FABRIC DEFECT DETECTION USING DIGITAL IMAGE PROCESSING

Dissertation submitted in partial fulfillment of the requirement for the Degree of

BACHELOR OF TECHNOLOGY

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ELECTRONICS AND COMMUNICATION ENGINEERING

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DECLARATION BY THE SCHOLARS

We hereby declare that the work reported in the this report entitled **“Fabric Defect Detection using Digital Image Processing”** submitted at **Jaypee University of Information Technology, Waknaghat** is an authentic record of our work carried out under the supervision of **Ms. Pragya Gupta**. We have not submitted this work elsewhere for any other degree or diploma.

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Date -

SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in this report entitled "**Fabric Defect Detection using Digital Image Processing**", submitted by **Shubham Bhargava, Shirin Dewan and Abhinav Arora** at **Jaypee University of Information Technology, Waknaghat**, **India** is a bonafide record of their original work carried out under my supervision. This work has not been submitted elsewhere for any other degree or diploma.

(Signature of Supervisor)

Date -

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We would also like to expand our deepest gratitude to all those who have directly and indirectly guided us in this project.

ABSTRACT

The goal of this project is to recognize faults in fabrics. The textile industry, as with any industry today, is extremely worried with quality. It ought to create the most noteworthy quality merchandise in the briefest measure of time conceivable. Texture faults or deformities are in charge of about 85% of the imperfections found by the producers, while they recoup just 45 to 65 % of their benefits from seconds or off-quality merchandise. It is basic, hence, to recognize, to distinguish, and to keep these imperfections from reoccurring.

There are very techniques used to identify defects. The first is Image Enhancement. It implies upgrading the visual appearance of an image and giving "better" contribution for other computerized image processing techniques. The principle objective of image improvement is to modify attributes of an image to make it more appropriate for a given errand.

OBJECTIVE

The main objective of the project is to detect the different types of defects that occur in the fabric during the manufacturing process. The types of defects that will be included in the present thesis are namely holes, stains and weaving defects. For the sake of simplicity of computation, we take woolen fabric with thick yarn for detecting the weaving defects using the same technique. The main focus of the thesis is to detect and also identify what type of defect is present in the input fabric image. Exploring various techniques such as thresholding, filtering, erosion, dilation, etc. and implementing them together to create of successful model of defect detection will remain the cornerstone in our project thesis.

Our data set contains 20 images each with a defect of either hole, stain or weaving. Furthermore, our algorithm will be able to detect the missing warp defects in the weaving category.

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KEY TERMS

- **HSV IMAGE**

HSV image includes three components namely –Hue, saturation and Value and it is a color space .In this model Value is sometimes considered as brightness and then it is known as HSB image. This model was generated by Alvy Ray Smith and is known as hex-cone color model[3].

Hue

In HSV, hue component represents color. In this model, hue is an angle which is varied from 0 degrees to 360 degrees.

ANGLE	**COLOR**
0-60	Red
60-120	Yellow
120-180	Green
180-240	Cyan
240-300	Blue
300-360	Magenta

Table (i) [3]

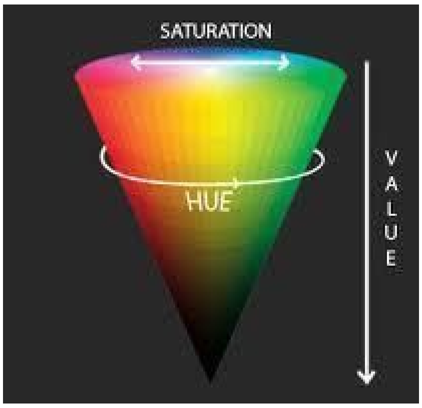


Fig (i)

Saturation

Saturation value is used to indicate the range of grey shade present in the color space. It ranges from 0 to 100%. Sometimes the value is from 0 to 1. When the value is '0,' represents the color grey and the value is '1,' represents any primary color. Presence of A faded color is due to fact that there is lower saturation level, which means the color contains more grey value.[3]

Value

Value represents the brightness of the color and it varies with color saturation value. It can range from 0 to 100%. When the value is '0' the color space will represent a totally black state. With the increase in the value, the color space brightness up and shows various colors.[3]

Applications of HSV

This scheme is widely used to generate high quality computer graphics. It can also be used to select various different colors needed for a particular picture. An HSV color wheel is used to select the desired color. It is used to provide the color according to human perception.

Advantages of HSV

The HSV color space similar to the way in which humans perceive color. The colors used in HSV can be clearly defined by human perception, which is not the case with RGB or CMYK. Therefore it is quite useful.

- ## DILATION AND EROSION

Dilation and Erosion components are used as operators in the area of mathematical morphology. These are basically applied to binary image.. The use of these operators on a binary image is to enlarge the boundaries of regions of foreground values of pixels. Thus due to these areas of foreground pixels grow in size while that the holes which are present within those regions become smaller.

WORKING

The working of these process is as follows:

- Firstly, it takes two pieces of data as its input. The first one is the image which is meant to be dilated and the second is structuring element which determines the effect of the dilation on the image.
- Suppose that *X* is the set of Euclidean coordinates corresponding to the input binary image, and that *K* is the set of coordinates for the structuring element.
- Let *Kx* denote the translation of *K* having origin at x.
- Then the dilation of *X* by *K* represents the set of all points *x* such that the intersection of *Kx* with *X* is non-empty thing.

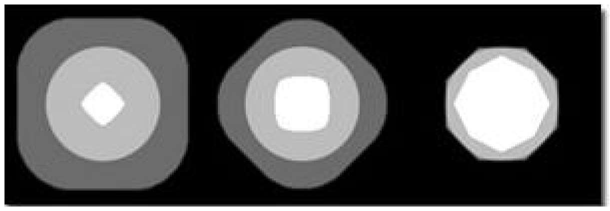


Fig (ii)

DILATION AND EROSION PROCESS

- **FILTERING**

Filtering is a technique which is used for modifying or enhancing image. For example, if we want to filter an image to emphasize certain features or remove other features we use this method. Many image processing operations can be implemented with filtering function including smoothing, sharpening, and edge enhancement.

Filtering represents a neighborhood operation*,* which works by determining the value of any given pixel in the output image and by applying some algorithm to the values of the pixels in the neighborhood of the given input pixel. A pixel's neighborhood is set of pixels, defined by their locations relative to that pixel. Also Linear filtering is the process in which the value of an output pixel is a linear combination of the values of the pixels in the input pixel's neighborhood.

CHAPTER 1: INTRODUCTION

In a right triangle, as hypotenuse completes the right triangle process, in the same way in manufacturing industry, quality completes the triangle process along with the other two lines of triangle i.e. cost and in-time delivery. It implies that the quality is the most critical parameter regardless of the expansion in either of alternate parameters (geometrical actuality). Scientifically, a process quality control implies leading perceptions, tests and investigations and in this way settling on choices which enhance its execution. Since no production or manufacturing process is 100% deformity free (this applies especially where characteristic materials, as material ones, are prepared), the success of a weaving factory is essentially highlighted by its achievement in diminishing texture defaults [1].

Although quality levels have been extraordinarily enhanced with the constant change

of materials and innovations, most weavers still think that it’s important to perform 100% review since client desires have additionally expanded and the danger of conveying second rate quality textures without examination is not adequate. So, the main issue lies how can the fabric inspection lead to quality improvement. To see this issue, we first have to differentiate between offline and online inspection systems. Online system provides images from current production and is located directly on or in the production line. These are real-time systems whereas offline systems is located after the production line. Offline systems are done by manually skilled staff with an accuracy of 60%-75%.

The current weaving Industry confronts a considerable measure of troublesome difficulties to make a high profitability and high-quality-manufacturing environment. Since production speeds are quicker than any time in recent memory and as a result of the expansion in move sizes, producers must have the capacity to distinguish defects, find their sources, and make the important remedies in less time in order to diminish the measure of second quality faults. This puts a more noteworthy strain on the investigation bureaus of the makers. Because of elements, for example, tiredness, weariness and, carelessness, the staff execution is frequently untrustworthy. The examiner can barely decide the level of deficiencies that is adequate, however looking at such a level between a few examiners is practically outlandish. Accordingly, the best probability of objective and predictable assessment is through the use of a programmed investigation framework.

From early time, the humans' focus is to modify the manufacturing techniques to achieve optimum results in quality, cost, comfort, accuracy, precision and speed.

An automated inspection system usually consists of a computer-based vision system. Since, these are computer based they do not suffer the errors and faults of manual vision inspection [1].

As given above, offline systems suffer the faulty drawbacks therefore, to be more efficient, inspection systems must be implemented online or on-loom.

1.1 What is Digital Image Processing?

Fig 1.1.1

In the above figure, an image has been captured by a camera and has been sent to a digital image processing system to remove all the other details, and just focus on the water drop by zooming it in such a way that the quality of the image is not compromised.

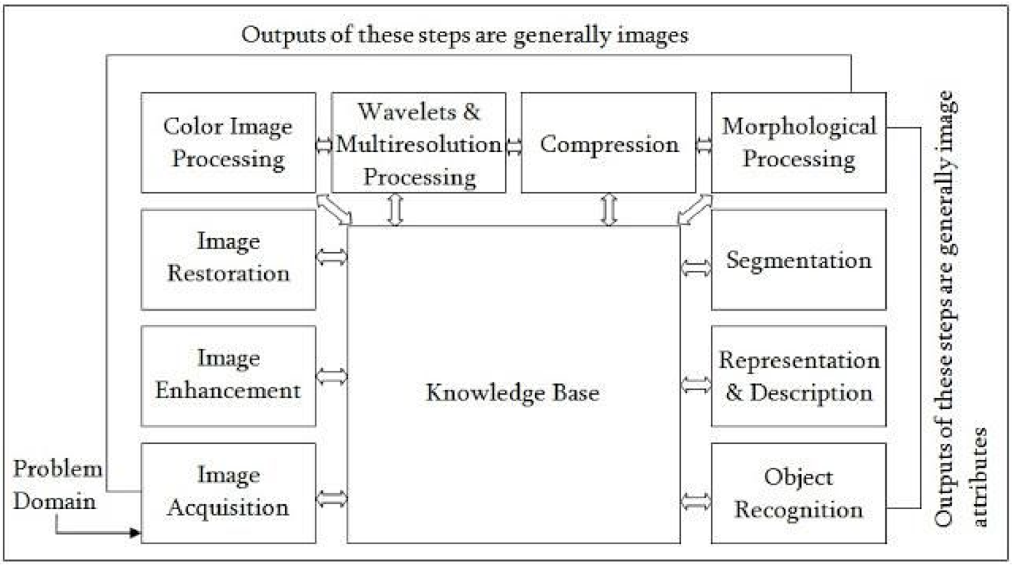


Fig 1.1.2

The above figure briefly describes the steps involved in a digital image processing system. In this, the output of some steps are images whereas for some the output are image attributes.

1.2 Image processing consists of the following steps –

I. **<u>Image</u> <u>Acquisition-</u>**It is the first step in any digital image processing system. It is generally an image in digital form.

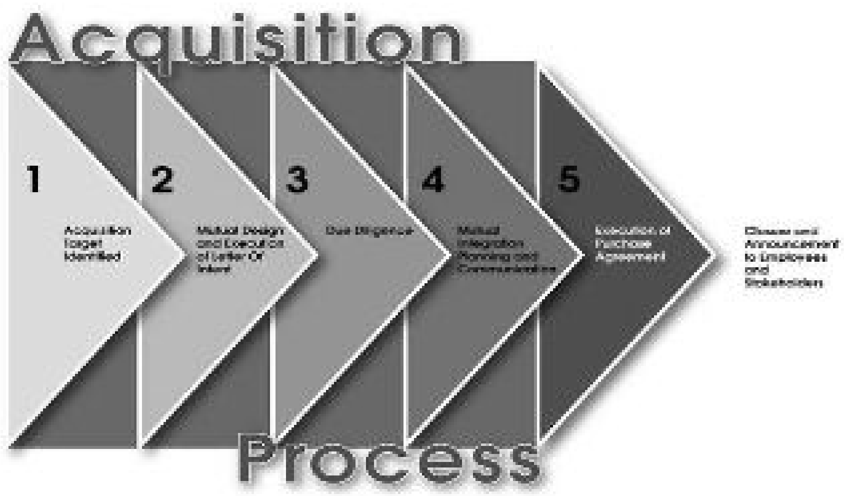


Fig 1.2.1

II. **Image Enhancement-** Image enhancement is among the least complex and most engaging regions of digital image processing. Fundamentally, the thought behind this is to bring out detail that is darkened, or just to eliminate certain features of disinterest in the image.

Fig 1.2.2

III. **Image Restoration-**It also deals with improving the presentation of an image. The main difference between image enhancement and image restoration is that the latter is based more on mathematical models of image degradation.

Fig 1.2.3

IV. **Color Image Processing-** It is again a lot of importance because of so many digital images all over the internet. It basically represents the colors in color models which shows different color components.

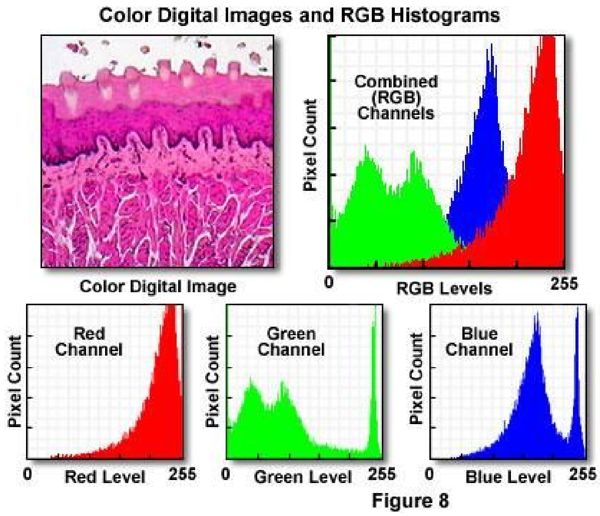


Fig 1.2.4

V. **Wavelets and Multi-Resolution Processing-** It represents images in degrees of resolution.

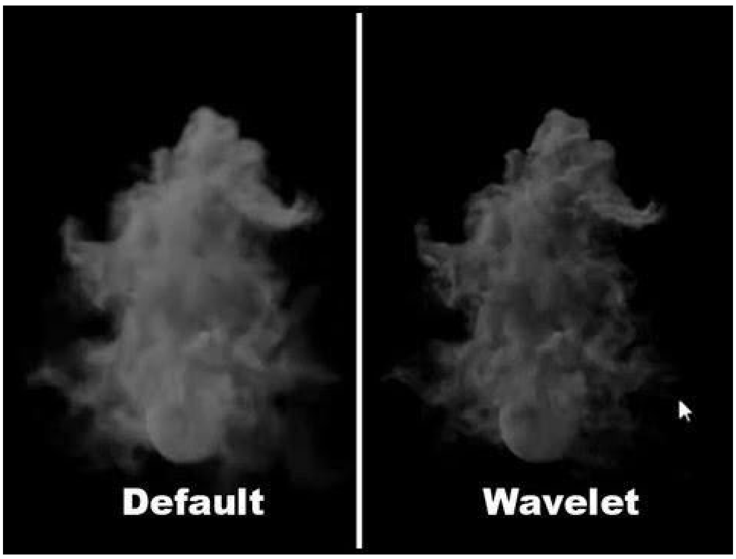


Fig 1.2.5

VI. **Compression** – It deals with minimizing the storage required to save an image.

Fig 1.2.6

1.3 SYSTEM SPECIFICATION

HARDWARE SPECIFICATION

Processor:	Intel Dual Core or higher
RAM:	1024 MB
Hard Disk Drives:	40 GB
Monitor:	15" Color Monitor
Keyboard:	Multimedia Keyboard
Mouse:	Logitech Mouse
NIC:	Realtek / Intel 10/100 Mbps
Camera:	Canon with 16 mega pixel

SOFTWARE SPECIFICATION

Operating System:	Windows 7
Technology:	Image processing
Tool:	MATLAB R2012a
Processor:	Intel Dual Core or higher
RAM:	1024 MB
Hard Disk Drives:	40 GB
NIC:	Realtek / Intel 10/100 Mbps

1.4 Types of Defects

I. Hole

This can be cause to a broken needle or there may be a sharp machinery part which could cause this defect.

Fig 1.4.1

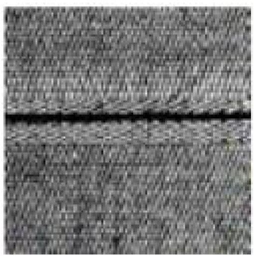
II. Stain

Stains can be caused due oil spilled by machinery, or due to rust or grease stains found on some machinery parts.

Fig 1.4.2

III. Weaving defects

These defects can be caused due to irregularity in the weft yarn.



CHAPTER 2: REVIEW OF LITERATURE

1. **Kumar A.**: Computer vision-based fabric defect detection: a survey, IEEE, Transactions on Industrial Electronics, Vol. 55, Issue 1, 2008, pp. 348-363.

The above paper provided a survey of fabric defect detection by working on three approaches which are statistical, spectral and model-based. The results came different while working on different approaches, therefore the paper proposed that the combination of these approaches would give better results and would be more efficient.

2. **Mahajan P.M., Kolhe S.R. and Pati P.M.**: A review of automatic fabric defect detection techniques, Advances in Computational Research, ISSN: 0975–3273, Volume 1, Issue 2, 2009, pp.18-29.

The above paper provided a survey of fabric defect detection by working on two approaches which are statistical and spectral. Due to the lack of deformity in the image database, performance evaluation could not be done on which approach is the best for fabric defect detection. Although, between statistical and spectral approaches it considered statistical approaches to be ideal one as they were less complex.

CHAPTER 3: IMAGE PROCESSING AND FABRIC INSPECTION

3.1 INTRODUCTION

Image Processing operations are defined as the operations which are applied on the input image to obtain an output image with desired characteristics. In image analysis the extraction and measurement of image features like lines and corners are done also transformation of these features to the desired outputs i.e. to numbers, vectors, strings etc are done. Nowadays intelligent image processing is used for various production processes including online fabric inspection .This online fabric defect detection process is generally a two phase process which includes

- A system is trained with the images of surface which is defect free .This system is made by calculating the extreme values of the features and on the basis of it a simple classifier is made.
- In second phase the region of interest are processed .this is done by dividing the image into sub images and then calculating the statistics of each other .This statistics calculation depend on a set threshold value ,the calculated value is compared to the original training texture and if the value exceeds the threshold then it is concluded that there is a defect.

3.2 CHALLENGES AND DIFFICULTIES

Implementation of online fabric defect detection may suffer from following difficulties:

- There are large number of fabric defect classes, due to which task becomes very challenging.
- There are various inter-class diversity and inter-class similarity of defects.
- In textured materials it becomes very difficult to characterize the defect.
- There is a large variety of fabric patterns.
- There are various stochastic variations present in the scale.
- The process also suffers due to presence of noise.
- Due to various reasons like environment and nature of weaving process, there is presence of stretch and skew in the fabric.
- The tasks involves the intake of high data.

3.3 ALGORITHMS OF AUTOMATED FABRIC DEFECT DETECTION

After the image of the fabric which is under inspection is captured it undergoes through various processes that include image enhancement, image restoration, image segmentation, image feature extraction and recognition. All these processes are carried out by various algorithms that are employed by processing unit of the system. Thus the fabric defect detection need a robust detection algorithm.

3.3.1 AUTOMATED FABRIC DEFECT INSPECTION CLASSIFICATION

The texture analysis is done on the basis of six approaches based on the used algorithm which include: structural approach, statistical approach, spectral approach, model based approach, combination of the computational approaches and the comparative studies.

3.3.1.1 STRUCTURAL APPROACH

According to this approach it is assumed that textures are made of primitives. These primitives may include individual pixels, a region with uniform gray level or various line segments. This approach has the two main objectives:

- Firstly to extract the texture primitive from the given sample.
- Secondly, to generalize the spatial placement rules accordingly.

These placement rules are obtained by modelling various geometrical relationship between the primitives or by learning the statistical properties from the different texture primitive. This approach was not useful because of various stochastic variations in fabric that appear due to elasticity in yarn, noise or fabric motion. Due to these variations there were difficulty in extraction of various texture primitives from the given samples.

3.3.1.2 STATISTICAL APPROACH

In this approach the spatial distribution of pixel values is measured and the main objective is to separate the image of the inspected fabric into regions of distinct statistical behaviour. The assumption that is made while considering the statistical approach is that the statistics of defect free image are stationary and these statistics are extended over the significant portion of the inspected images. Based on the number of pixels present, that define the local features this approach is divided into three parts: first order statistics, second order statistics and the higher order statistics. The first order statistics analyses the properties like the average and variance of the individual pixel, while ignoring the interaction that is between the neighbouring image pixel. While the second and the higher order statistics analyze the various properties of the two or more pixels that occur over specific locations that are relative to each other. This approach is commonly used as it is well distinguished by computer vision and can be easily applies to many tasks. The most commonly used approaches under this are:

- **GRAY LEVEL THRESHOLDING APPROACH**

This approach is used to detect the high contrast fabric defects that maybe be present in the image. As the signal variation occurs due to high contrast this method is used by comparing the gray level values with that of reference threshold values. If the value of the gray level is greater than the threshold value then this area is considered to have a defect, or otherwise it is considered to be defect free. The advantage in using this technique is that the it is easy to implement. The disadvantage is that it is not possible to detect the defects without changing the mean gray level values in the defect free region.

- **NORMALIZED CROSS –CORRELATION APPROACH**

This method is used to identify and locate the various features that are present and one image and may appear in another image. The correlation coefficient that is generated is used to make a correlation map which tells that there is a defect present in the region. The cross-correlation method is used to measure the similarity between the two given images. Any variation in the measurement of this value indicates the presence of defect.

- **STATISTICAL MOMENTS APPROACH**

Under this approach, the mean, standard deviation, kurtosis, skewness are used to provide the statistical information of the region while the calculated values are used for image segmentation process. The main advantage of using this approach is the ease of their computation.

- **MULTILEVEL THRESHOLDING APPROACH**

This approach is useful for the inspection of uni-coloured fabric and it does not consider the printed fabric .This thresholding method is subjective. One should be careful that while imaging all conditions should be constant and all the non-defective samples under consideration should be identical. It should be carefully checked that while imaging dust particles, lint and lighting conditions should be properly checked as due to these false alarm may be introduced.

- **HISTOGRAM PROPERTIES APPROACH**

This approach is useful for point to point analysis. Different images can be compared to each other after histogram equalization has been done. This method help to make object more structurally defined and helps to see the details which are not visible clearly with human eye because there is gradient in brightness. Histogram technique is useful because of their low cost and high detection accuracy.

- **RANK ORDER APPROACH**

This approach is based on the results of histogram analysis .This process takes place in following manner:

- ➢ The sequence of different gray levels are given and then this sequence is sorted in ascending order.
- ➢ If there is a correspondence of 1:1 between the given histogram and rank function then the histogram will provide exactly the same information .

In general rank functions are used as compared to histogram technique because there is presence of the very efficient definition of the rank functions which are extremely efficient to be computed. The commonly used rank filter are median filter minimum and maximum rank order filers. These filters are commonly used as it can very easily adjust and act accordingly even when there is slight modifications in the local properties of the image. These local information is extremely useful because various other functions like adaptive modifications of histogram can be performed. The disadvantage of this filter is that the information regarding the fabric which includes spatial information and the orientation measure is not determined by just mere knowledge of this function. Due to this fact these approaches are not commonly used in the fabric defect detection process.

- **EDGE DETECTION APPROACH**

One of the traditional techniques which are used today for fabric defect detection is edge detection technique. The concept for using this technique is that the information regarding the distribution of edge amount in the per unit are is the important feature to be known in the given textured images. The transitions that are present in the image is due to presence of line , point defects , edges and that might be any other spatial discontinuity. This is an ideal approach to be used for the images having low resolution. This technique is widely used for final conformation checking, fabric defect detection and during the inspection .The only drawback of this process is that the noise which may be added may result in false alarming and thus due to this ,technique is not widely preferred.

- **MORPHOLOGICAL FILTER APPROACH**

This approach is used to provide the geometrical and the various structural properties of the image. By the knowledge of this one can have information regarding the grouping conditioning, matching the operations on the given images. The main advantage because of which this technique is highly used is that it helps to fix the noise problem that may cause defect during the performance of different operations.

- **EIGEN FILTER APPROACH**

This approach is used for the separation of the linear dependencies between the image pixels rather than the higher order dependencies. The advantage of using this approach is that in this case fillers are highly flexible as they can be easily adapted to the different textures which they come across. The more enhanced versions of these filters can be made which will be efficient enough to measure the rotation and negation in the images captured. These filters give good detection results which are highly accurate and can be trusted. They provide the efficiency of 96-97%.

- **AUTO -CORRELATION APPROACH**

This approach is useful as in this case all the parts of the image are combined and these parts are used for characterizing the repetitive structures that are present in the given fabric image.

This works with the fact that there is the measurement between the correlation of the original image and with that of the translated image with displacement vector. This functions on the Fourier transformation technique by analysing the power spectrum of the given image.

3.3.1.3 SPECTRAL APPROACH

These approach is used commonly as this approach works for the features like variation in the intensities and sensitivity towards noise. Nowadays they are widely used in computers for research work. They help to analyse the textured images in the space and frequency domains.

These are applied in the case where there are uniform textured fabrics. These methods are very efficient as they are used to overcome the shortcomings of various statistical approaches. These methods are widely used in online fabric defect detection processes.

The main objectives of this approach are:

- ➢ To detect and identify the primitives of the given texture
- ➢ To generalise and modify the placement rules in the fabric.

The various spectral approaches are listed below:

- **FOURIER TRANSFORM APPROACH**

This approach is widely used to characterize the various images which n=may include both textured and plain images. This method is used because of the following advantages:

- ➢ Has noise immunity
- ➢ Invariance in translation
- ➢ Enhancement in the periodic features of the fabric.

This method is applied by comparing the power spectrum of the image contain defect with that which is defect free. When the defect occurs there are variations in some positions of the frequency spectrum and this could tell the occurrence or presence of the defect. The various methods of implementation of this technique includes: Optical Fourier Transform, Digital Fourier Transform. To recover the images in the spatial domain Inverse Fourier Transform is also carried. To analyse the various features Classic fast Fourier Transform, windowed Fourier Transform are used .These techniques of defect detection are versatile both in the case of local defects and global defects.

Some of the disadvantage of using this defect is that this approach does not work well in the condition when frequency components are highly mixed with uniform regions and theydonot affect the components of the defected regions. Also this process is highly costly and complex .It also takes large computation time in order to see that Fast Fourier Transform is used. It provides the computation time of $2N\log_2 N$. The Fast Fourier Transform is highly effective in computation of defects that appear during run time.

- **GABOR FILTER APPROACH**

It is the traditional form. It helped to introduce the dependency of the Fourier transform and analysis through the windowed operation this new technique was known as Gabor Transform. This method is closely related to the working of that of our brain. When the image is captured by our eye it is decomposed into various images having different intensities and these also vary over a narrow band of frequencies. Similarly the Gabor Filter works in the same way.

The algorithm for this filter is very fast, robust and is highly efficient. It is effective in the detection of the defects which are present on the textured materials. The disadvantage of this filter is that it is non–orthogonal.

- **OPTIMIZED FINITE IMPULSE RESPONSE FILTER APPROACH**

Some fabrics are having the defects which are very difficult to detect even by using the above mentioned approaches so for the detection of such defects the FIR filters are used. These filters are having more parameters as compared to that of Gabor filter thus due to this there is more advantage in using these filters. Because of these features more accurately one can separate a defect free fabric image from the defected fabric images.

These algorithms are very useful as they provide the ease of computing the results. These filters also implement the impulse response. They are available in different size with the mask size available from 3×3 and 5×5. While they have many advantages they donot detect the some specific defects present. However they improve the performance of the system which are employed for the defect detection.

- **WIGNER DISTRIBUTION APPROACH**

This approach is effective as it provides better co-joint resolution as compared to other spectral approaches. The computation time in this has is prohibited but it is highly used in the defect detection online process. It cannot detect the various defects and also it allows the interference between different components of the given images.

3.3.1.4 MODEL BASED APPROACH

This method is used to basically capture the process which is responsible for the generation of texture. In this, procedure starts by determining the parameters of pre-defined model. The use of this approach is preferred when the statistical and spectral approaches fail to give the required results. The task of computation is difficult and complex .Some of the processes under this approach are. [1]

- **GAUSS MARKOV RANDOM FIELD (GMRF) MODEL APPROACH**

This approach uses the concept that the brightness level at any point in the image depends on the brightness of any neighbouring point in the image provided that the image is not corrupted with the random noise. In this capturing of local spatial information in the image is done. The assumption is made that the intensity level at any pixel value is dependent on the intensities values of the neighbouring pixel. This method provides a convenient way for modelling the context dependent values such as pixels by characterizing the mutual influences by using this type of distribution or approach.

- **POISSON'S MODEL APPROACH**

The model talks about the stochastic behaviour of textured materials which are based on the manufacturing process. These materials may include non-woven materials which are used for air filtration .

- **MODEL –BASED CLUSTERING APPROACH**

Generally during computation the problem of computing clusters in the given data set is there. Thus, various techniques were combined to get the accurate result. This type of approach is used to detect the faint defects present in the fabric. For this detection the criteria of Bayesian information is used.

COMBINATION OF COMPUTATIONAL METHODS

It is very difficult to detect all the defects present in the fabric by using a single approach .It is due to the fact that some techniques are having some advantages and the other disadvantages at the same time. Thus combination of different approaches are done in order to have better results. The main motive is to get accurate detection and to reduce the computational complexity.

3.3.1.5 COMPARATIVE RESULTS FOR DIFFERENT APPROACHES

In order for achieving the goal for accurate detection and lesser computational complexity the need of comparison between the various defect detection algorithms and techniques are done. The result from this can be used as a research guide. Advantage of using this guide is that the differences between the various algorithms can be made and thus we can compare them on the basis of feasibility and realiability.

CHAPTER 4: RESULTS AND OBERSVATIONS

4.1 Flowchart

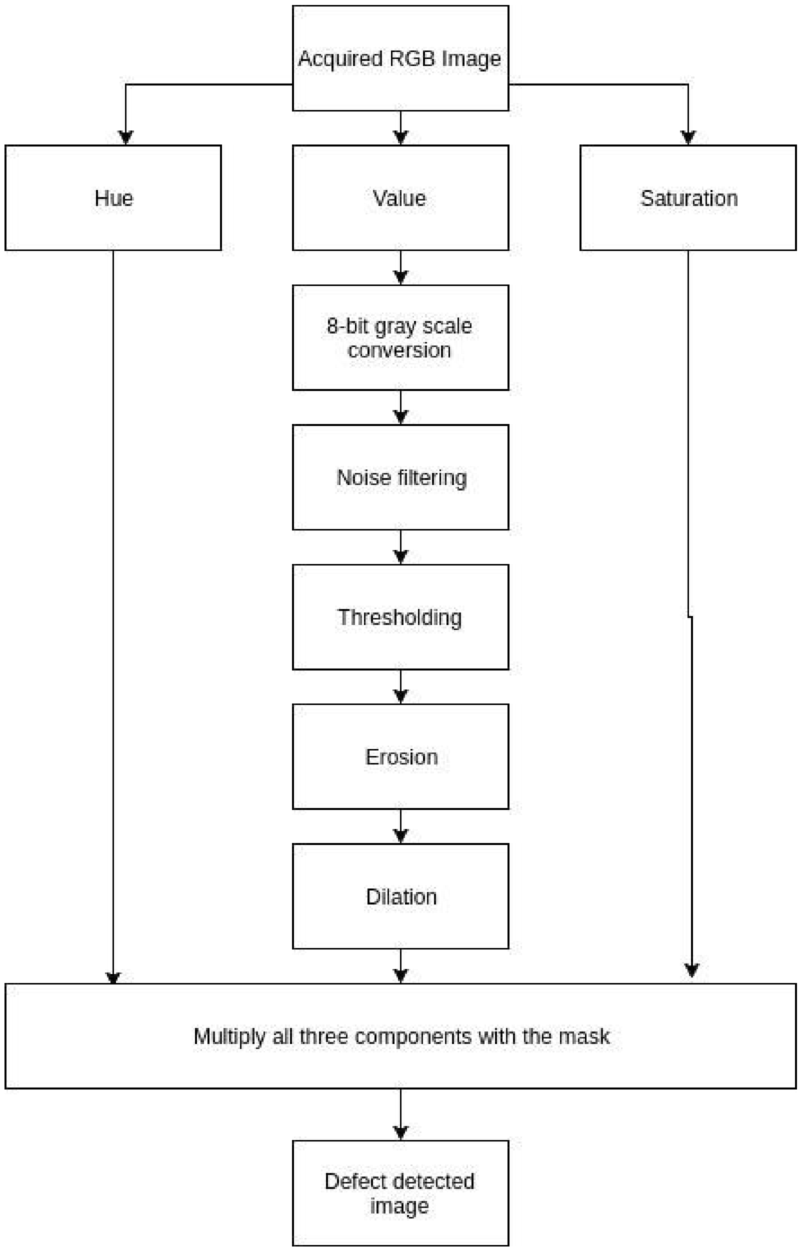


Fig 4.1.1

4.2 MATLAB CODE

```
clc;
clear all;
close all;

% Read image LOAD AN IMAGE
[filename, pathname] =
uigetfile('fabricTest1.jpg','C:\Users\abhinavarora\Documents\matlab files\');
scan_img1=imread(fullfile(pathname, filename));
scan_img=imresize(scan_img1,[300 300]);


%Convert the RGB Image to HSV Image
hsvImage = rgb2hsv(scan_img);


% Extract out the H, S, and V images individually
hImage = hsvImage(:,:,1);
sImage = hsvImage(:,:,2);
vImage = hsvImage(:,:,3);
v2Image = im2uint8(vImage);


%V to gray and noise reduction
z=fspecial('average',3);
filtImage=imfilter(v2Image,z);
```

%Display

```
figure(1);
subplot(2,3,1);
imshow(scan_img);
title('Original Image');
subplot(2,3,2);
imshow(hsvImage);
title('HSV Image');
subplot(2,3,3);
imshow(hImage);
title('Hue');
subplot(2,3,4);
imshow(sImage);
title('Saturation');
subplot(2,3,5);
imshow(v2Image);
title('Value');
subplot(2,3,6);
imshow(filtImage);
title('Value image filtered using mean filter');
```

% Setting the Threshold Value For Hue,Saturation and Value for

```
valueThresholdLow=0;
valueThresholdHigh=0.2;
```

% Now apply each color band's particular thresholds to the color band

```
totalMask = and((vImage>= valueThresholdLow),(vImage<= valueThresholdHigh));
```

%Erosion of thresholded image to remove noise(only in detection of weaving defects)

```
w4 = strel('line',10,40);
totalMask_eroded = imerode(totalMask,w4);
figure;
imshow(totalMask_eroded);
```

%Dilate the Output Image to Smoothen the Image%

```
w5=strel('disk',10);
totalMask_dilated =imdilate(totalMask,w5);
```

%Display the Mask Image

```
figure(3);
subplot(1,2,1);
imshow(totalMask);
title('Mask');
subplot(1,2,2);
imshow(totalMask_dilated);
title('Dilated Mask');
```

%Deficient Colour Image

```
hue1=totalMask_dilated.*hImage;
sat1=totalMask_dilated.*sImage;
value1=totalMask_dilated.*vImage;
```

%Again Converting the HSV image to RGB image

```
hsv1(:,:,1)=hue1;
hsv1(:,:,2)=sat1;
hsv1(:,:,3)=value1;
rgbimage_dd = hsv2rgb(hsv1);
figure(4);
imshow(rgbimage_dd);
title('Fabric Defect RGB Image');

pixelsDefected = sum(totalMask_dilated(:) ~= 0);
display(pixelsDefected);

ifpixelsDefected>= 5000
display('weaving defect in image');
else if (pixelsDefected>5 &&pixelsDefected<5000)
display('hole/stain defect in image');
end
end
```

4.3 ALGORITHM EXPLANATION

- First the file is read using the function *uigetfile*. Resize the image to 300x300 pixels.
- Convert the acquired rgb image to hsv. Function used is *rgb2hsv*.
- Split out the hue, saturation and value images individually. We would only use the value image to process the image.
- Convert the value image to 8-bit image so that it can be used in the mean filter. Function used is *im2uint8*.
- Create a predefined 2-d filter using the function *fspecial*. Set the type of filter to 'average' and window size '3'.
- Filter the image using the function *imfilter*.
- Set the low and high values for thresholding the value image. We use '0' to '0.3'.
- Construct mask using *and* function and use threshold values set above.
- Create a morphological structuring element using the function *strel*.
- Use this structuring element to erode the unwanted pixels in the image using the function *imerode.*
- Create another morphological structuring element using the function *strel.*
- Dilate the mask using the above structuring element.
- Count the number of pixels with value 1 and store this value in the variable '*pixelsDefected'*.
- If *pixelsDefected>5000,* weaving defect is present in the image.
- If *pixelsDefected*<5000, smaller defects such as holes and stains are present in the image.
- Multiply the dilated mask with H, S and V images and store them in a different variable.
- Use these new H, S and V images to construct the final RGB image which highlights the defect in the fabric.

4.4 OBSERVATIONS

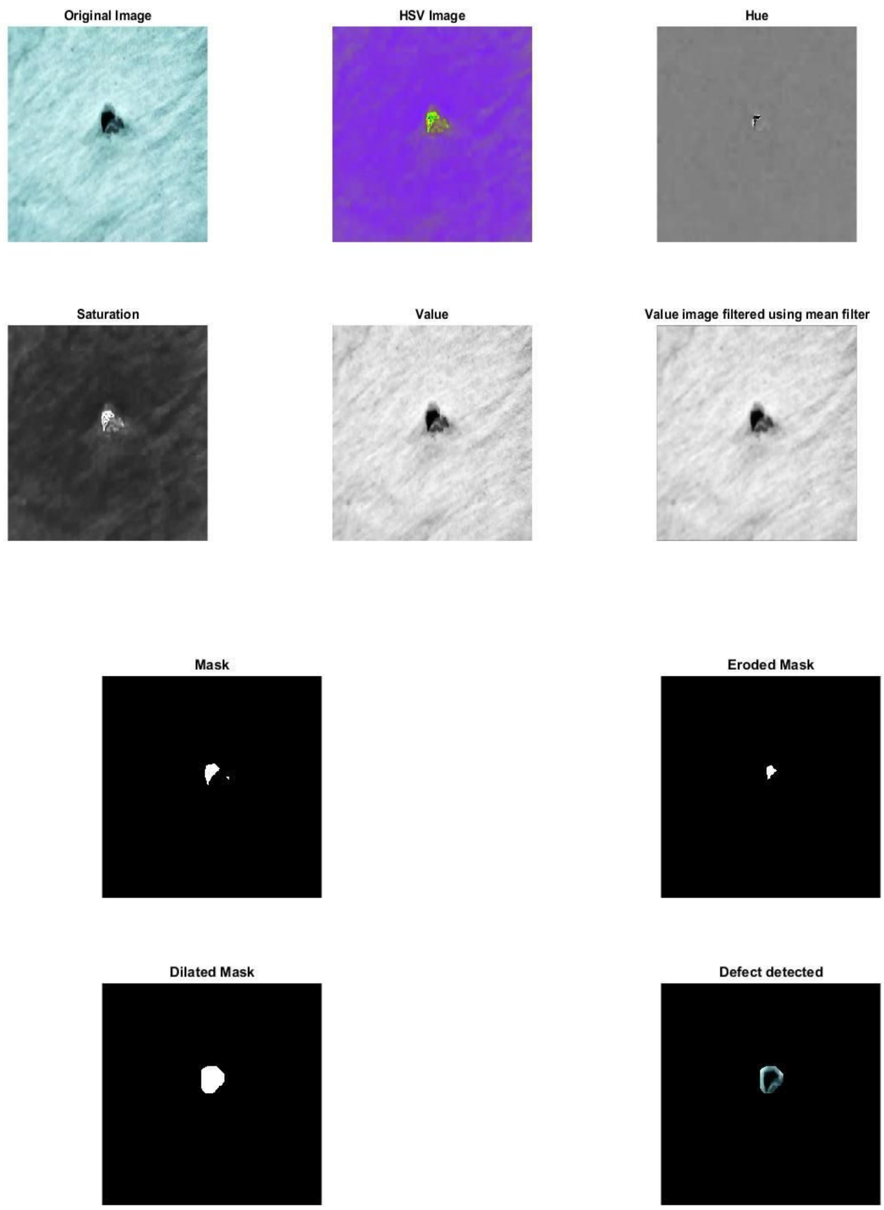
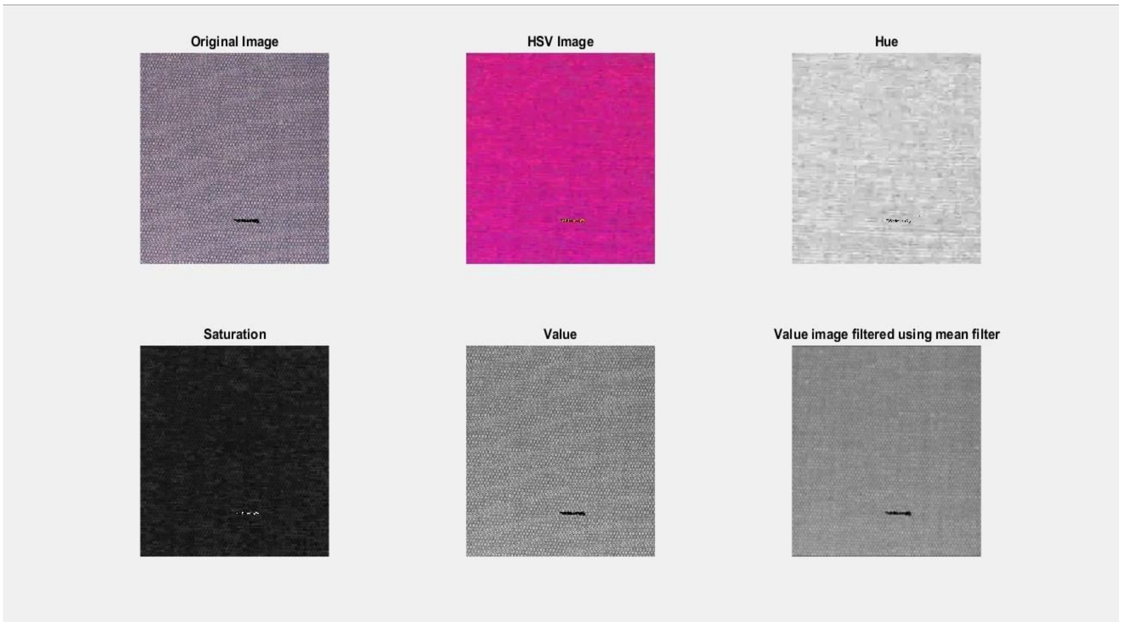
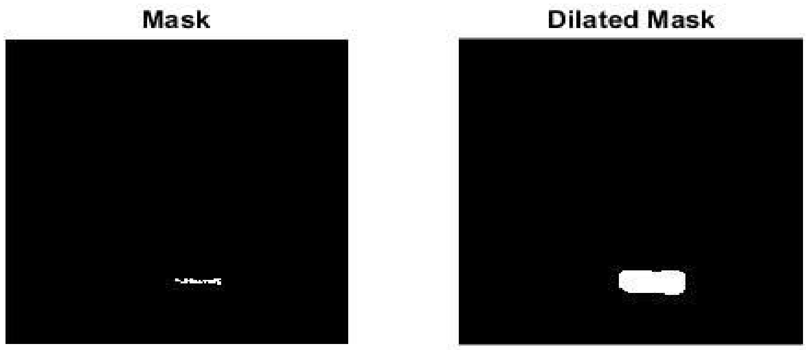


Fig 4.4.1


Original Image
HSV Image
Hue
Saturation
Value
Value image filtered using mean filter


Mask
Dilated Mask

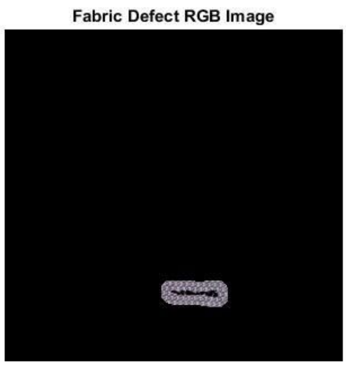
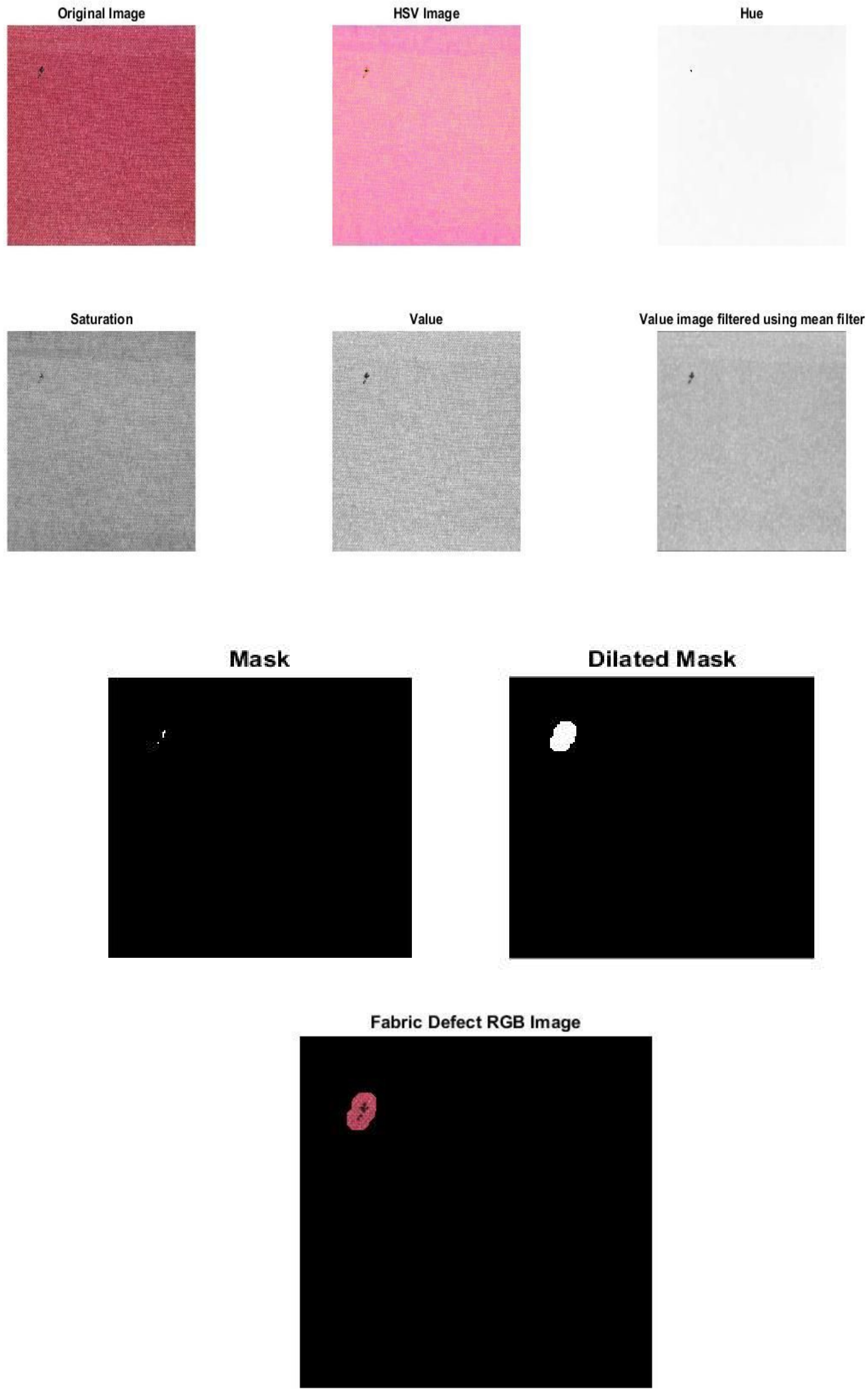

Fabric Defect RGB Image

Fig 4.4.2



Original Image
HSV Image
Hue
Saturation
Value
Value image filtered using mean filter
Mask
Dilated Mask
Fabric Defect RGB Image

Fig 4.4.3

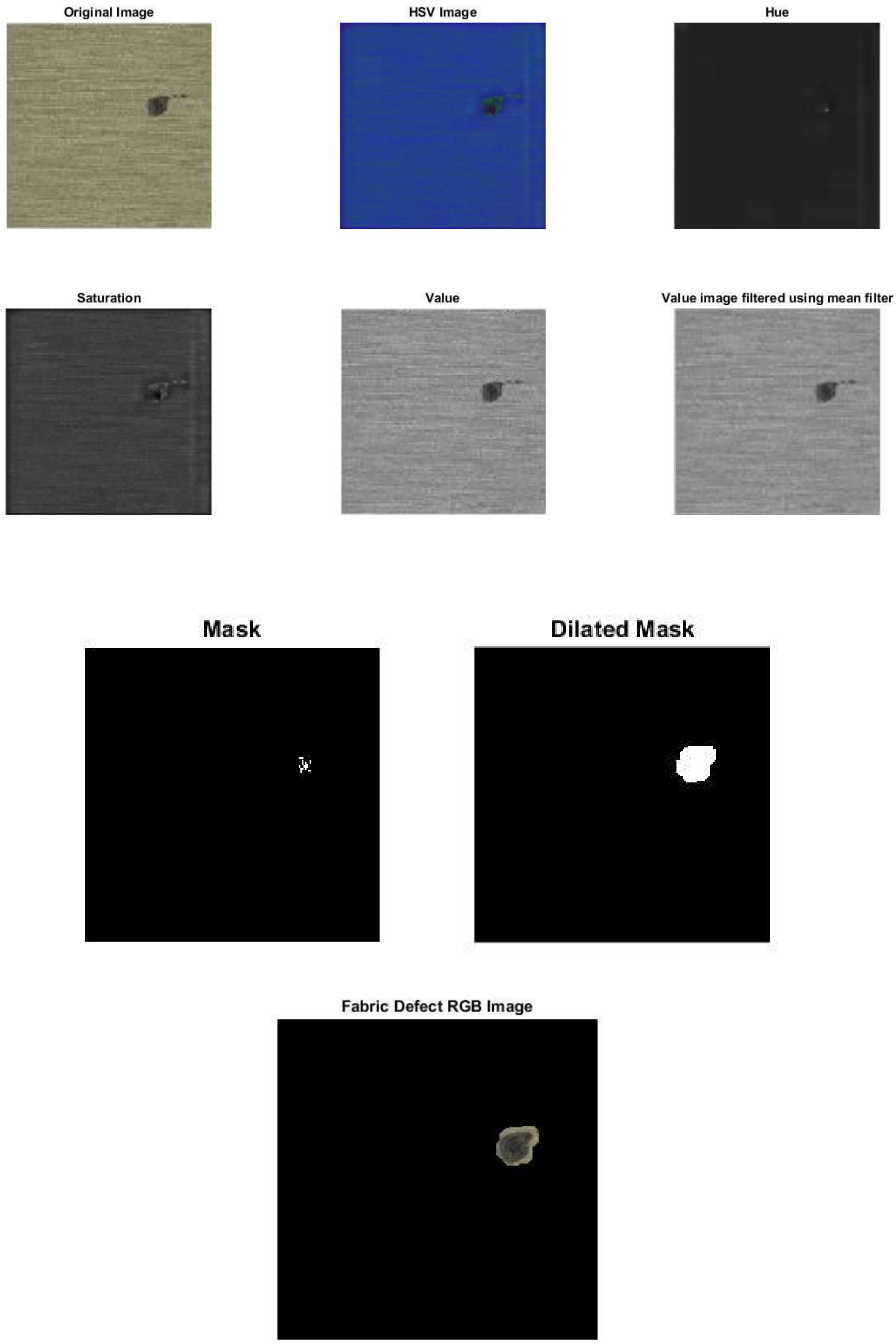

Original Image
HSV Image
Hue
Saturation
Value
Value image filtered using mean filter
Mask
Dilated Mask
Fabric Defect RGB Image

Fig 4.4.4

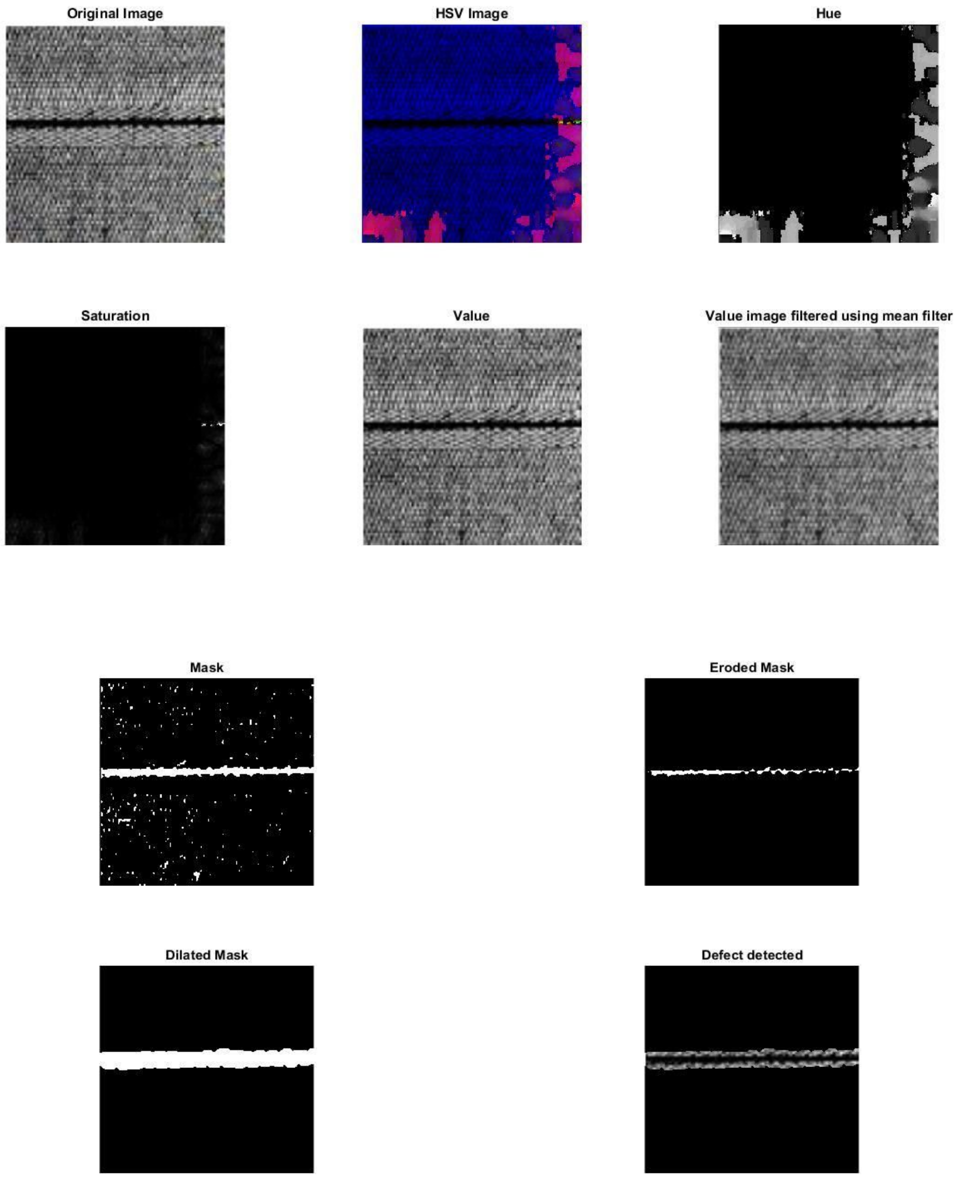

Original Image
HSV Image
Hue
Saturation
Value
Value image filtered using mean filter
Mask
Eroded Mask
Dilated Mask
Defect detected

Fig 4.4.5

CHAPTER 5: CONCLUSION AND FUTURE WORK

CONCLUSION

Using the thresholding approach, defects such as holes, stains and weaving defects were successfully detected. The number of test images we chose was 20 for each of the defects (holes, stains and weaving) and the overall efficiency of our system came out to be 86%. Most of the defects which could not be detected were either of very light shade or very small. However, the efficiency will increase subsequently if higher resolution images are available and high-speed processors are available for computation of algorithms.

The color of the fabric affects the results of the system in a considerable way. The darker the color of fabric, more difficult it is to identify the defect from the fabric. In this case, the threshold should be set very carefully because a very small change in value of threshold can lead to a very high error rate. In our case most of the fabric images in which the defect remains undetected are either of very dark shade or it is too small that it blurs with the low resolution of image.

Defect	Holes	Stains	Weaving
Number of defected images	2	3	3
Total test images	20	20	20
Percentage	10%	15%	15%
Average Percentage	13.33 %		
Efficiency	86.66 %		

FUTURE WORKS

Fabric defect detection using image processing is already being implemented in majority of fabric manufacturing countries. Processing the fabric for defects in real time is the technology the companies are still testing because processing in the real time requires high computational resources. Use of high end cameras to capture high quality images so that smaller and smaller defects are visible also demands high computational power. And certainly the companies are trying to move through this revolution smoothly, because even small defects in one piece of fabric can cause a huge loss to the company.

In order to recognize defects in patterned fabrics, research on advance neural networks is being done. These algorithms will identify the pattern of any fabric that is given as input to the system and then process it to acknowledge the defects.

Also with the advent of AI and machine learning, the computer will be able to identify what kind of defects are possible by learning the algorithm by itself by experience. These machines will be able to identify the defects and remove them if possible.

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