Image Stitching and Mosaicing

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Abstract-- **In this paper, we present an algorithm that stitches images automatically. When images are stitched, we stumble upon dark lines at the edges. Initially we deal with the analysis and processing of Black & White images. As these images don't contain RGB planes, it is easier to handle the pictures and implement stitching on them. We develop a procedure that detects the torn/missing part of an Image, which were initially separated and appropriate methods to join these images. Then we deal with the dispensation of colored images in which simultaneously we modify the three-color planes as per the requirements. However, there will be cases when the images don't merge correctly or variation in color, brightness or contrast may have occurred. Such cases will be taken into account by the implementation of various filtering and Image enhancement techniques. We were able to compare and decide as to how much accuracy we have obtained from our method.**

I. INTRODUCTION

IMAGE stitching is a technique to merge a sequence of images into one blended picture [1]. The automatic construction of Image stitching is an active research area of research in the fields of photogrammetry, computer vision, and computer graphics. Image mosaicing is the process of combining multiple images to produce a panorama or larger Image [2]. It is the integration of plenty of small images to create one large Image. Mosaicing is also defined as the process of perspective warping of images [3].

In our paper the stitching capability is not restricted to the space between the two stitched images. A larger white space between the two images will yield the same result as that by two images with very less distance between the stitched images. Also our project can stitch both color and 8-bit gray scale images. Image alignment and stitching are the main procedures in this application. Image alignment establishes geometric correspondences among the images. Stitching blends the aligned images seamlessly. Assembling panoramas by simply overlaying them in a graphics program will not give good results because of the numerous transformations that occur when a camera is rotated.

Signal or Image processing methods can be executed either directly in the time or spatial domain, or one can first transform the signals into another domain, perform the processing in the transform domain, and then perform the back transformation. Digital signal or Image processing has found many applications in today's commodity markets, and can be extremely compute-intensive. Much effort went into the methods, but also into the development of fast algorithms and into computer architectures.

Images in the RGB color model consist of three independent image planes, one for each primary color. Finally these three images combine to produce a composite color image. While applying any enhancement techniques on a color image, we have to consider applying the same on each image plane.

II. IMAGE ENHAMCEMENT TECHNIQUES

The aim of Image enhancement is to improve the interpretability or perception of information in images for human viewers, or to provide `better' input for other automated Image processing techniques [4]. There are various types of enhancement techniques which include some in spatial domain and others in frequency domain. Spatial domain methods include Contrast Stretching, Thresholding, Clipping, Negation, Bit Plane Slicing, Intensity Level Slicing etc. We will implement stitching first and then apply some of the enrichment techniques in order to get a regenerated Image, identical to that of original Image.

1. Averaging Filter

Simple averaging can be used to reduce the effects of noise. A moving average filter smoothes data by replacing each data point with the average of the neighboring data points defined within the span [5]. This process is equivalent to low pass filtering with the response of the smoothing given by the equation.

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$$y(i, j) = (1/N)\sum_{i=1}^{m}\sum_{j=1}^{n} x(i, j) \quad (1)$$

where y (i, j) is the new averaged image, x (i, j) is the image before averaging, N=m*n is the total number of elements in the mask. Generally a square mask is used in the above process i.e. m=n; however masks of different dimensions can also be used according the requirements of the program.

The averaging filter averages all the elements interpolated by its mask size and assigns the pixel the average value. We can take a larger number of elements and use its average to give a better estimate of its true value (provided there is no systematic error or bias in the measurements and we select a square mask i.e. m=n). This is actually standard procedure in experimental work, where a number of readings are taken at a sampling instant and the average of these readings.

The moving average filter regards each data point in the data window to be equally important when calculating the average (filtered) value. In dynamic systems, however, the most current values tend to reflect better the state of the process. A filter that places more emphasis on the most recent data would therefore be more useful.

2. Median Filter

Median filtering is similar to using an averaging filter, in that each output pixel is set to an average of the pixel values in the neighborhood of the corresponding input pixel. It is a non-linear signal enhancement technique for the smoothing of signals, the suppression of impulse noise, and preservation of edges [6].

In the one-dimensional case, it consists of sliding a window of an odd number of elements along the signal, replacing the centre sample by the median of the samples in the window. However, with median filtering, the value of an output pixel is determined by the median of the neighborhood pixels, rather than the mean.

The median filter gathers the pixel elements according to the mask size used and arranges them in ascending or descending order. It then calculates the median value which is $n/2^{th}$ element when number of elements is odd and $[n/2^{th} + ((n/2)+1)^{th}]/2$ element when number of elements are even. The median value is then assigned to the centre pixel of the mask chosen and hence an improved Image is obtained.

The median is much less sensitive than the mean to extreme values (called outliers). Median filtering is therefore better able to remove these outliers without reducing the sharpness of the image.

III. ALGORITHMS AND APPROACHES

1. Image Acquisition Algorithm

The acquisition algorithm describes how an image is scanned and is made ready for further processing.

i. Gather the torn images together and align them properly so as to have minimum distortions due to rotation of images.
ii. Stick the images onto a white paper maintaining the minimum distance of 2mm between the torn pieces.
iii. Scan the document properly using a scanner and resize the image so as to avoid having unwanted areas in our final scanned image.
iv. Also adjust the image as per the requirements of gray scale (8 bit image) or RGB format.

2. Image Processing Algorithms

These algorithms deal with the main execution of our program. It gives a sequential method to stitch images.

i. Obtain the original image by the image acquisition algorithm.
ii. Apply averaging filter on the full original image.
iii. Obtain the torn image, by image acquisition algorithm.
iv. Scrutinize the image to identify the empty columns.
v. Arrange the column numbers in an array.
vi. Make new image by removing the unwanted columns.(Deleting from all three color planes in case of colored image)
vii. Apply the average filter only on the torn area.
viii. Apply the median filter only on the torn area.
ix. Repeat steps vii. And viii. for five to ten times for better results.
x. Finally apply averaging filter on the complete regenerated image.
xi. Calculate the error between original and regenerated image.

IV. SURVEY RESULTS

We have dealt with the stitching of torn images. Subjective analysis is also been done so as to get a review from the general public of our accuracy in retaining the true image details.

Some of the sample images that were used in our report for stitching purposes are displayed below.

The first image of coins1 is taken from a file stored in the computer.

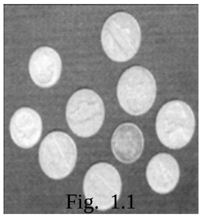

Fig. 1.1
Coins1 original image

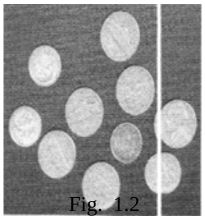

Fig. 1.2
Coins1 cut image

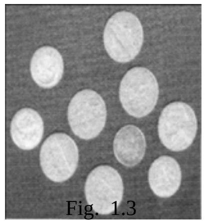

Fig. 1.3
Coins1 regenerated image

The second image used is a black and white photograph of Rishi.

Fig. 2.1
Rishi original image

Fig. 2.2
Rishi torn image

Fig. 2.3
Rishi regenerated image

The algorithm even works for more than two cuts in a picture. The image coins2 is regenerated from our algorithm as shown below.

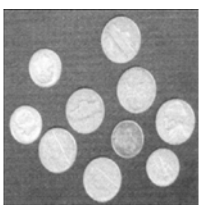

Fig. 3.1
Coins2 original image

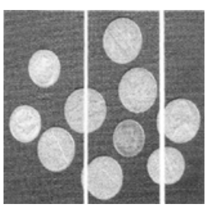

Fig. 3.2
Coins2 cut image

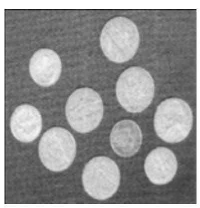

Fig. 3.3
Coins2 regenerated image

We have also implemented our algorithm on colored image kids and the results are shown below.

Fig. 4.1
Kids original image

Fig. 4.2
Kids cut image

Fig. 4.3
Kids regenerated image

The general public was asked to rate (on a scale of 10) our regenerated image in comparison to our original image. This survey is based on the results obtained by 36 persons. The results for each image are displayed in the charts below.

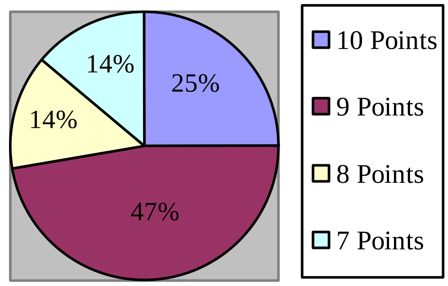

Chart for figure 1.3 Coins1 regenerated

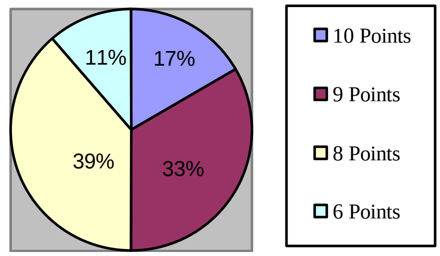

Chart for figure 2.3 Rishi regenerated

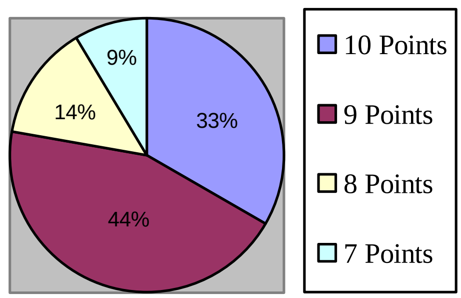

Chart for figure 3.3 coins2 regenerated

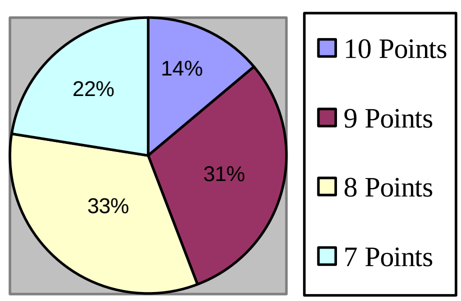

Chart for figure 4.3 kids regenerated

The root mean square error in our regenerated image is theoretically calculated using the equation (2) for each image and tabulated below.

$$MSE = (1/MN)\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}[x(i,j) - x'(i,j)]^{\wedge}2 \qquad (2)$$

where MSE is the root mean square error obtained, x(i,j) is the original image, x'(i,j) is the regenerated image, and M*N is the total number of rows and columns of the image.

TABLE 1
Details showing the theoretical root mean square error calculated on each of the regenerated images.

Figure details	Root mean square error
Fig. 1.3 Coins1	16.46
Fig. 2.3 Rishi	19.82
Fig. 3.3 Coins2	31.14
Fig. 4.3 Kids	32

IV. CONCLUSION

In our work, theoretically mean square root error with respect to the original image has also calculated. In inference to charts and errors obtained we conclude that our algorithms of image stitching yield up to 80% accuracy. One area where our project finds its major applications is in Image Mosaicing. Mosaicing of images has been in practice long before the age of digital computers. Its use was first developed in topographical mapping. Images acquired from hill-tops or balloons were manually pieced together [7]. With the development of airplane technology, aero photography became an exciting new field, which interested many people. We intend to complete image mosaicing and the generation of ultra wide-angle images. We will be working to handle images on any type of cuts/ distortions/ scratch present in our image. We will also be working to develop and execute new algorithms, which will reduce the mean square error caused due to alignment error to its minimum. Insertion of image in an image will also be covered in the upcoming term of our project.

A further extension of our project could be in Forensic Document Analysis. An example of this is the identification of relevant data from torn Image obtained from the crime site.

VI. REFERENCES

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