Study on Various Glass Defect Using SIFT

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Abstract—Glass defects are a major reason for poor quality and of embarrassment for manufacturers. It is a tedious process to manually inspect very large size glasses. The manual inspection process is slow. In this paper various glass defects and the possible automated solutions using image processing techniques for defect detection are explained .In this paper, we are using new algorithm which is the combination of both canny edge and SIFT algorithm and new result is produced which is better than the canny and simple SIFT.

Key Terms: - Defects; methods; processing

I. INTRODUCTION

Image is a matrix, an array or elements of picture called elements in the square form which are arranged in the form of rows and columns. Image Processing is a process to convert an image into digital form and perform some operations to get an enhanced image and extract useful information from it. It is a study of any algorithm that takes an image as input and returns an image as output. Image processing is referred to processing of a 2D picture by a computer. It is a form of signal privilege in which image is input similar to video frame or photograph and is image or characteristics associated with that image may be output. Image processing system treat images as two dimensional signals and set of signals processing methods are applied to them. It is latest technologies and its applications in various aspects of a business. Image Processing forms core research area within engineering and computer science disciplines too [21].

Image processing is used in a wide variety of applications to improve the visual appearance of images and to prepare images for measurement. Image processing usually refers digital Image processing but optical and analog image processing also are possible. This article is about general techniques that apply to all of them. The acquisition of images is referred to as imaging. Image processing is also known as digital image processing.

Optical and analog image processing are also possible. There are different types of image processing fields like computer graphics where images are created, image processing where manipulation and enhancement of images are to be done and computer vision where analysis of images is done [17].

Image processing is also defined as the discipline in which input and output both are images. An image processing defines a new image y in terms of the existing image x. An image can be transformed in two ways. These ways are as follow:

1. Domain Transformation
2. Range Transformation

A pixel is a sample of continuous function. Modern digital technology has made it feasible to control multi-dimensional signals with systems ranges from simple digital circuits to advanced parallel computers. The goal of this manipulation can be divided into three categories

Image Processing (image in -> image out)

Image Analysis (image in -> measurements out)

Image Understanding (image in -> high-level description out)

An image may be considered to contain sub-images sometimes referred to as regions-of-interest. This concept reflects the reality that images commonly contain collections of objects which can be the basis for a region. In a sophisticated image processing system it should be feasible to apply specific image processing operations to regions that are selected only. Thus one part of an image might be processed to improve color rendition and other is to be processed to suppress motion blur.

The images should be available in digitized form is the most requirements for image processing of images, that is, arrays of finite length binary words. For digitization, first of all the given Image is sampled on a discrete grid and each sample or pixel is quantized using a finite number of bits. The digitized image is processed by a computer. To display a digital image, it is first converted into analog signal, which is scanned onto a display [18].

Computer graphics and Computer vision are closely related to image processing. In computer graphics, physical models of objects of images are manually made from the environments, and lighting, in its place of individual acquired from natural scenes, as in most animated movies. Computer vision is often measured as high level image processing out of which a machine/computer/software intends to decipher the physical contents of an image or a sequence of images e.g., videos or 3D full-body magnetic resonance scans.

II. TYPES OF DEFECTS ON GLASS

Once the glass sheet is manufactured, it is sent to the defect detection division of the glass production unit for testing and validation of defects. The various types of defects that can be present in the glass are:

a) **Foreign material**: This defect has the appearance of a lump. It is an unmelted, opaque material embedded in the glass.

b) **Low-Contrast Defect regions**: These defect areas are roughly defined as fairly large, several millimeters in diameter, and relatively dark and/or bright regions that stand out against the background. The dark region compare with the light color region which compare with both the region.

c) **Scratches and spots**: These are the marks or irregular patches on the surface. These occur mainly during transportation within the factory. It adds imperfections to the material which is responsible for the breakage of the material. Scratches decrease life of the material.

d) **Bubbles and inclusions**: It is an air bubble like material trapped inside glass as a defect during its production. It depends upon the gas concentration to diffuse bubble of the glass.

e) **Holes and dirt**: These are the surface defects which cause major problems for manufacturers, particularly when the production process includes a surface treatment stage. Hole is also responsible for the breakage of the glass. Sometimes a hard material struck with the glass sheet which cause a problem of holes and decrease the lifetime of glass and make it unusable.

Fig: 1.4 : Scratches on glass sheet [22]

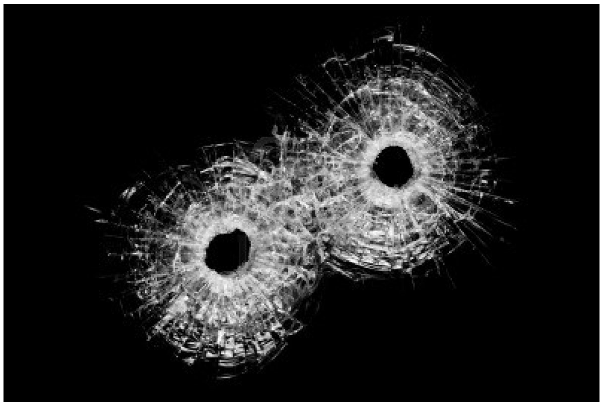

Fig. 1.5: Holes in glass sheet [22]

III. CANNY EDGE DETECTION METHOD[23]

The purpose of edge detection in common is to significantly trim down the amount of data while preserving the structural properties to be used for further image processing in an particular image. A number of algorithms are there and this worksheet focuses on a particular one developed by John F. Canny (JFC) in 1986. Even though it is quite old, it has become one of the standard edge detection methods and it is still used in research.

The aim of JFC was to develop an algorithm that is optimal with regards to the following criteria:

1. Detection: The probability of detecting real edge points should be maximized while the probability of falsely detecting non-edge points should be minimized. This corresponds to maximizing the signal-to-noise ratio.

2. Localization: The detected edges should be as close as possible to the real edges.

3. Number of responses: One real edge should not result in more than one detected edge. With JFC's mathematical formulation of these criteria, Canny's Edge Detector is optimal for a certain class of edges (known as step edges).

IV. SIFT

SIFT is scale invariant feature transform provides motion tracking, multiview geometry and recognition. Applications include object recognition, robotic mapping and navigation, image stitching, 3D modeling, gesture recognition, video tracking, individual identification of wildlife and match moving. Features of SIFT are highly distinctive, relatively easy to extract and allow for correct object identification with low probability of mismatch. They are relatively easy to match against a large database of local features. Different algorithms can also be used but SIFT algorithm is less time consuming algorithm and produce results better than any other algorithms [24].

SIFT is local descriptor which is consists of four major stages. These stages are:

1. Scale-space peak selection
2. Keypoint Localization
3. Orientation Assignment
4. Keypoint descriptor

a)Scale-space Peak Selection:

At particular stage and location points are identify by scanning the image. To search at a multiple scale space is used with the help of Gaussian functions. The SIFT detector construct scale space. It is multiple signal representation theory. Gaussian kernels are also used in it. The framework of scale space makes it space variant. Gaussian pyramids are constructed efficiently in it. For the local key points in the series of Differentiate of images (DoG) are also constructed efficiently. Mainly it is used to decrease the space. The main function is to resize the image according to first image or comparative image. Gaussian function is attached with the resize function.

b)Keypoint Localization:

It is the second stage of the SIFT function. It the candidate of the main pixel into sub pixels to find out the accuracy and remove the unstable particles or key points. It is used to improve the pixels and remove the bad pixels. It is point descriptor like rings. In this process all the points are scans so that to improve its accuracy and remove unwanted points. It is used to find out the points and mark them as circles. It removes the large edges.

c)Orientation Assignment:

The assigned orientation, location and scale for all key point enables SIFT to create a canonical view for the candidate points that are invariant to similarity transforms. Its orientation depends upon the identification of the local images patches. It removes the effect of scaling and rotation according the requirement. Here set the good points and scale them and rotate them according the requirement we needed. Scale of point is used to find out the good points. Using different types of differentiation find out orientations and gradient magnitude.

d)Keypoint Descriptor:

Descriptor means to mark point. In this process all the points are scans so that to improve its accuracy and remove unwanted points. It is used to find out the points and mark them as circles. It removes the large edges. This final stage creates the local images based upon the local image patches present in its local neighborhood. Each point has its own value. Each particular region has different types of values.

Verbosity:

It displays the code which is used in it. It specifies the code after the generation of the result. The time value may vary. Its value can either increase or decrease. If the value is 1 means result is producing means continuing of the result and if value is 0 means result produced.

Threshold:

In it Grayscale is used which is less then binary. It has two types of value. If the grayscale values are greater than 1 then pixel is white and if value is less than 1 then pixel is black.

Grayscale>1 means white pixel
Grayscale<1 means black pixel

Frame is used in it. Frame means cropping the picture according to the requirement so that two images matches. Suppose in an image we have two persons picture. We want to choose head of one person so choose one frame for this. For the selection of second head choose second frame and so on.

V. EXPERIMENT SETUP

Following steps are followed by the SIFT.

Step 1: Read the image

Read the image using run>browse>copy address than using imread() function. , or using imreadbw() function in which I = imreadbw(file)

```
IMREADBW  Reads an image as gray-scale
I=IMREADBW(FILE) reads the image FILE and converts the result to a
gray scale image (with DOUBLE storage class anr  range normalized in [0,1])
```

do this step for second image also.

If we want to read simple method used run command than after that we have converts into grayscale image.

```
I1=imreadbw('\data\img3.jpg') ;
I2=imreadbw('\data\img5.jpg') ;
```

Or

```
I=imread('C:\Users\Gagan\Desktop\k.JPG');
J=imread('C:\Users\Gagan\Desktop\kc.JPG');
```

Step 2: Apply rotation function:

Rotation function in which we have to take only image which we want ,we have to do match with another image as like without using read function for 2^{nd} image we have to used rotation function in which commands are: before using this one we have to read one image

```
text(size(a,2),size(a,1)+15, ...
    'thesis work', ...
    'FontSize',7,'HorizontalAlignment','right');
scale = 0.7;
J = imresize(original, scale);
theta = 30;
distorted = imrotate(J,theta);
figure, imshow(distorted)
```

now the result will come rotation image which u called 2^{nd} image the angle value depend upon.

Step 3^{rd}: Resize the image:

After doing this resize the image because every image have not same size like one image having 10 kb and another one have 13.23 kb so we have to give both image constant value or same value using function:

```
imresize(Image_name, [240 320]); and
```

same for second image,

Step 4^{th} : Set max and min value:

After this one we have to give min or max value of image which we have to resize in the previous step using function:

```
Image_name=Image_name-min(Image_name(:)) ;
Image_name=Image_name/max(Image_name(:)) ;
```

Doing this step or using this function it declare that if one image having 256 rows 406 columns or second image having 200 rows and 389 columns than it give the min value that is appropriate for both image in rows and columns.

Step 5^{th} : Apply Gaussian verbosity:

These step are basic for that now we have to find frames and descriptors for each image , in which they used function **frames, descriptors, Gaussian**(gaussian scale space of image I), **verbosity**(Specify level of detail for messages displayed during code generation , When Verbosity is set to 0, minimal code generation progress messages are displayed as code generation proceeds. When Verbosity is set to 1, more detailed progress messages are displayed.) , **numoctaves**(like [M, N, s_num] = size(octave); % M is the height of image, N is the width of image; num_level is the number of scale level of the octave) , **threshold**(if converts the grayscale image I to a binary image. The output image BW replaces all pixels in the input image with luminance greater than level with the value 1 (white) and replaces all other pixels with the value 0 (black). Specify level in the range [0,1]. This range is relative to the signal levels possible for the image's class. Therefore, a level value of 0.5 is midway between black and white, regardless of class. To compute the level argument, you can use the function graythresh. If you do not specify level, im2bw uses the value 0.5).

In which u have to used

[frames1,descr1,gss1,dogss1] = sift(I1, 'Verbosity', 1, 'NumOctaves', 4, 'Threshold', 0.2/3/2) ; kind of function or command.

Similarly for 2^{nd} image.

In that type of process descriptors used

```
octave, ... % gaussian scale space of an octave
oframes, ...  % frames containing keypoint coordinates and scale, and orientation
 sigma0, ...   % base sigma value
 S, ...        % level of scales in the octave
 smin,  varargin.
```

The process in the descriptors is as follow:

1. Compute the image gradients
2. Round off

3. Within the big square, select the pixels with the circle and put into the histogram. no need to do rotation which is very expensive.

A *frame* is a sequence of samples combined into a single vector. By setting **Samples per frame** to `100` in the Sine Wave block, you set the frame size to 100, so that each frame contains 100 samples.
The process of frame in which we using function h=plotsiftframe(frames,varargin)
PLOTSIFTFRAME Plot SIFT frame
H=PLOTSIFTFRAME(FRAMES) plots the SIFT frames FRAMES and returns and handle H to the resulting line set. FRAMES has the same format used by SIFT().
Gaussian is the radial basis function most commonly used in the neural network community.In this first we initialize the octave with S sub-levels than initialize the first sub-level than other sub-level and then convert all octave.

In this we used dogss function Local maxima extracted from the DOG have coordinates.We used extrafine function which having an function to Refine the location, threshold strength and remove points on edges.

Step 6th

Same command run for 2nd image in which same function do their own task. To doing this we can find different frames for image 1 and 2 in which we have to match their function with help of descriptors. Like a image having chess board in which if they have not any kind of box than it is image which having no frames , if we divided into row or column having same length of each box that we called or say we divided into frames.

To doing this we have an easy to catch out the object like a box divide into 50 frames now we match the second image which having also 50 frames with same or different object. First we see in the image 1 having like 41 no frame match with image 2 having 39 no frame , than it is easy to catch them do not match each and every object of an image.

Similarly for 2nd image we used this command or find descriptors.

Step 7th: Matching frames and descriptor:

Now match them all the frames or descriptors which u find them inside the image, in this we pass the int value to enhance the matching speed.

The basics syntax of match function num = do_match(im1, des1, loc1, im2, des2, loc2) in which it keep matches in which the ratio of vector angles from the nearest to second nearest neighbor is less than distRatio.

In the matching process:

1. For each descriptor in the first image, select its match to second image.

2. Check if nearest neighbor has angle less than distRatio times 2nd

3. Check each matching point, eliminate false matches by voting from neighboring area

4. Compute the corresponding distances of the matching points in image 2

5. Normalize the distance and orein_diff vector

6. Create a new image showing the two images side by side.

7. Show figure

To doing match we used uint8 function, like in your process it’s not working , either you have to change into double or cannot used these two function , you can directly run this one command without using uint8 function. After first work done in which you have to find points where match done with another image now you want compress that image using PCA method.

In our work we have different types of images of glass in which defects are find out using SIFT algorithm because this algorithm is find out more accurate result as compare to other algorithms. It is less time consuming process. By following all the above method two images are compare and their defects can be find out easily and mark them as a lines or circle so that the defects can be easily find out. Here we have suppose two types of image first read the image using read function. Now rotate both the images according to the requirement in the second function. After doing this resize the image because every image have not same size like one image having 10 kb and another one have 13.23 kb so we have to give both image constant value or same value using function.
After this one we have to give min or max value of image which we have to resize in the previous step using function:
Image_name=Image_name-min(Image_name(:)) ;
Image_name=Image_name/max(Image_name(:)) ;

Doing this step or using this function it declare that if one image having 256 rows 406 columns or second image having 200 rows and 389 columns than it give the min value that is appropriate for both image in rows and columns. In the next step Gaussian functions are applied like descriptor, verbosity etc. In second last step we have to frame the images which we want remove rest of all. In final step, we have matching the descriptor and lines or circle are formed which indicate the defect on glass sheet.
In this paper we used new algorithm which is the combination of both canny edge and SIFT algorithm and new result is produced which is better than the canny and simple SIFT both. From till date SIFT is used to find object of similar types but with new algorithm we have to find out the defection and defects of different images also which are more efficient than other existing algorithms.

VI. Results and Discussion

Image Processing Toolbox is included in MATLAB and Simulink Student Version. Its key features as follows:

- Importing and Exporting Images
- Displaying and Exploring Images
- Post processing Images and Preprocessing
- Analyzing Images
- Image Registration and Geometric Transformations
- Working with Large Images

Solution of the Problem:
We discussed earlier the solution of our problem. Further are the snapshots of the implementation work. First of all here we have the simple images of both defected glasses. In these images defect cannot be recognized easily with naked eye.

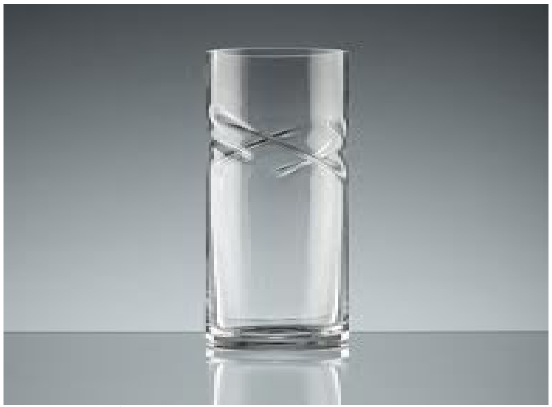

Fig 4.1: 1st Input image or simple image of defected glass

Now we combine above glass image with other image and find out defects from these glass images. With the help of matching descriptors defects can be easily find out.

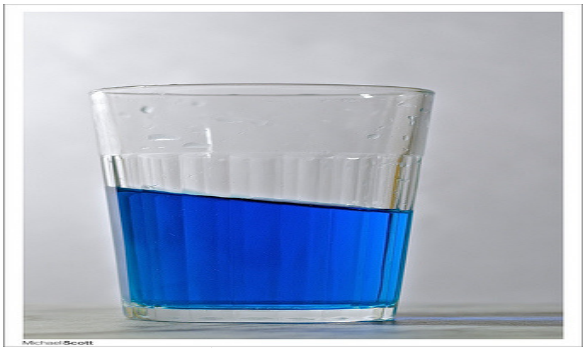

Fig 4.2: 2nd Input image of defected glass

After combining both the images SIFT algorithm is applied on them. SIFT algorithm here is used to identify the defects in glass images. Both images are of different types. This proves that our algorithm can be used to find out defects in different glass images which is not possible in existing SIFT algorithm.

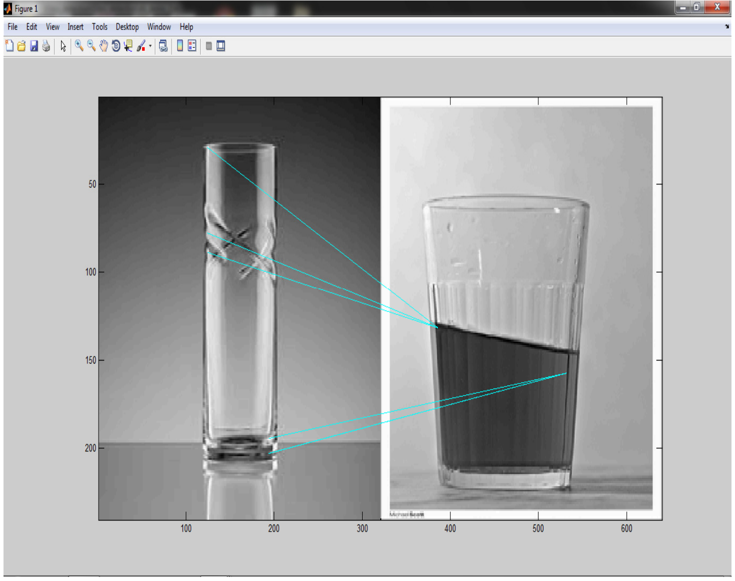

Fig 4.3: shows the glass detection of two different images and their matching using SIFT

Here we have two different images. First we have to follow all the step of SIFT algorithm. We have to adjust the size and height of the images also that all the defects can be easily find out. First of all we have to adjust the size of the image so that defects can be easily found out and matching key points easily.

In the above figure the lines which are drawn from one image to other. These lines are indicate the matching of defect of one image to the defects of other image using matching function of the SIFT algorithm.

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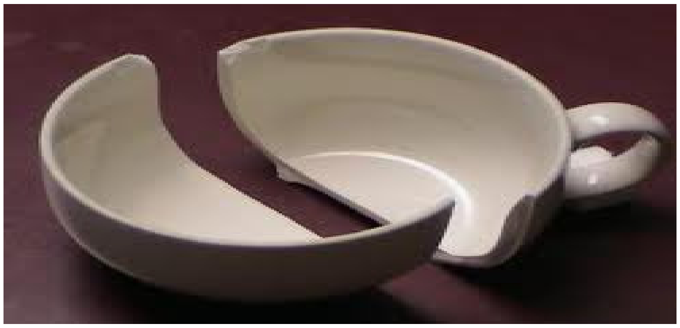

Fig. 4.4: 3rd Input Image of Glass

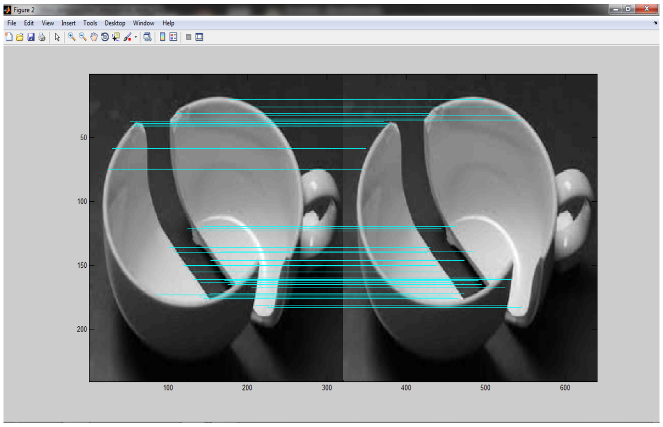

Fig.4.5: shows two similar images merge them which indicating same types of defect at both sides.

In the above figure we have two images which are of similar types. By resizing them, cropping, framing we can say that by using SIFT function properties two images are combined to find out defection from both the images.
Here as we know similar images of glass or glass sheets are available so that defects at both the images are also same. At both the images defects are same which are matched by using matching functions.

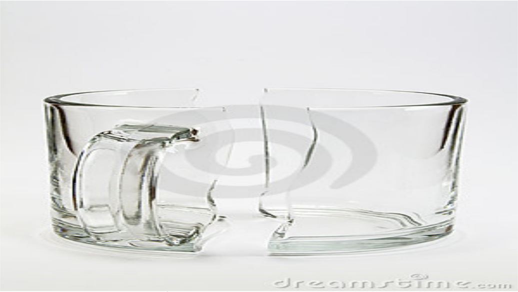

Fig 4.6: 4th Input image of Defected Glass

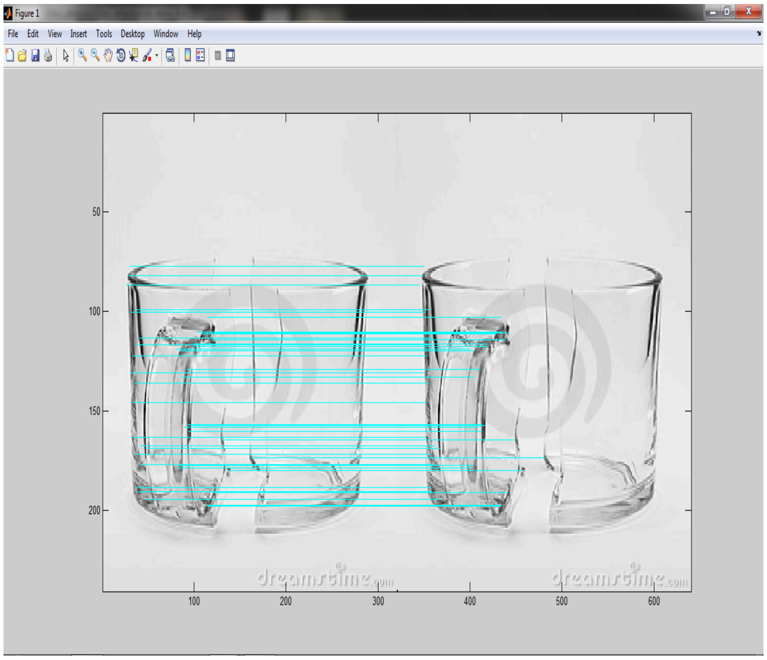

Fig.4.7: shows the defection at glass images at both sides similar defects

Defects can be easily found out by comparing two images at both the sides as shown in the above figure. We combined similar images here. We have two images of similar types both are identical so defects which are present in both images also similar. By using SIFT functions images are adjusted and defects are found out. At the end these defects are shown with the help of green lines using matching function which are now easily visible as compared to circles or any other types of marks.

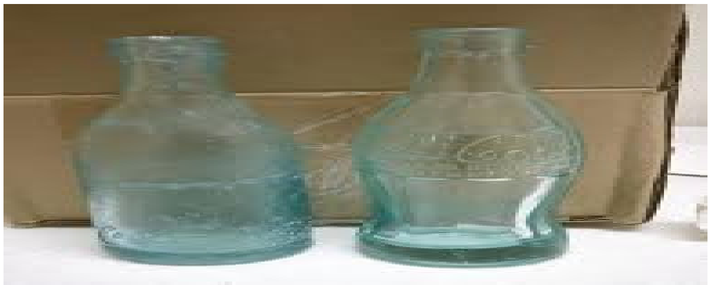

Fig 4.8: 5th Input image of Glass

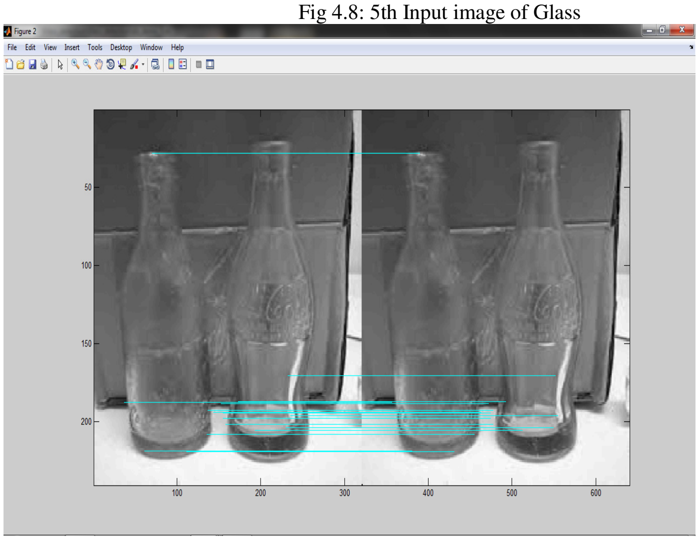

Fig. 4.9: shows defects at the two similar images and matching defects indicate with lines

We have similar types of images as shown in figure 4.3, here first of all following the initial steps of SIFT functions i.e. resizing, scaling, find out local descriptor etc. After using these steps find out defects at both the images. Now with the scale space and orientation and matching functions match the defects of both the images so that these defects can be easily recognized with naked eyes. Green lines are indicating the defection matching of one image to other image.

VII. Conclusion and Future Scope

In this paper, we used new algorithm which is the combination of both canny edge and SIFT algorithm and new result is produced which is better than the canny and simple SIFT both. From till date SIFT is used to find out object of similar types but with new algorithm we have to find out the defection and defects of different images also which are more efficient than other existing algorithms.

Future work will focus on:

1) Using more computational resources to improve the efficiency of defect detection techniques.
2) Reducing the complexity of thresholding and segmentation algorithms.
3) Working on multiple defects (e.g. scratches and inclusions together) using single technique
4) Improving the machine learning method
5) Combining BFH with other features to obtain higher accuracy.

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