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SVD Based CT-Scan Image Enhancement and Effect of Decomposition Matrix

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Abstract: In this study, research work is done in the field of image enhancement by using the SVD technique. In my study, I took into consideration CT-scan lungs images of COVID-19 patient for carrying out my work and the SVD technique used in it. The main objective of this whole study is to obtain an improved enhanced image by applying the SVD technique and also computing image enhancement parameters such as root mean square error (RMSE), percentage fit error (PFE), mean absolute error (MAE), correlation (CORR), signal to noise ratio (SNR), peak signal to noise ratio (PSNR), mutual information (MI), and quality index (QI), a measure of structural similarity (SSIM). An algorithm is developed for image enhancement of biomedical images. On the image taken into consideration, the SVD technique is applied.

Keywords: CT-scan, SVD, Image quality, Decomposition Matrix.

I. INTRODUCTION

The signal processing of analog and digital signals which is the part of mathematics and EE deals with storing, filtering, and other operations on signals. These signals include sound or voice signals transmission signals, image signals and all other signals. From all that signals, the field that deals with the type of signals for which the input is an image and the output are also an image is done in image processing. And according to their name, it deals with the processing of images. It is often further divided into analog image processing and digital image processing [1-2]. Image processing is any sort of signal processing that the input is a picture, such as a photograph or a video frame, the output of image processing could also be either a picture or parameters associated with the image. In a general way, it can be defined as the processing of the given input image to fulfil the requirement in the application. Most of the image-processing techniques, take the image as a two-dimensional signal and applying standard signal-processing techniques to it. Image Processing is employed in various applications like remote sensing, medical imaging, forensic studies, textiles material science, military, film industry, document processing, graphic arts, printing industry, etc [3-6].

The image Processing is mainly classified into two categories: analog image processing and digital image processing. In electrical engineering and computer science, analogue image processing is an image processing task is conducted on two-dimensional signals by analogue means. Analog Image Processing is the way to alter the image through electrical means. The most common example is the television image. The television signal is a voltage level that works on the principle of varies in amplitude to represent brightness through the image. By electrically varying the signal, the displayed image appearance is altered [7-8]. The brightness and contrast controls on a television receiver serve to regulate the amplitude and reference of the video signal, which is responsible for the brightening, darkening and alteration of the brightness range of the displayed image. Analog image are often mathematically represented as endless range of values for representing position and intensity. In case of analog image the intensity are represented on a normalized scale from 0 to 1 with infinite divisions, and spatially with an infinite number of coordinates [9-10]. Digital image processing is the processing of digital images by means of a digital computer by applying some function to vary the worth (f(a, b)) of the pixel to get a different function value. Modern digital technology has made it possible to control with the help of multi-dimensional signals and with systems that range from simple digital circuits to advanced parallel computers. Knowing that image processing is a way we can use different functions in an image. Image processing is one of the fastest-growing technologies. It creates a major research space within the engineering and computer fields as well. Nowadays there is a great deal of image processing in a different field but it is also very important in the medical field. There are three important steps in image use and the following sequence first with image detection tools, importing an image, secondly, analyzing and applying the image, and finally, the resulting converted image is displayed. However, there may be many steps involved in the use of an image depending on the type of image processing [10-15]. By combining the various types the most important steps involved in the use of an image are given below and are represented in the Fig. 1.

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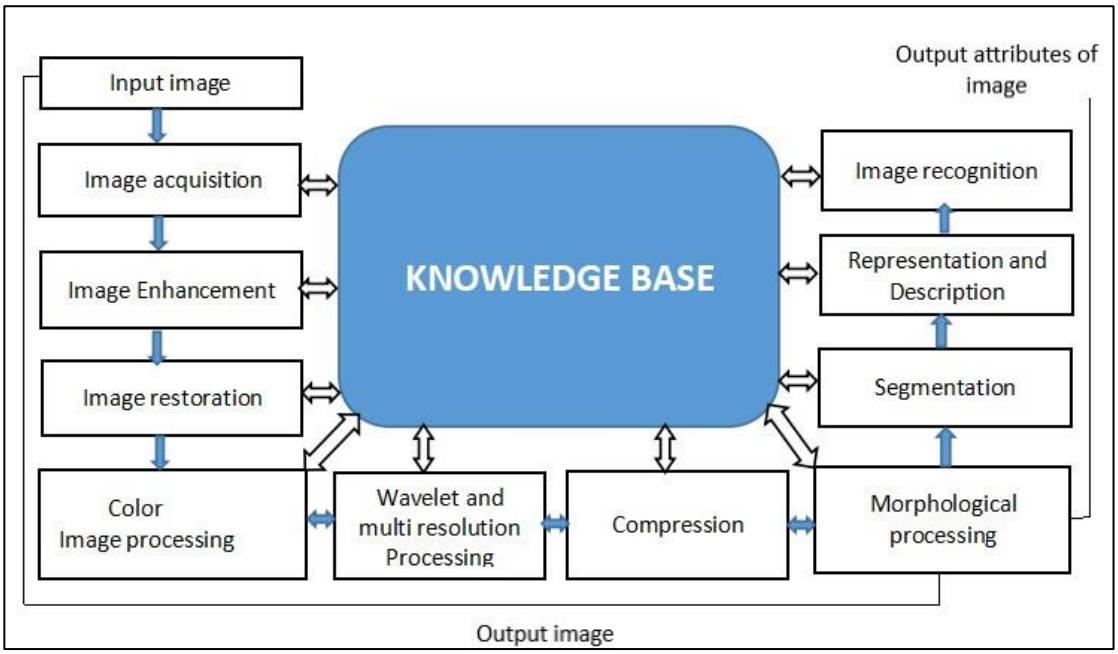

Fig.1 Block representation of image processing.

II. SIMULATION PROCESS FLOW

The research work is formulated to develop an algorithm for biomedical image enhancement. Technique explored for the image processing to be integrated is singular value decomposition (SVD) as discussed in above section. Lungs CT-scan image of COVID-19 positive image of the patient is take for the research purpose. If you do not have a specific COVID-19 vaccine, it is important to diagnose the disease early and diagnose the infected patient. To date there is a global shortage of test labs and test kits for COVID-19. The role of the technique for important information such as lung computed tomography (CT) scan should be the first / other real-time transcriptase-polymerase chain reaction (RT-PCR), COVID-19 pneumonia separate from other viral pneumonia and if so how can you differentiate it using lung CT scan images from carefully selected details of lung CT scan patients with COVID-19 infection from hospitals. From this we can see that a CT scan is one of the most important tests to help diagnose a person. Based on the above interventions the formulated research was pursued to utilize the image processing technique in enhancing the CT-scan image. Block diagram of methodology is shown in Fig. 2.

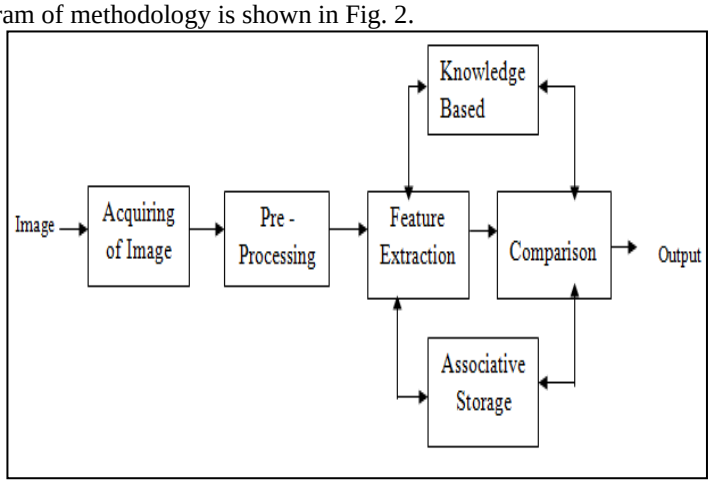

Fig. 2 Methodology block diagram.

Figure 3 show how the image is being processed step by step. The very first step is to take the raw image and convert it into a desired format and also acquire and the parameters of raw image. After acquiring the image the next step is to send the image for preprocessing and after preprocessing the process of extracting the features of the image is being done. When its features is being extracted the there is two modules which is directly associated with the extraction process which is knowledge based and also associative storage. When all these steps are being completed then the resultant parameters or image is compared to their referenced image and attain the output.

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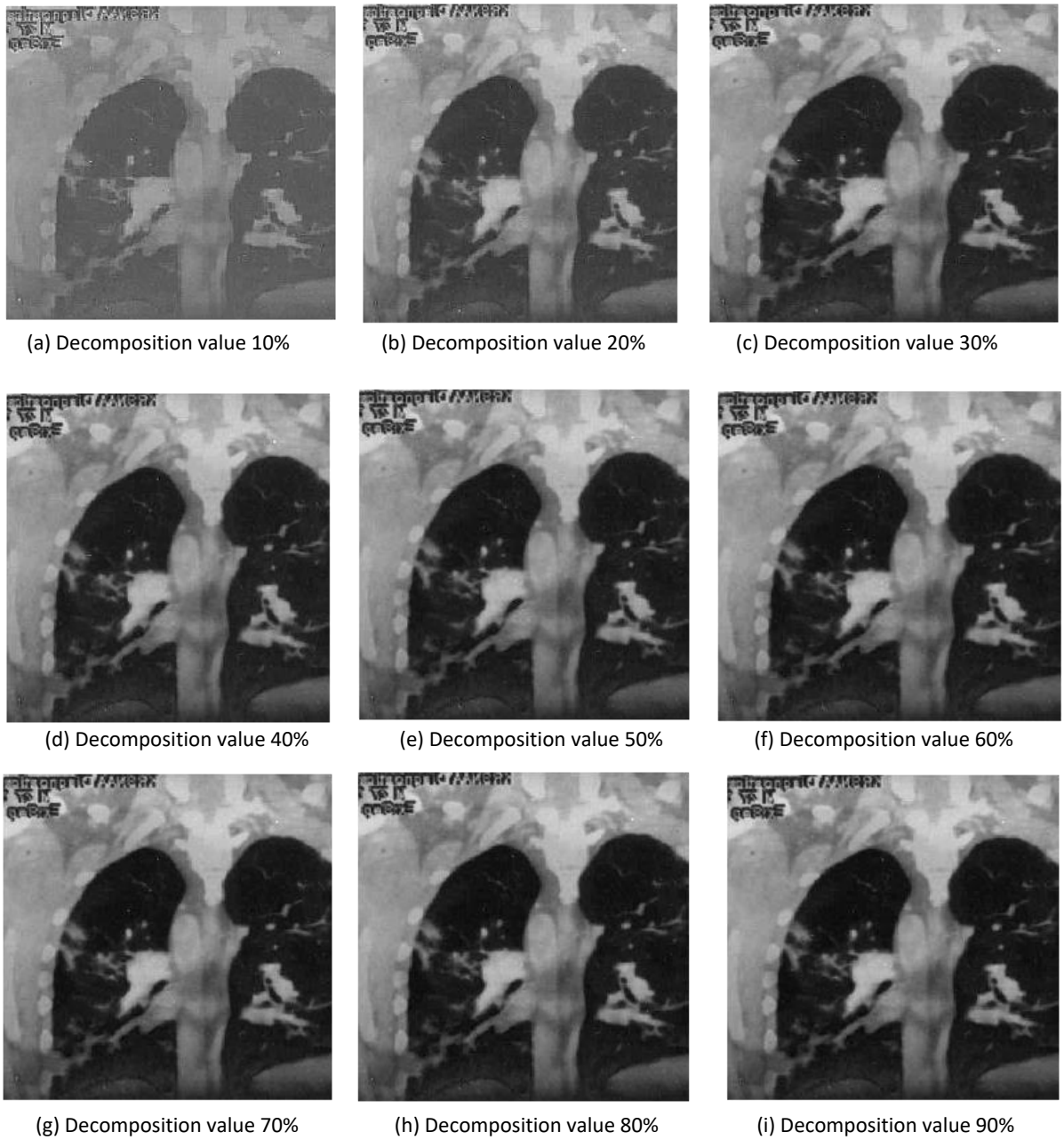
III. Results And Discussion

The proposed research work is carried out to achieve image enhancement using SVD method. The research is focused on lungs CT-Scan image of COVID19 positive patient. An algorithm is formulated to apply SVD method on the input image in finite element method (FEM) based tool. The fusion method is applied on the inhale lungs CT scan image with varying decomposition percentage of amplitude of matrix. The range of decomposition was varied from 10% to 90% with 10% step size of total decomposition value. Figure 3 show the fused image with various decomposition percentages. From the figure it is observed that as the decomposition amplitude percentage increases, the quality of image increases based on human perception. Image fusion quality evaluation parameters such as signal to noise ratio (SNR), power signal to noise ratio (PSNR), root mean square error (RMSE), PFE, MAE, CORR, MI, QI, SSIM were computed. The parameters are tabulated in Table 1. From the computed observation it is analyzed that the error between the references image and the processed image is minimum with 50% decomposition amplitude which is reflected in RMSE, PFE and MAE. Signal to noise ratio and power signal to noise ration tends to have maximum value at 50% decomposition amplitude. The quality index factor should be unity for perfectly matched images but in this case the maximum value attained is 0.998 which shows there is some disparity between the referenced and processed image.



(a) Decomposition value 10% (b) Decomposition value 20% (c) Decomposition value 30%

(d) Decomposition value 40% (e) Decomposition value 50% (f) Decomposition value 60%

(g) Decomposition value 70% (h) Decomposition value 80% (i) Decomposition value 90%

Fig. 3 Fused image with various decomposition percentages.

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Table 4.1 Computed image parameters with various decomposition percentages.

Computed Parameter	Percentage of Decomposition value								
	10%	20%	30%	40%	50%	60%	70%	80%	90%
Root mean square error (RMSE)	59.163	51.766	39.44	22.185	0.001	27.114	59.156	96.128	138.028
Percentage fit error (PFE)	95.993	83.991	63.991	35.994	0.001	43.992	95.981	155.968	223.953
Mean absolute error (MAE)	56.743	49.651	37.829	21.279	0.001	26.008	56.743	92.208	132.401
Correlation (CORR)	0.081	0.313	0.638	0.909	1.001	0.938	0.81	0.678	0.564
Signal to noise ratio (SNR)	0.356	1.516	3.878	8.876	307.782	7.133	0.357	-3.861	-7.004
Peak signal to noise ratio (PSNR):	30.445	31.025	32.206	34.705	184.158	33.834	30.445	28.337	26.766
Mutual information (MI):	1.172	1.398	1.558	1.745	2.001	1.848	1.735	1.662	1.605
Quality index (QI):	0.01	0.111	0.424	0.828	0.998	0.878	0.66	0.465	0.322
Measure of structural similarity (SSIM):	0.076	0.294	0.616	0.9	1.001	27.114	0.776	0.618	0.482

IV. CONCLUSION

In experiment-I fusion algorithm is applied on the inhale CT-scan image of subject. In this experiment various SVD decomposition amplitude percentage ranging 10% to 90% were applied on the fusion process and the reconstructed image is compared with reference image and image parameter were computed. The result of these experiments shows that the reconstructed image is far better than the original image with improvement in its quality.

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