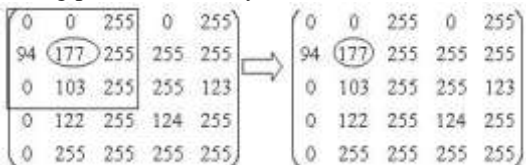
Output = mean of neighbours

$$= (0 + 255 + 0 + 0 + 255 + 255 + 255 + 255) / 9$$

$$= 141$$

4.3 Case 3

Processing pixel is not noisy



The processed pixel is not noisy that is 177. So, pixel is left unaltered.

V. RESULTS AND DISCUSSION

5.1 De-Noising

The input is exposed to salt and pepper noise as it is the noise that commonly exists during the transmission of images. Here, we use K-Winsorized mean in order to de-noise the image.

Noise=0.1 dB



Fig. 2 Denoising process with 10% Noise

Noise =0.9 dB

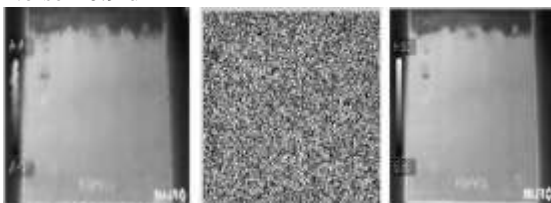


Fig.3 Denoising process with 90% Noise

5.2 Edge Detection

In edge detection we had compared different edge detection methods like Canny edge detector, Perwitt edge detector, Sobel edge detector, Roberts edge detector, LoG edge detector.

These edge detectors are compared with each other based on four factors:

PSNR - Peak Signal to noise Ratio

SSIM - Structural Similarity Index Metric

IEF - Image Enhancement Factor

MSE - Mean Square Error

5.2.1 Canny edge detector



Fig 4 Grayscale Image & Edge detection using canny

5.2.2 Sobel edge detector



Fig 5 Grayscale Image & Edge detection using Sobel

5.2.3 Roberts edge detector



Fig 6 Grayscale Image & Edge detection using Roberts

5.2.4 Perwitt edge detector



Fig 7 Grayscale Image & Edge detection using Prewitt

5.2.5 LoG edge detector

5.2.6 Test results

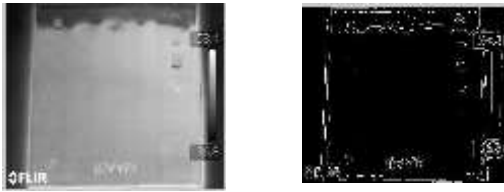


Fig 8 Grayscale Image & Edge detection using Log

Table 1 SSIM Factor of various operators

Noise Percentage	Canny	Sobel	Perwitt	Roberts	LoG
10	0.9932	0.9932	0.9933	0.9929	0.9932
20	0.9849	0.9848	0.9858	0.9856	0.9858
30	0.977	0.9763	0.9674	0.9768	0.9768
40	0.9679	0.9666	0.977	0.9672	0.9673
50	0.9551	0.9549	0.9553	0.9558	0.9561
60	0.9407	0.9404	0.9508	0.9412	0.9405
70	0.9216	0.9206	0.9207	0.9221	0.9226
80	0.8894	0.892	0.894	0.8931	0.8956
90	0.842	0.8418	0.8398	0.8465	0.8361

Table 2 MSE Factor of various operators

Noise Percentage	Canny	Sobel	Perwitt	Roberts	LoG
10	9.7939	10.9956	10.2118	11.9349	9.7766
20	23.8032	23.425	21.3481	22.1942	21.905
30	37.8556	37.4954	49.189	36.7545	37.3054
40	47.3315	48.2695	36.6358	48.2744	50.371
50	63.5484	67.0218	68.3177	66.0262	63.887
60	84.2318	84.6887	86.9242	84.3603	89.1611
70	111.2808	107.3757	112.9434	111.3069	114.7345
80	152.6216	154.4616	152.0048	154.5079	146.689
90	261.2941	261.0109	266.426	244.8254	255.9564

Table 3 PSNR Factor of various operators

Noise Percentage	Canny	Sobel	Perwitt	Roberts	LoG
10	38.2213	37.7186	38.0755	37.3626	38.2289
20	34.3644	34.434	34.8371	34.6684	34.7234
30	32.3495	32.391	31.2121	32.4777	32.4084
40	31.3793	31.2941	32.4918	31.2938	31.1102
50	30.0998	29.8686	29.7855	29.9336	30.0767
60	28.876	28.8525	28.7394	28.8694	28.629
70	27.6666	27.8217	27.6022	27.6656	27.5339
80	26.2946	26.2146	26.3122	26.2413	26.4668
90	23.9603	23.9642	23.875	24.2422	24.0491

Table 4 IEF Factor of various operators

Noise Percentage	Canny	Sobel	Perwitt	Roberts	LoG
10	199.9601	175.3903	191.6425	164.9989	200.9311
20	163.5117	167.9164	178.3094	175.8131	179.0002
30	153.7334	156.0429	155.9477	159.0127	156.3028
40	164.7108	161.0205	158.8174	162.3188	154.1915
50	152.7306	144.1673	143.2159	147.2998	152.4754
60	137.6454	136.4958	134.6727	138.2466	130.3732
70	121.8251	127.7853	119.791	121.8201	118.4062
80	102.703	99.9698	102.2441	100.5764	106.298
90	67.2249	66.5292	65.8633	71.7173	68.2365

5.3 Morphological Processing

By using the canny detector the edge detection is being performed. Then the image segmentation is performed by morphological processing as it detects both internal and external boundaries.

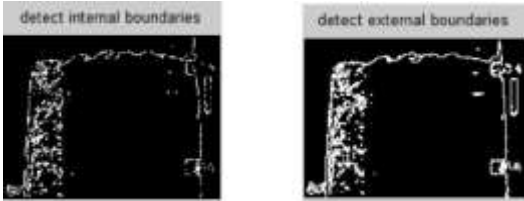


Fig 9 Internal Boundaries & External Boundaries

5.4 Feature Extraction

The mBm is being used in order to extract the required features in the given input image.

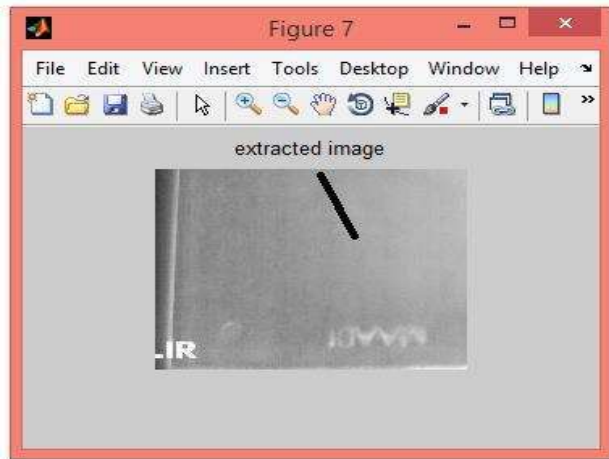


Fig 10 Feature Extraction with defective image

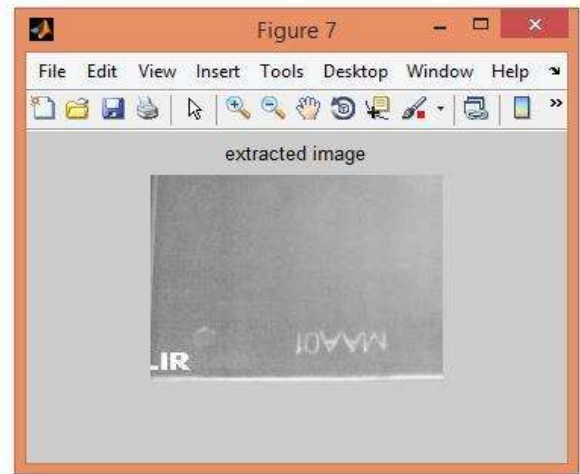


Fig:

Fig 11 Feature Extraction with defect free image

5.5 Classification And GUI

Even the minor defects can be detected by using the correlation process



Fig 12 Defective Image & Output Image

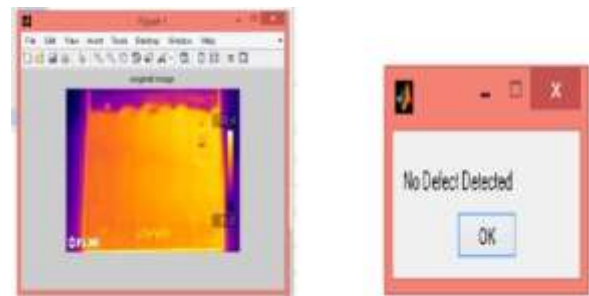
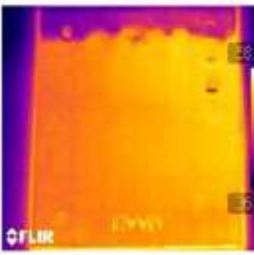
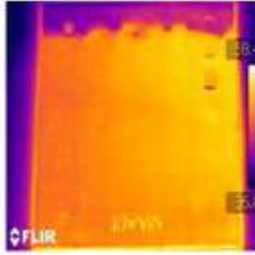
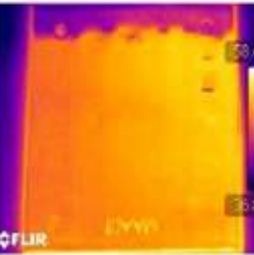
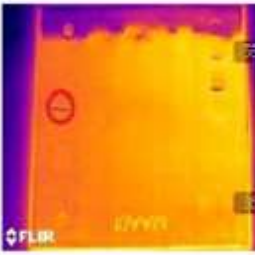
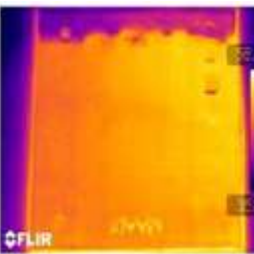
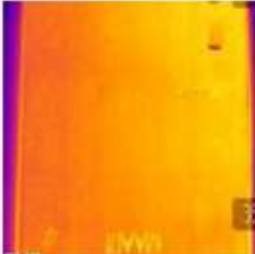
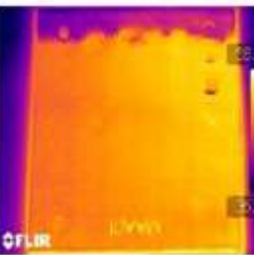
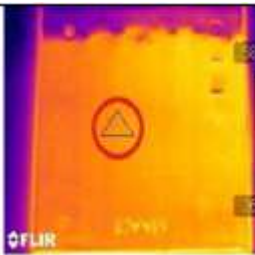


Fig 13 Defect Free Image & Output Image

Table 5 Comparisons of various image inputs

Master images	Input images	Cross-correlation value	Defect/No Defect
		1.0000	No Defect
		0.9992	Defect
		0.9996	Defect
		0.9960	Defect

5.5.1 GUI Performance

Step 1

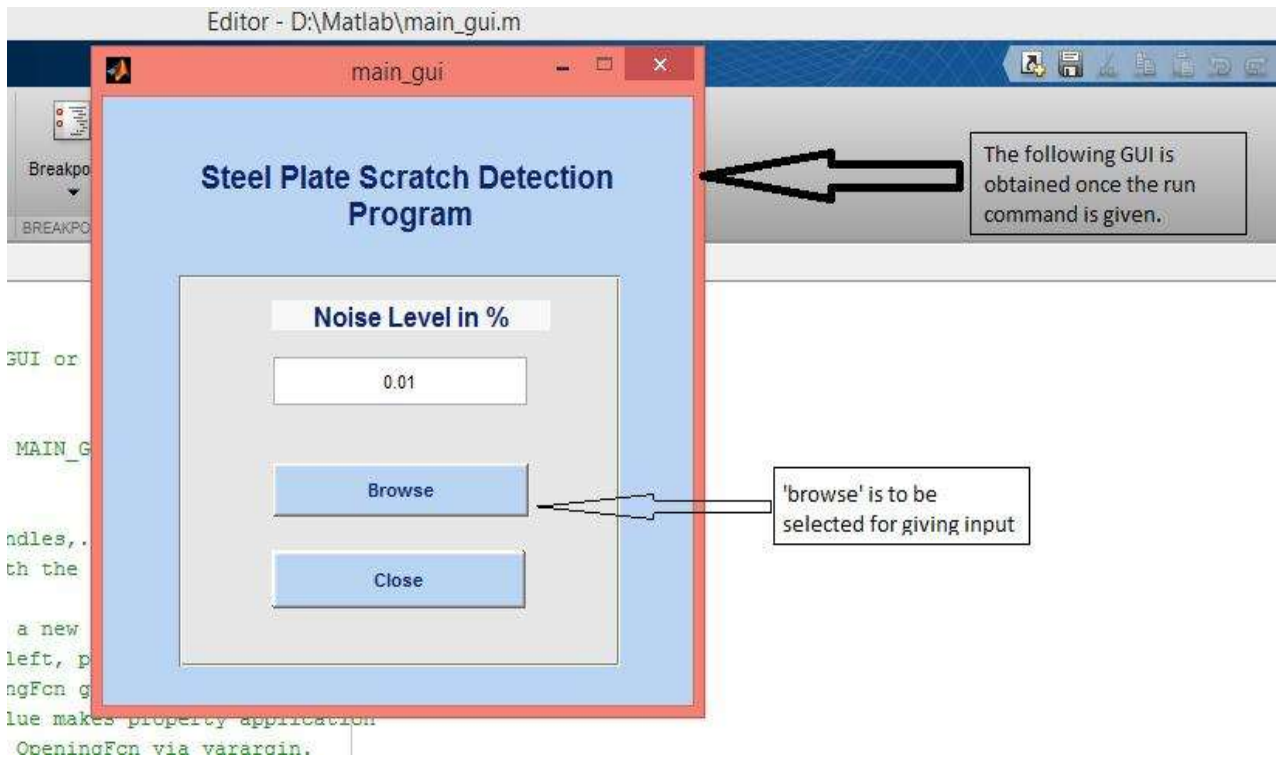


Fig14 GUI Step 1

Step 2

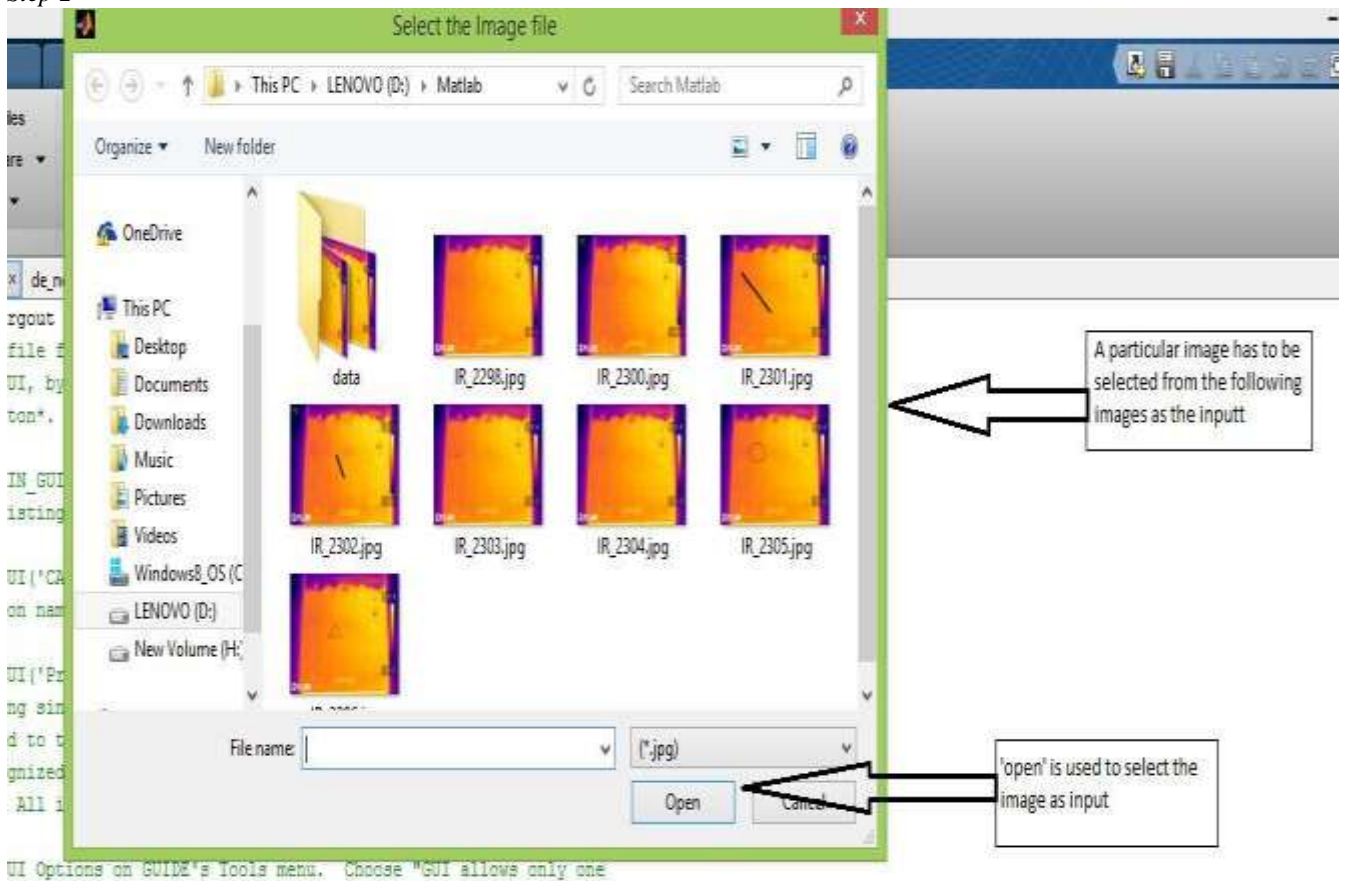
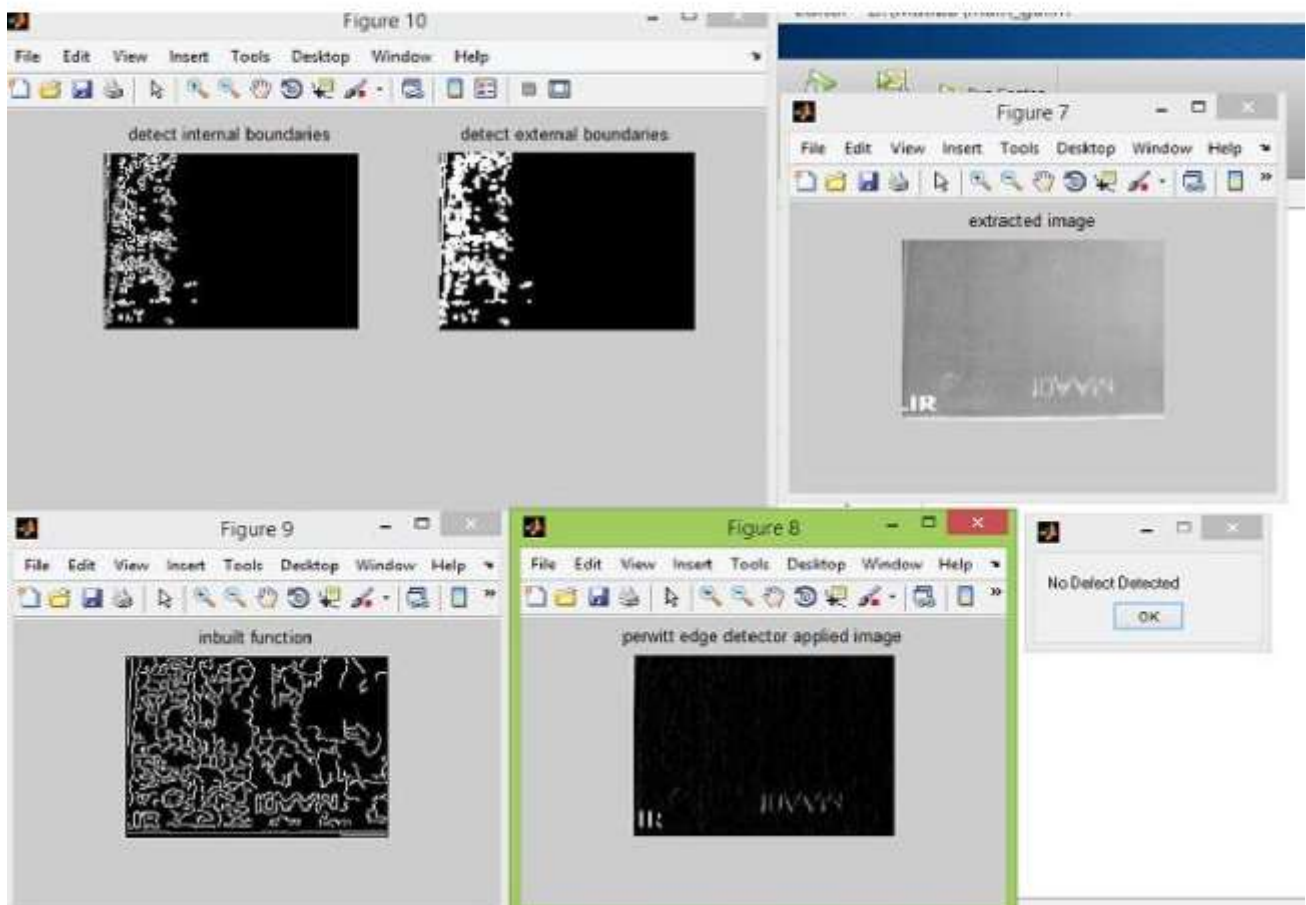
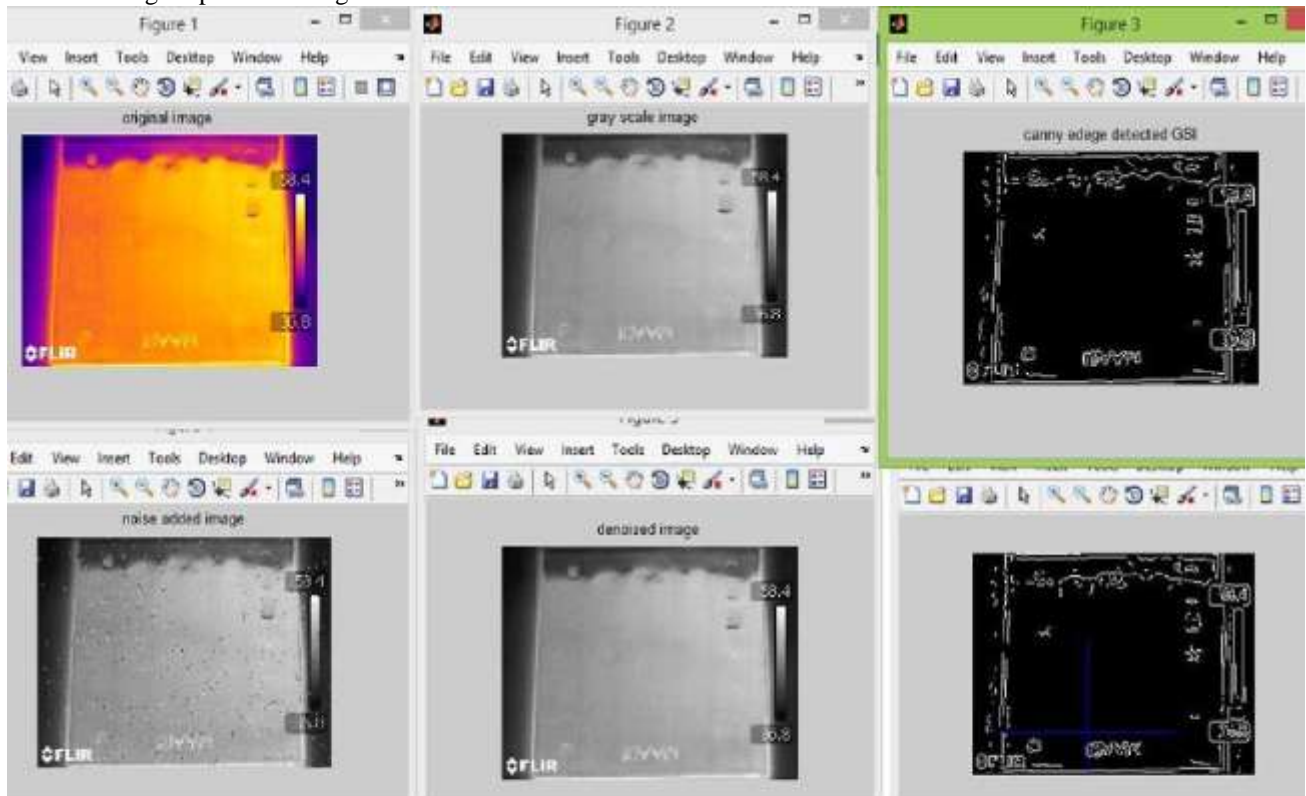


Fig15 GUI Step2

Step 3

The following outputs are being obtained



VI. CONCLUSION

The de-noising capacity of modified K-Winsorized mean has shown very good results. Its de-noising capability has been tested at various levels of noise which range from 0.01 (1%) to 0.999(99.9%) of noise. At each level the noise has been removed providing the accurate output. Edge detection has tested using various filters like sobel, perwitt, Roberts, canny, LoG. In order to compare the output of these filters some parameters like PSNR(Peak Signal To Noise Ratio), MSE(Mean Square Error), IEF(Image Enhancement Factor), SSIM(Structural Symmetry Indication Matrix) are considered. Comparing these parameters for all the filters as shown in tables 1, 2, 3, 4 it can be inferred that canny provides the best output for the edge detection. Then internal and external edges for the images are deduced using morphological processing. Multiple Brownian motion iterates the image multiple time and gets the required extracted region. A data base is developed in order to compare the images during the correlation process for classification and GUI is developed for easy usage of the user.

VII. FUTURE WORK

The de-noising of the image lacks in its performance when the noise value is 1 which has to be improved. In Brownian motion during resizing the image to 256*256 it makes delay of about 30 seconds for it. This delay time during the resizing has to be decreased or the image should be resized to 128*128 in order to decrease the time lag. A database is being created for the correlation process.

The major drawback is that it can't be used for a bulk of images at a time. So, a method to improve this and make an access has to be developed. This user to classify many images at the same time.

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