A MAJOR PROJECT REPORT ON

"FEATURE LEVEL MEDICAL IMAGE FUSION USING SGTD"

Submitted partially fulfillment of requirement for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

BY

NAME	REGISTER NUMBER
Y.Vyshnavi	(18091A04P8)
Y.Vishnuvardhan	(18091A04P6)
B.Karthik	(18091A0480)
B.Sudarsan	(19095A0426)

Under the guidance of

Mr . M.V.Rajasekhar M.Tech.,

Assistant Professor, ECE Department

ESTD-1995

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

RAJEEV GANDHI MEMORIAL COLLEGE OF ENGINEERING & TECHNOLOGY

(AUTONOMOUS)

Affiliated to J.N.T.U.A - Anantapuramu, Approved by A.I.C.T.E., New Delhi, Accredited by N.B.A. & NAAC with 'A+' Grade – New Delhi, Nandyal-518501, Kurnool Dist. A.P.

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CERTIFICATE

This is to certify that **Y.Vyshnavi(**18091A04P8**), Y.Vishnuvardhan(**18091A04P6**), B.Karthik (**18091A0480**), B.Sudarsan(**19095A0426**)** of B.Tech ECE final year carried out the project work on "**Feature Level Medical Image Fusion Using SGTD**" under the esteemed guidance of **Mr. M.V.Rajasekhar, Assistant Professor** ECE department, for the partial fulfillment of the award of degree of **B.Tech** in ECE in **RGMCET,** Nandyal as a bonafide record of work done by them during the year 2021-2022.

Head of the Department	**Project Guide**
Dr.Kethepalli Mallikarjuna	**Mr. M.V.Rajasekhar**
M.Tech., MISTE., FIETE., MIE., Ph.D	**M.Tech**
Professor and H.O.D	**Assistant Professor**
Department of E.C.E	**Department of E.C.E**

Signature of the External

Examiner Date:

CANDIDATE'S DECLARATION

We here by declare that the work done in this Project title **"Feature Level Medical Image Fusion Using SGTD"** submitted towards completion of major project in IV Year II Semester of B.Tech (ECE) at the **Rajeev Gandhi Memorial College of Engineering & Technology**, Nandyal. It is an authentic record of our original work done under the guidance of **Mr. M.V.Rajasekhar, Assistant Professor**, Dept. of ECE, RGMCET, Nandyal. We have not submitted the matter embodied in this project for the award of any other Degree in any other institutions.

By:

Y.Vyshnavi	(18091A04P8)
Y.Vishnuvardhan	(18091A04P6)
B.Karthik	(18091A0480)
B.Sudarsan	(19095A0426)

Place:Nandyal

Date:

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Whatever one does, whatever one achieves, the first credit goes to the **Parents** be it not for their love and affection, nothing would have been responsible. We see in every good that happens to us their love and blessings.

By:

Y.Vyshnavi (18091A04P8)
Y.Vishnuvardhan (18091A04P6)
B.Karthik (18091A0480)
B.Sudarsan (19095A0426)

ABSTRACT

Medical image fusion improves clinical interpretation and analysis by combining the complementary information of multimodal images into one that leads to more accurate diagnosis and treatment planning. This article presents a novel feature-level medical image fusion (FMIF) method using a structural gradient based decomposition, which provides uncorrelated structural and textural components. A feature codebook obtained from multiple low-scale features followed by clustering and choose-max with consistency verification rule is applied to fuse structural components. An optimized pulse-coupled neural network is utilized to fuse texture component using a differential evolution algorithm, which helps to improve the model efficiency and retain the natural response of pixel activity. The fusion performance of the proposed method is explored on a large data set of neurological images. The experimental result demonstrates that the proposed method provides better fusion results and outperforms the state of-the-art fusion approaches with enhanced visual quality and computational parameters.

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CHAPTER 1

INTRODUCTION

Currently, medical imaging techniques play a vital role in the visualization of important diagnostic information. The rapid progress in medical imaging helps radiologists in disease identification, localization, and treatment planning. Though several medical imaging modalities reflect different anatomical, structural, and metabolic information, no single imaging technique can reflect all appropriate structural and activity details of a region of interest.

Moreover, the existence of several imaging modalities creates the problem of information redundancy and data overloading. Therefore, medical image fusion is required by integrating the useful details of multimodal images in a single fused one that comprising improved visualization, minimum redundancy with no loss of information. The main motivation of the work is to conceptualize a medical image fusion model that can provide explicit and relevant information for human–machine perception with minimum loss of information. Previously, several researchers have reported many works on image fusion that can be classified in pixel-, feature-, and decision-level fusion. These abstraction levels could be processed in spatial and transform domains.

Transform domain fusion methods are widely utilized to get better fusion performance based on different multiscale decomposition techniques (MSTs), such as discrete wavelet transform (DWT), curvelet (CRT), nonsubsampled contourlet (NSCT), and nonsubsampled shearlet transform (NSST). However, MST-based fusion models usually suffer from low spatial consistency, poor contrast, and blocking artifacts.

Considering the limitations, several spatial domain decomposition techniques, such as total variation (TV), guided filtering (GF), gradient-domain guided filtering (GDGF), sparse representation (SR) , and hybrid have also been successfully applied to provide an improved fusion outcome.

A TV-based fusion rule works efficiently for preserving the information even for noisy input, whereas GF is used as edge-preserving filters. However, these techniques are limited to capture fine details and texture preservation and yield local smoothing, especially at the edge boundaries. In the last few years, several pulse-coupled neural network (PCNN) and fuzzy-logic based fusion methods have gained attention due to their robust pixel selection methodology.

Though the PCNN-based models show good visual results, their performance is affected by manual settings of free parameters, improper contrast, and loss of fine detail information. Yang et al. and Yin et al. proposed fuzzy-adaptive and parameter-adaptive PCNN models, respectively, which provide a promising result compared to other MST and PCNN-based approaches. Recently, deep learning has become popular and utilized for image fusion.

CNN-based fusion rules produce good results and comprise an automatic feature selection. However, these methods suffer from large execution time. With the progress of different feature descriptors, many visual features and transfer learning-based approaches have gained attention in image fusion.

A codebook learning approach also involves the characterization of fundamentally present discriminative and visually significant features. Hence, by combining some key features heuristically, an improved output with high accuracy can be obtained. Based on the results and limitations of state-of-the-art methods, this paper presents a feature-level medical image fusion (FMIF) approach based on structure gradient and texture decorrelating (SGTD) regularization-based decomposition, feature codebook and optimized PCNN (OPCNN) model. The SGTD model provides two independent structural detail and local repetitive variations without introducing any distortion.

1.1 Image Fusion:

Image Fusion Introduction Image fusion is the process of combining relevant information from two or more images into a single image that is more informative than any of the original images.

Image Fusion can be categorized into three categories such as pixel level feature level, and decision level. In pixel level fusion, the input images are fused pixel by pixel followed by the information extraction.

1.1.1 Pixel level Fusion:

To implement the pixel level fusion, arithmetic operations are widely used in time domain and frequency transformations are used in frequency domain. The main goal of pixel level fusion is to enhance the raw input images and provide an output image with more useful information than either input image. Pixel level fusion is effective for high quality raw images but not suitable for images with unbalanced quality level because information from one physical channel might be impeded by the other. The scheme of pixel level fusion is shown in the following figure.

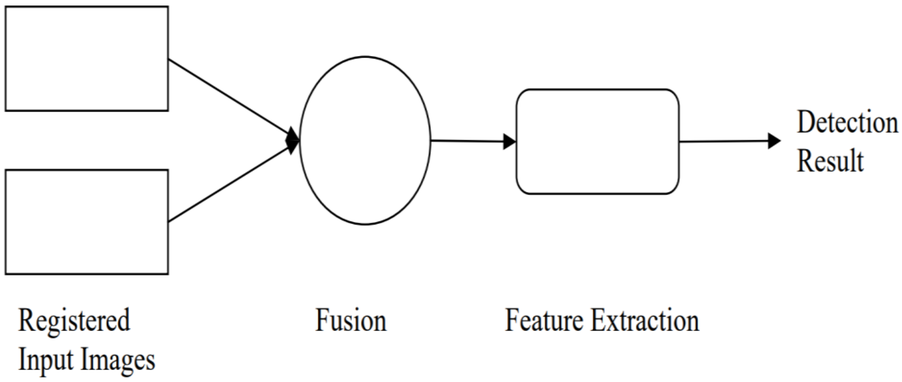


Fig 1.1: Pixel level Fusion

1.1.2: Feature level Fusion:

In feature level fusion, the information is extracted from each input image separately and then fused based on features from input images. The feature detection is typically achieved through edge enhancement algorithms, artificial neural networks, and knowledge based approaches. Feature level fusion is effective for raw images with unbalanced quality level. It requires a feature-extraction algorithm effective for both physical channels. The scheme of feature level fusion is shown in figure below.

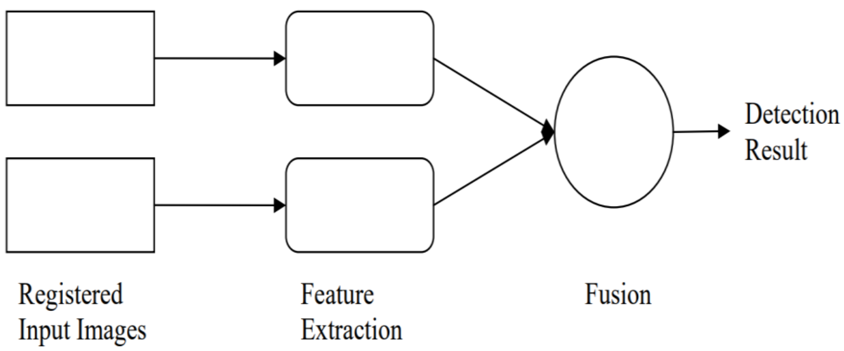


Fig 1.2: Feature level fusion

1.1.3: Decision level Fusion:

In decision level fusion, the information is extracted from each input image separately and then decisions are made for each input channel. Finally, those decisions are fused to form the final decision. Decision level fusion is effective for complicated systems with multiple true or false decisions but not suitable for general applications. The scheme of decision level fusion is shown in the following figure.

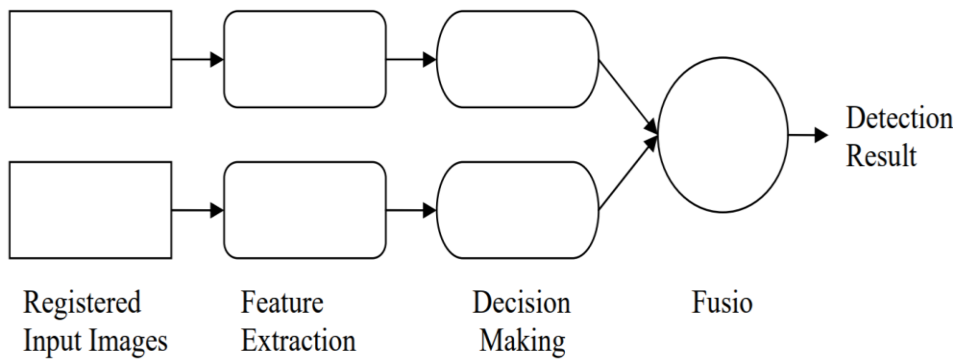


Fig 1.3: Decision level fusion

Based on the fusion mechanism, decision level and feature level fusions are high level fusions that require more complex algorithms and more intensive computation. Considering the 30Hz image frame rate of online split detection, they are not efficient enough for real time application. On the contrary, pixel level fusion is the lowest level fusion that fuses raw images from different physical channels pixel by pixel to enhance the features not complete in either channel.

Therefore, it requires less processing time and is found suitable for time critical image fusion applications. This dissertation focuses on pixel level grayscale image fusion techniques. And original images for image fusion have the same resolution and have been aligned and registered from hardware level.

CHAPTER 2

LITERATURE SURVEY

The main motivation of the work is to conceptualize a medical image fusion model that can provide explicit and relevant information for human–machine perception with minimum loss of information. Previously, several researchers have reported many works on image fusion that can be classified in pixel-level, feature-level, and decision-level fusion. These abstraction levels could be processed in spatial and transform domains. Transform domain fusion methods are widely utilized to get better fusion performance based on different multiscale decomposition techniques (MSTs), such as discrete wavelet transform (DWT), curvelet (CRT), nonsubsampled contourlet (NSCT), and nonsubsampled Shearlet transform (NSST). However, MST-based fusion models usually suffer from low spatial consistency, poor contrast, and blocking artifacts. Considering the limitations, several spatial domain decomposition techniques, such as total variation (TV), guided filtering (GF), gradient-domain guided filtering (GDGF), sparse representation (SR), and hybrid, have also been successfully applied to provide an improved fusion outcome.

A TV-based fusion rule works efficiently for preserving the information even for noisy input, whereas GF is used as edge-preserving filters. However, these techniques are limited to capture fine details and texture preservation and yield local smoothing, especially at the edge boundaries. In the last few years, several pulse-coupled neural network (PCNN) and fuzzy-logic based fusion methods have gained attention due to their robust pixel selection methodology. Though the PCNN-based models show good visual results, their performance is affected by manual settings of free parameters, improper contrast, and loss of fine detail information. Yang et al and Yin et al proposed fuzzy-adaptive and parameter-adaptive PCNN models, respectively, which provide a promising result compared to other MST and PCNN-based approaches.

Recently, deep learning has become popular and utilized for image fusion. CNN-based fusion rules produce good results and comprise an automatic feature selection. However, these methods suffer from large execution time. With the progress of different feature descriptors, many visual features and transfer learning-based approaches have gained attention in image fusion. A codebook learning approach also involves the characterization of fundamentally present discriminative and visually significant features. Hence, by combining some key features heuristically, an improved output with high accuracy can be obtained.

2.1: Structure Gradient and Texture Decorrelating Regularization:

Image decomposition defined as separating an image f as the sum of two independent components f = x + v, usually is the first step to the solution of many image processing tasks like inpainting and registration. The piecewise smooth function x with quasi-flat intensity plateaus and jump discontinuities is called “cartoon”. This component contains main large-scale structure features of the image, and can be used for feature detection, segmentation and object recognition. Another component v usually represented by a small-scale oscillatory function and having some periodicity nature, captures texture and possibly noise, and thus is suitable for solving various texture depended applications example classification, surface analysis, shape/orientation from texture. Variational approach is the most popular approach to address the image decomposition problem. The common part in this approach is often related to total variation (TV) minimization.

The pioneering formulation of such approach was originated from Meyer, who suggested starting from the regularization of Rudin et al. (ROF) model, or TV-L2 model:

$$x = \text{argmin}\left\{\frac{u}{2}\|f - x\|_2^2 + \sum_{i=1}^{n^2}||D_i x||_2\right\}$$

where TV(x)= $\sum_{i=1}^{n^2}||D_i x||_2$, for each i, Dix ∈ R2 represents the first-order finite-difference of x at pixel i in both horizontal and vertical directions. The term Dix2 is the variation of x at pixel i, and the summation T V (x) is taken over all pixels for a n × n image. It can be seen that TV-L2 model performs decomposition by modelling the cartoon component x with TV semi-norm and using the L2- norm for oscillating features v = f − x. Starting from this model, the strategies for improving image decomposition can be divided into three approaches, based on searching the suitable model for texture, cartoon or for both texture and cartoon.

A new decomposition model involving the SGTD regularizer is presented. Mathematically, the objective function can be expressed as:

$$x = \text{argmin}\left\{\frac{u}{2}\|f - x\|_2^2 + n\sum_{i=1}^{n^2}\left|\left|D_i x\right|\right|_2 + \sum_{i=1}^{n^2}|f_i - x_i|\,||D_i x||_2\right\}$$

where u and n are the weights. The first term in the cost function enforces data fidelity in the image domain. The second term favors that the structure part to be sparse in the gradient domain. The effect of more powerfully decomposing cartoon and texture is introduced by the third term, which measures the correlated quality between the gradient of structural component and the textural component. Compared to the TV-L2 model, the new added term alleviates the drawback introduced by only using TV regularizer and makes the proposed model be able to handle images containing complex patterns.

In this paper, a decorrelating regularizer for extracting meaningful structure from texture was proposed. The image decomposition results were improved by forcing incoherence between the gradient magnitude of the cartoon and texture components.

2.2: MULTIMODAL MEDICAL IMAGE SENSOR FUSION FRAMEWORK USING CASCADE OF WAVELET AND CONTOURLET TRANSFORM DOMAINS:

Advancements in large number of sophisticated medical imaging modalities like: Magnetic Resonance Imaging (MRI), Computed Tomography (CT), Positron Emission Tomography (PET), Ultrasound, X-ray, Single Positron Emission Computed Tomography (SPECT), Electrocardiography (ECG) etc. have added to the visual response from these devices in terms of interpretation and diagnostic analysis. Response(s) of these imaging modalities contain plenty of useful information that are extracted and analysed by the radiologists for the purpose of analysis, detection and the diagnosis of diseases. Numerous image processing techniques like enhancement, denoising, de-blurring etc. are also used to further enhance and improve upon the visual responses obtained from these modalities. The obtained sensor responses of the various medical imaging modalities are often complementary in nature, i.e. a particular sensor modality is deprived of the features acquired by another sensor (imaging modality).

For example, CT images deals with the demonstration of the extent of disease and provides information of denser tissues with less distortion; while MRI contains the information regarding soft tissues. Hence, a radiologist always purposes to analyze the sensor responses of the different modalities simultaneously. Also, image enhancement applied as post-processing on such images are restricted to improve the attributes of the individual images only. For instance, if contrast enhancement is performed on the CT and MRI scans, it can only serve to improve upon the contrast of the individual scans but still the problem of examining different modalities simultaneously prevails. This calls upon the need to integrate the useful as well as complimentary information from the images (which are the outcome of various sensor modalities for diagnosis) using fusion algorithms to yield a single image for optimum analysis and diagnosis.

A. Review on Image Fusion Approaches

Wavelet transforms are based on multi-resolution approaches dealing with the image analysis at different resolution levels, so that the feature missing at one level can be easily acquired at another. Choi [20] in their work used IHS rule with the wavelet transform as fusion approach. However, the combo of wavelets and IHS contributed for the spatial distortion in the fused image. In work of Yang et al., wavelets were combined with maximum energy based selection rule. The algorithm by authors employed different fusion rules for high level and low level coefficients separately; which constrained the detection of border line in fused images. Xhao and Wu implemented fusion method using lifting wavelets, but limited to facilitate the shift invariance and phase information. Singh and Khare employed the Redundant Discrete Wavelet Transform (RDWT, also referred to as Stationary Wavelet Transform-SWT) along with the maximum selection rule for the fusion. However, the fused image contained a lot of redundant information.

B. Motivation for Problem Formulation

With the above review of image fusion approaches, it can be inferred that SWT not only provided good time and frequency localization; but also detects the curved shapes more precisely than DWT. However, processing via SWT leads to a high level of non-directionality in the decomposed coefficients. As a remedy, the same could be balanced by applying PCA based fusion rule. PCA which is a highly directional fusion rule not only counters the non-directionality limitation of SWT, but also enhances the feature which makes it more suitable for fusion of medical images. Although, usage of PCA along with SWT can pose improvements via removal of its nondirectionality, but the constraint of shift variance of SWT still prevailed. In order to overcome this drawback, NSCT, a highly shift invariant transform serves as a remedial solution. Hence, the present work proposes a multimodal sensor fusion framework employing cascade combination of SWT and NSCT domains. Application of PCA in wavelet domain serves to reduce data redundancy and improves upon the feature enhancement.

Later, the maximum fusion rule has been incorporated under NSCT transform domain to enhance the productivity of PCA and improve upon the contrast and morphological details (in the finally fused image).

CHAPTER -3

BASICS OF DIGITAL IMAGE PROCESING

Image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or, a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. Image processing usually refers to digital image processing, but optical and analog image processing also are possible.

3.1 Image

An image is an array, or a matrix, of square pixels (picture elements) arranged in columns and rows.

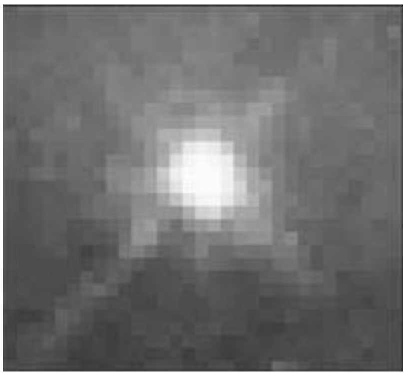


Fig 3.1: An image

An image is an array or a matrix of pixels arranged in columns and rows

3.1.1 Pixel:

A picture element is a single point in a graphic image. Every such information partis not actually a dot, nor a square except a conceptual sample. Each element of the abovematrix is known as pixel where, dark = 0 and bright = 1. A pixel with solely 1bit will signifya black and white picture. An image is represented as a matrix in digital image processing.

In Digital Signal Processing we utilize only row matrices. Obviously happening images should be sampled and quantized to get a digital image A free image should have 1024*1024 pixels which is known as 1k*1k=1mega pixel.

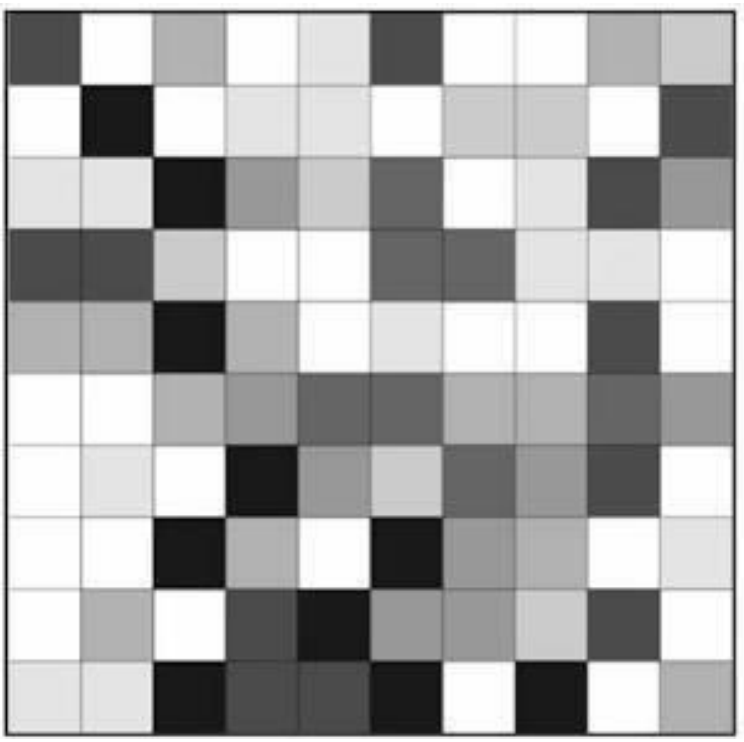


Fig 3.1.1: Each pixel has a value from 0(black) to 255(bright).

3.2 Types of Images:

3.2.1 Gray Scale Image:

Every pixel is a shade of gray, typically from 0(dark) to 255(bright). This extent implies that every pixel can be spoken to by eight bits, or precisely one byte. Other gray scale reaches are utilized, however for the most part they are a force of 2.

3.2.2 Binary Image:

Each pixel is just black or white. Since there are only two possible values for each pixel (0,1), we only need 1bit per pixel.

3.2.3 Indexed Image:

An index image comprises of an array and a shading guide lattice. Pixels in the exhibit or immediate list into a shading guide. By tradition, this documentation utilizes the variable name x to allude to the exhibit and guide to allude to the shading guide.

3.2.4 RGB Image:

Every pixel has a specific color, that color is depicted by the measure of red, green, and blue in it. On the off chance that each of these segments has an extent 0-255, this gives an aggregate of 2563 different conceivable hues. Such an image is a “stack “of three grids; speaking to the red, green and blue qualities for every pixel. This implies that for each pixel there relate three values.

3.3 Image Digitization:

A picture caught by a sensor is expressed as a continuous function f(x,y) of two directions in the plane. To process a caught picture by PC it must be spoken to in frame work structure. A matrix is the most widely recognized information structure for low level representation of a picture. Components of the network are whole number numbers relating to splendor or to another property of the comparing pixel of the inspecting lattice. Picture data frame work is available through the directions of a pixel that compare with the line and segment records. Picture digitization implies that the capacity f(x,y) is inspected frame work with M lines and N segments.

3.3.1 Sampling:

A continuous picture function f(x,y) can be inspected utilizing a discrete network of testing focuses in the picture plane. A second plausibility is to extend the picture capacity utilizing some orthogonal capacity as a base-Fourier change.

A continuous picture is digitized at sampling focuses. These inspecting focuses are requested in the plane and their geometric connection is known as the GRID. The computerized picture is then an information structure, for the most part a grid. Matrices utilized as part of a practice or typically square and hexagonal.

One endlessly little inspecting point in the lattice compares to one picture component in the advanced picture. The set of pixels together covers whole picture. The pixel is a unit, which is not further separable from the picture investigation perspective.

3.3.2 Quantization:

An estimation of the sampled image is determined as a digital value in the image processing. The transition between proceeds with estimations of the capacity and its advanced identical is called quantization. Most digital image processing gadgets use quantization into K equal intervals. In the event that b bits are utilized to express the pixels estimation brightness, then the quantity of the brightness levels is K= 2b. Eight bits for each pixel are usually utilized albeit a few frame works utilize six or four bits. A binary image pixel which is either dark or white can be spoken to by one bit.

3.4 File Formats:

3.4.1 GIF (Graphic Interchange Format):

GIF works best for pictures with just a couple of particular hues, for example, line drawings and basic toons. GIF is valuable for toon pictures that have under 256 hues, dark scale pictures and dark and white content.

Like JPEG, GIF is standard organization for web pictures. The essential confinement of GIF is that it meets expectations just on pictures with 8 bits for every pixel or less, which implies 256 or less hues. Most shading pictures are 24 bits for pixel. To store this GIF design, you should first over the picture from 24 bits to 8 bits. The change will bring about lost information and an extensive debasement in quality. PC screen that shows just 26 hues are less show GIF's well. GIF is lossless picture record passion. With lossless pictures, the greater part of the information that was initially in the document stays after the record is uncompressed. GIF packs pictures utilizing LZW pressure. LZW pressure is named for the people who created it LIMPEL-ZEV WELCH. It was initially concerted to pack content for transmission over phone lines. This type of pressure is a lossless pressure structure with proportions differing relying upon the shading multifaceted nature of picture.

3.4.2 JPEG (Joint Photographic Experts Group):

JPEG is a commonly used method of lossy compression for digital images, particularly for those images produced by digital photography. The degree of compression can be adjusted, allowing a selectable tradeoff between storage size and image quality.

3.4.3 TIFF (Tagged Image Format File):

TIFF has risen as the standard chronicling picture document position for library use. Its qualities are that the organization is extensible, new picture sorts can be presented without discrediting more established sorts and convenient, it is an autonomous of equipment and working framework sorts. There are numerous sorts of TIFF documents: the most widely recognized ones are portrayed beneath. Uncompressed TIFF pictures are put away in an uncompressed crude organization. This is the essential arrangement for archival pictures on the grounds that the information is left unaltered.

3.4.4 PNG (Portable Network Graphics):

PNG is a file format for picture pressure. It was produced as a patent free swap for GIF (Unisys possesses the GIF position). It gives various changes over the GIF design.

Like a GIF, a PNG record utilizes lossless pressure. It permits you to make an exchange off between record size and picture quality when the picture is packed. Regularly, a picture in a PNG record can be 10 to 30% more compressed than in a GIF position. Like GIFS, you can make one shading straight forward, however you can control the level of straight forwardness this is likewise called “opacity”. Interweaving is a bolstered and is speedier in creating than in the GIF group.

3.4.5 PS (Post Script):

Post script, a standard vector format. It has numerous sub-standards and can be difficult to transport across platforms and operating systems.

3.4.6 PSD (Photo Shop Document):

PSD is a dedicated photoshop format that keeps all the information in an image including all the layers.

3.5 Fundamental Steps in Digital Image Processing:

There are some fundamental steps. But as they are fundamental, all these steps may havesub-steps. The fundamental steps are described in the Fig 2.5 as shown below.

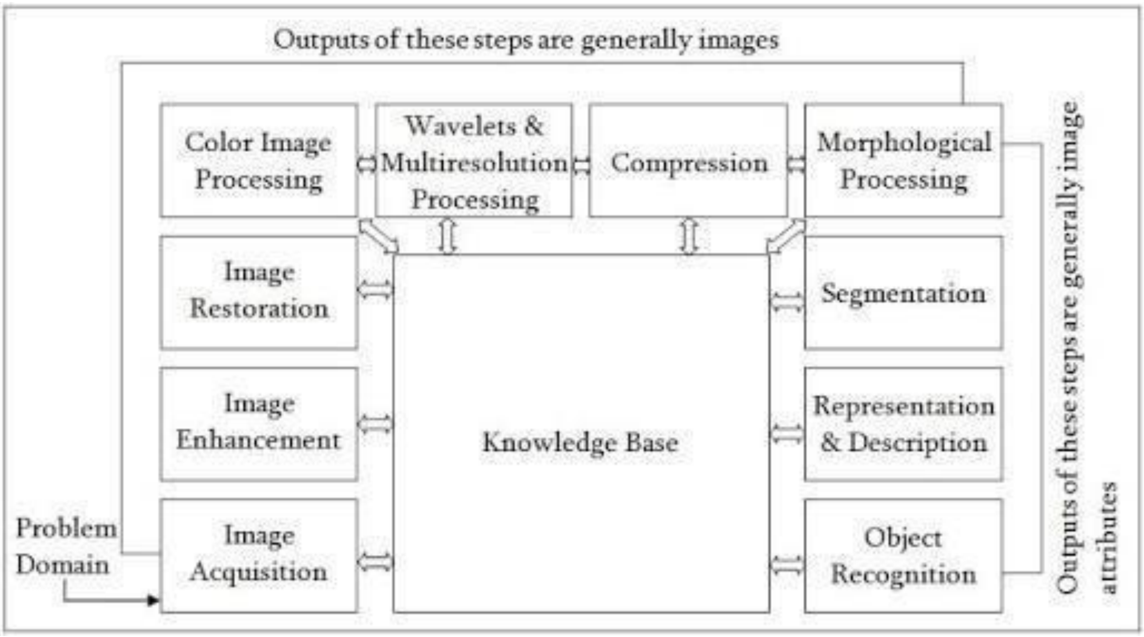


Fig 3.5: Fundamental steps in Digital Image Processing

3.5.1 Image Acquisition:

This is the first step or process of the fundamental steps of digital image processing. Image acquisition could be as simple as being given an image that is already in digital form. Generally, the image acquisition stage involves preprocessing, such as scaling etc.

3.5.2 Image Enhancement:

Image enhancement is among the simplest and most appealing areas of digital image processing basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image, such as changing brightness & contrast etc.

3.5.3 Image Restoration:

Image restoration is a range that likewise manages enhancing the presence of the image. On the other hand, not at all like enhancement, which is subjective, image restoration is objective, as in rebuilding methods have a tendency to be founded on numerical or probabilistic models of image degradation.

3.5.4 Colour Image Processing:

Color image processing is a range that has been gaining up its significance due to the noteworthy increment in the utilization of advanced images over the internet, this may incorporate color displaying and processing in an advanced space and so on.

Color image processing is an area that has been gaining its importance because of the significant increase in the use of digital images over the internet.

3.5.5 Wavelet and Multi-Resolution Processing:

Wavelets are the establishment for representing to images in different degrees of resolution. Image progressively subdivided into littler regions for information pressure and for pyramidal representation.

3.5.6 Compression:

Compression deals with techniques for reducing the storage required to save an image or the bandwidth to transmit it. Particularly it is used to compress the data.

3.5.7 Morphological Processing:

Morphological processing deals with tools for extracting image components that are useful in the representation and description of shape.

3.5.8 Segmentation:

Segmentation procedures partition an image into its constituent parts or objects or set of pixels, in general, autonomous segmentation is one of the most difficult tasks in digital image processing. A rugged segmentation procedure brings the process a long way toward successful solution of imaging problems that require objects to be identified individually.

3.5.9 Representation and Description:

Representation and description almost always follow the output of a segmentation stage, which usually is a raw pixel data, constituting either the boundary of a region or all the points in the region itself. Choosing are presentation is only part of the solution for transforming raw data into a form suitable for subsequent computer processing. Description deals with extracting attributes that result in some quantitative information of interest or are basic for differentiating one class of objects from another.

3.5.10 Object Recognition:

Recognition is the process that assigns a label, such as, “vehicle” to an object based on its descriptors.

3.5.11 Knowledge Base:

Knowledge may be as basic as specifying districts of an image where the data of premium is known not found, in this way contrasting the hunt that must be led in looking for that data. The learning base additionally can be entirely mind boggling, for example, an interrelated rundown of all real conceivable imperfections in a materials review issue or an image database containing high-determination satellite images of a district regarding change- detection applications

3.6 Applications of Image Processing:

There are different types of image processing in which some are Image enhancement, Image restoration and Image Compression.

3.6.1 Image Enhancement:

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. Image enhancement techniques can be divided into two broad categories:

Spatial domain methods, which operate directly on pixels.

Frequency domain methods, which operate on the Fourier transform of an image. The spatial domain refers to the image plane itself and approaches in this category or based on direct manipulation of pixels in image. The frequency domain processing techniques are based on modifying the Fourier transformation of an image.

3.6.2 Image Restoration:

As an image enhancement, the ultimate goal of restoration techniques is to improve an image in some sense. For the purpose of differentiation, we consider restoration to be a process that attempts to reconstruct or recover an image that has been degraded by using some a priori knowledge of the degradation phenomenon. Thus, restoration techniques are oriented toward modeling the image.

3.6.3 Image Compression:

Compression, as the name implies, deals with techniques for reducing the storage required for saving an image, or the bandwidth required to transmit it. This is true particularly in usage of the internet, which are characterized by significant pictorial content. Image compression is familiar to most usage of computers in the form of image file extensions such as the jpg file extension used in the JPEG (Joint Photographic Experts Group) Image compression standard.

Reducing the storage required saving an image, or bandwidth required to transmit is known as image compression. Image compression addresses the problem of reducing the amount of data required to represent a digital image. The underlying basis of the reduction process is the removal of redundant data. At some later time, the compressed image is decompressed to reconstruct the original image or an approximation of it.

Image Compression plays a major role in many important and diverse applications, including Tele-video conferencing, remote sensing document and medical imaging, facsimile transmission (FAX), and the control of remotely piloted vehicles in military, space, and hazardous waste management applications, in short, an ever-expanding number of applications depends on the efficient manipulation, storage, and transmission of binary, gray and color images.

Compression techniques mainly fall into two categories:

1. Loss less
2. Lossy

The first method is useful in image archiving (as in storage of legal or medical records). These methods allow an image to be compressed and decompressed without losing information. The methods in the second category, provides higher level of data reduction but results in a less than perfect reproduction of original image. Lossy image compression is useful in applications such as broadcast of television, video conferencing, and FAX transmission, in which a certain amount of error is acceptable for increased compression performance.

3.6.4 Image Segmentation:

Image Segmentation is the process of partitioning a Digital image into multiple regions or sets of pixels. Actually, partitions are different objects in image which have the same texture or color.

3.7 Image Resolution:

Image resolution is an umbrella term that describes the detail an image holds. The term applies to raster digital images, film images, and other types of images. Higher resolution means more image detail. Image resolution can be measured in various ways. Basically, resolution quantifies how close lines can be to each other and still be visibly resolved. Resolution units can be tied to physical sizes (e.g., lines per mm, lines per inch), to overall size of a picture (lines per picture height, also known simply as lines, TV line so TVL), or to angular subtenant. Line pairs are often used instead of lines; a line pair comprises a dark line and an adjacent light line. A line is either a dark line or a light line. A resolution of 10 lines per mm means 5 ark lines alternating with 5 light lines, or 5 lines pairs per mm (5 LP/mm). Photographic lens and film resolution are most often quoted in line pairs per millimeter.

3.8 Normalization:

In image preparing, standardization is a procedure that progressions the scope of pixel force values. Applications in corporate photos with poor difference because of glare, for instance. Standardization is in some cases called complexity extending or histogram extending. In more broad fields of information handling, for example, computerized sign preparing, it is alluded to as dynamic reach development.

The reason for element range development in the different applications is as a rule to bring the image, or other sort of sign, in to a range that is more recognizable or typical to the sense, subsequently the term standardization. Regularly, the inspiration is to accomplish consistency in element range for an arrangement of information, flags, or images to maintain a strategic distance from mental diversion.

3.9 Practical applications of Image processing:

Image processing has a gigantic scope of utilizations; each region of science and innovation can make utilization of image handling strategies. Here is a short run down just to give some sign of the scope of image handling applications.

3.9.1 Document processing:

It is utilized as a part of filtering, and transmission for changing over paper archives to an advanced image structure, compacting the image, and putting away it an attractive tape. It is likewise utilized as a part of archive perusing for consequently identifying and perceiving printed qualities.

3.9.2 Medical Applications:

Investigation and understanding of images acquired from X-beams, MRI or CAT examines, examination of cell images, of chromosome karyo sorts. In restorative applications, one is worried with preparing of midsection X-beams, cineangiograms projection images of trans axial tomography and other medicine of images that happen in radiology, atomic attractive reverberation (NMR) and ultrasonic checking. These images may be utilized for patients screening and observing or for location of tumors or other sickness in patients.

Inspection and interpretation of images obtained from X-rays, MRI or CAT scans, analysis of cell images, of chromosome karyo types. In medical applications, one is concerned with processing of chest X-rays, cineangiograms, projection images of trans axial tomography and other medical images that occur in radiology, nuclear magnetic resonance (NMR) and ultra-sonic scanning. These images may be used for patient screening and monitoring or for detection of tumors or other disease in patients.

3.9.3 Defence/Intelligence:

It is utilized as a part of observation photographic understanding for programmed elucidation of earth satellite imagery to search of delicate target or military dangers and target securing and direction for perceiving and following focuses progressively brilliant bomb and rocket direction frame works.

3.9.4 Radar Imaging System:

Radar and sonar pictures or utilized for location and acknowledgement of different sort of target or in direction and moving of air ship or rocket frameworks.

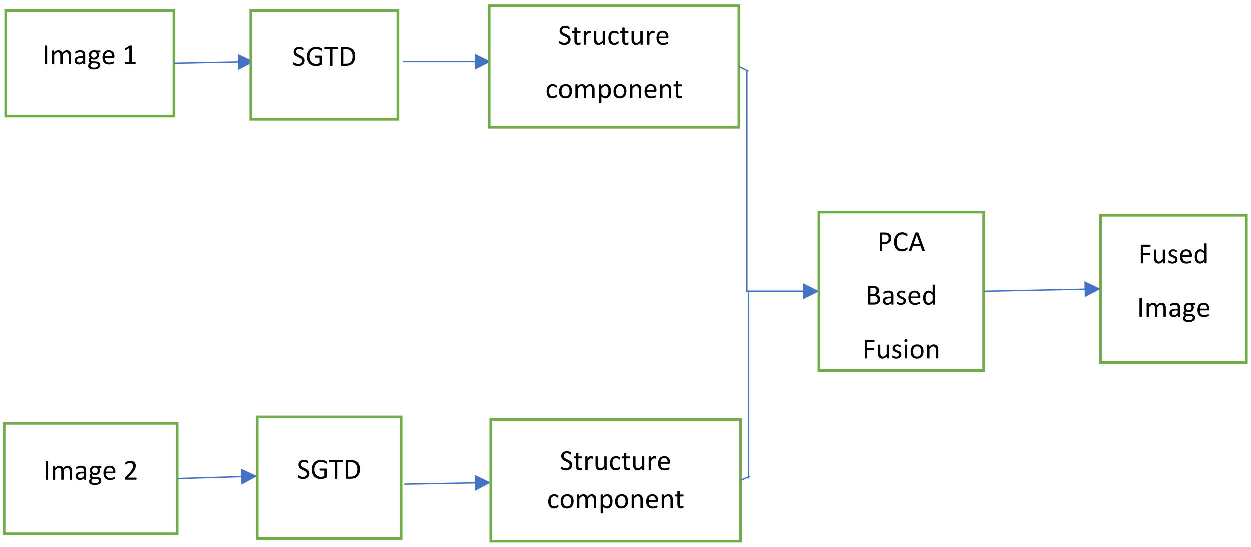
3.9.5 Agriculture:

Satellite/airborne perspectives of area, for instance to decide the amount of area is being utilized for purposes, or to examine the suitability of distinctive locales for distinctive yields, review of leafy foods recognizing great and crisp produce from old.

CHAPTER 4

PROPOSED METHOD

4.1: METHODOLOGY:



4.1: Block Diagram

4.2: Project Description:

Step 1**:** Taking Images as input.

Step 2: Decomposition of the input source images.

Step3: Extracting the Structure Component and Texture Components from images.

Step4: Applying PCA on structural Components of both Image components.

Step5: Fusion takes place.

4.3: SGTD

Structural Gradient and Textural Decomposition:

Intuitively, for a successful decomposition, any given feature in an image should be considered as either a cartoon feature or a textural feature. Therefore, the correlation between the cartoon and texture components of a decomposition should be low, i.e. the range of this random field will consist of values close to zero. This assumption has been adopted in previous work. The straightforward way to model this assumption is to minimize $\sum_{i=1}^{n^2} |\mathrm{fi} - \mathrm{xi}| \cdot |\mathrm{xi}|$.

However, directly calculating the correlation between these two components could cause problem since the texture part has an inherent zero mean while the cartoon does not. In order to help address this issue, we propose an alternative way by minimizing the above term. Different from the straightforward expression, the new model involves finite difference operation, which makes the gradient images have inherent zero mean since this operation for one pixel could be either positive or negative. Therefore, our proposed regularizer suggests the gradient magnitude of the cartoon and texture component are generated from independent process and thus are uncorrelated.

The aim of this type of decomposition is harder to formulate explicitly. The general concept is that an image can be regarded as composed of a structural part, corresponding to the main large objects in the image, and a textural part, containing fine scale-details, usually with some periodicity and oscillatory nature. The definition of texture is vague and highly depends on the image scale. A "structure" in one scale, can be regarded as "texture" in another scale. Nevertheless, we will attempt to use various variational models, to decompose an image into meaningful structural and textural parts. Moreover, we will examine the ability to perform the task automatically using the correlation criterion. This criterion is very simple and does not assume any information on the nature or scale of the texture. It works well in simple cases and can aid in finding the right weight between the structural and textural components. In more complicated multi-scale images, more elaborated mechanisms are needed, based on additional information.

Input Structural Textural

Fig 4.2: SGTD decomposition

4.4: Principal Component Analysis:

In original PCA, the data is projected from its original space to its eigenspace to increase the variance and reduce the covariance so as to identify patterns in the data. The flow chart of original PCA is shown in following figure.

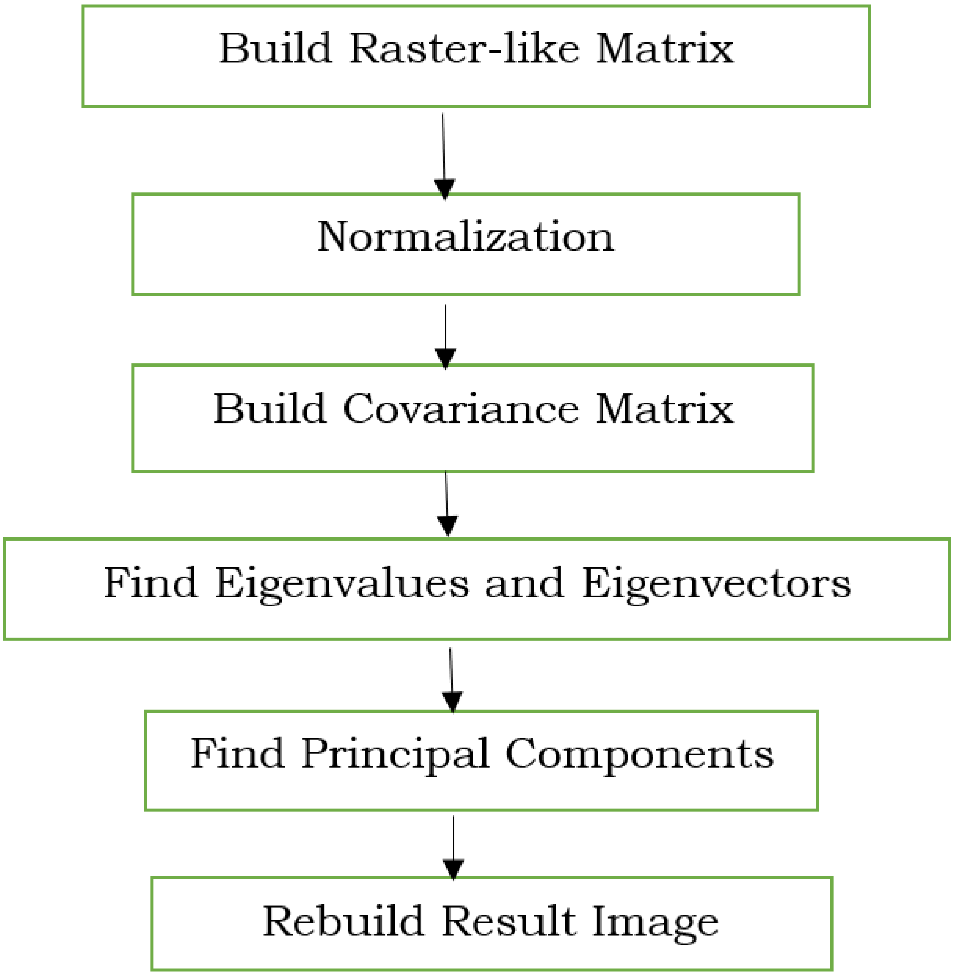


Fig 4.3: Flow Chart for PCA Algorithm

Principal component analysis is a statistical analysis for dimension reduction. It basically projects data from its original space to its eigenspace to increase the variance and reduce the covariance by retaining the components corresponding to the largest eigenvalues and discarding other components. PCA helps to reduce redundant information and highlight the components with biggest influence so as to increase the signal-to-noise ratio. PCA is also a linear transformation that is easy to be implemented for applications in which huge amount of data is to be analysed. PCA is widely used in data compression and pattern matching by expressing the data in a way to highlight the similarities and differences without much loss information.

Before applying PCA, a matrix operation is needed to convert this 3D matrix into a 2D matrix and subtract mean value from each data point to create zero-centred data [52, 53]. Each image frame of width N_x and height N_y can be represented as a vector x with $N_x N_y$ elements as shown in below,

$$X = (x_1, x_2, x_3, \ldots\ldots, x_{NxNy})$$

The rows of pixels in an image frame are placed one after another to form the vector X. The first Nx elements in the vector X are pixels in the first row of the image and the next Nx elements are pixels in the second row of the image and so on. Eventually, the last Nx elements in the vector X are pixels in the last row of the image. Similarly, the same operation is performed on all the Nt frames in the captured image sequence. Then, a 2D image sequence matrix is generated by combining the Nt vectors.

There are two choices to create this kind of 2D matrix also known as raster-like matrix.

Then the covariance matrix of the normalized raster-like matrix is calculated using following equation.

$$C = \frac{1}{N} A A^T$$

Where is the A^T is normalized raster-like matrix and C is the covariance matrix.

The eigenvalues and eigenvectors can be found using matrix diagonalization described in following equation.

$$C_D = p^{-1} C p$$

Where C is the covariance matrix, C_D is the diagonalized covariance matrix with eigenvalues on the diagonal is the matrix with eigenvectors as its columns.

Then sort the diagonalized covariance matrix C_D to make the eigenvalues in a descending order and also sort the matrix P in the same order. To reduce the dimension of the original matrix, retain the first K columns in matrix P to form matrix p_k. And then convert the original matrix to the new basis using Equation.

$$C_p = p_k t \, C$$

Finally, reconstruct the result image using the dimension reduced raster-like matrix C_p.The choice of K is based on the amount of the variance proportion desired to be retained in the first K eigenvalues described in Equation below. In many cases more than 95% of variance is contained in the first three to five components.

$$\text{R} = \frac{\sum_{i=1}^{k} ei}{\sum_{i=1}^{m} ei}$$

Where ei is the ith eigenvalue of the diagonal matrix C_D.

This is the process of Principal Component Analysis in Image Fusion.

4.5: Advantages:

- Keeps the key features in images.
- Removes Correlated features.
- Reduces the noise.
- Data Storage reduces.
- Complexity in Analysis of images also reduces.
- Improved visualization.

CHAPTER-5

5.SOFTWARE DESCRIPTION

5.1 MATLAB:

MATLAB is a high-performance language for technical computing. It integrates computation visualization and programming in an easy-to-use environment. MATLAB stands for Matrix Laboratory. It was written originally to provide easy access to matrix software developed by LINPACK (linear system package) and EISPACK (Eigen system package) projects. MATLAB is therefore built on a foundation of sophisticated matrix in which the basic elementin matrix that does not require pre dimensioning which to solve many technical computing problems especially those with matrix and vector formulations, in a fraction of time. MATLAB features of applications specific solutions called toolbox. Very important to most users of MATLAB, toolboxes allow learning and applying specialized technology. These are comprehensive collections of MATLAB functions that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control system, neural networks, fuzzy logic, wavelets, simulation and many others.

5.1.1 Typical uses of MATLAB:

The typical using areas of MATLAB are

1. Math and computation
2. Algorithm and development
3. Data acquisition
4. Data analysis, exploration and visualization
5. Scientific and Engineering graphics
6. Modelling

7. Simulation
8. Prototyping
9. Application development and including graphical user interface building.

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar noninteractive language such as C or FORTRON.MATLAB features a family of add-on application-specific solutions called toolbox. Very important to most users of MATLAB, toolbox allows you to learn and apply specialized technology. Toolbox is comprehensive collections of MATLAB functions that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation and many others.

5.1.2 Features of MATLAB:

1. Advance algorithm for high performance numerical computation, especially in the field matrix algebra.
2. A large collection of predefined mathematical functions and the ability to define one's
3. own functions.
4. Two- and three-dimensional graphics for plotting and displaying data
5. Powerful, matrix or vector oriented high level programming language for individual applications.
6. Toolboxes available for solving advanced problems in several application areas.

5.1.3 Basic Building Blocks of MATLAB:

The basic building block of MATLAB is matrix. The fundamental data type is the array. Vectors, scalars, real matrices and complex matrix are handled as specific class of this basic data type. The built-in functions are optimized for vectors operations. No dimension statements are requiring Med for vectors of arrays.

5.2 MATLAB Window:

The MATLAB works based on seven windows

1. Command window
2. Work space window
3. Current directory window
4. Command history window
5. Editor window
6. Graphics window
7. Online-help window

5.2.1 Command window:

The command window is where the user types MATLAB commands and expressions at the prompt (>>) and where the output of those commands is displayed. It is opened when the application program is launched. All commands including user-written programs are typed in this window at MATLAB prompt for execution.

5.2.2 Work space window:

MATLAB defines the workspace as the set of variables that the user creates in a work session. The workspace browser shows these variables and some information about them. Double clicking on a variable in the work space browser launches the array editor, which can be used to obtain information.

5.2.3 Current directory window:

The current directory tab shows the contents of the current directory, whose path is shown in the current directory window. For example, in the windows operating system the path might be as follows: c\ MATLAB \work, indicating that directory "work" is a sub directory of the main directory "MATLAB", which is installed in drive c. Clicking on the arrow in the current directory window shows a list of recently used paths. MATLAB uses a search path to find M-files and other MATLAB related.

5.2.4 Command history window:

The command history window contains a record of the commands a user has entered in the command window, including both current and previous MATLAB sessions. Previously entered MATLAB commands can be selected and re-executed from the command history window by right clicking on a command. This is useful to select various options in addition to executing the commands and is useful feature when experimenting with various commands in work sessions.

5.2.5 Editor window:

The MATLAB editor is both a text editor specialized for creating M-files and a graphical MATLAB debugger. The editor can appear in a window by itself, or it can be a sub window in the desktop. In this window one can write, edit, create and save programs in files called M- files.

MATLAB editor window has numerous pull-down menus for tasks such as saving, viewing and debugging files. Because it performs some simple checks and also uses color to differentiate between various elements of code, this text editor is recommended as the tool of choice for writing and editing M-files.

MATLAB editor window has numerous pull-down menus for tasks such as savings, viewing and debugging files. Because it performs some simple checks and also uses color to differentiate between various elements of code, this editor is recommended as the tool of choice for writing and editing M-files.

5.2.6 Graphics or figure window:

The output of all graphic commands typed in the command window is seen in this window.

5.2.7 Online help window:

MATLAB provides online help for its built-in functions and programming language constructs. The principal way to get help online is to use the MATLAB help browser, opened as a separate window either by clicking on the question mark symbol on the desktop toolbar, or by typing help browser at the prompt in the command window. The help browser is a web browser integrated into the MATLAB desktop that displays a hypertext markup language document. The help browser consists of two panes, the help navigator plane, used to find information, and the display plane, used to view this information. Self-explanatory tabs other than navigator plane are used to perform a search.

5.3 MATLAB Files:

MATLAB has some types of files for storing information. They are M-files and MAT- files.

5.3.1 M-Files:

These are standard ASCII text file with ‘m’ extension to the file name and creating own matrices using m-files which are text files containing MATLAB code. MATLAB editor or another editor is used to create a file containing the same statements which are typed at the MATLAB command line and save the file under a name that ends in m. There are two types of m-files.

5.3.2 Script files:

M-files with a set of MATLAB commands in it and is executed by typing name of file on the command line. These files work on global variables currently in that environment.

5.3.3 Function files:

A function file is also an M-file except that the variables in a function file are all local. This type of files begins with a function definition line.

5.3.4 Mat-files:

These are binary files with. mat extension to that file created by MATLAB when the data is saved. The data written in a special format that only MATLAB can read. These are located into MATLAB with load command.

5.4 MATLAB Tool:

The MATLAB tool consists of five main parts:

5.4.1 Development environment:

This is the set of tools and facilities that help you see use MATLAB functions and files. Many of these tools are graphical user interface. In includes the MATLAB desktop and command window, a command history, an editor and debugger, and browser for viewing help, the work space, files and search path.

5.4.2 MATLAB mathematical function:

This is a vast collection of computational algorithms ranging from elementary functions like sum, sine, cosine and complex arithmetic to more many functions like matrix inverse, matrix Eigen values, Bessel functions and fast Fourier transforms.

5.4.3 MATLAB language:

This is a high-level matrix or array language with control flow statements, functions, data structures, input or output and object-oriented programming features. It allows both programming in the small to rapidly create quick and dirty throw-away programs, and programming in the large to create complete large and complex application programs.

5.4.4 GUI construction:

MATLAB has extensive facilities for displaying vectors and matrices as graphs, as well as annotating and printing these graphs. It includes high-level functions for two-dimensional and three-dimensional data visualization, image processing, and animation and presentation graphics. It also includes low-level functions that allow you to fully customize the appearance of graphics as well as to build complete graphical user interface on your MATLAB application

5.4.5 MATLAB application program interface:

It is a library that allows you to write C and FORTRAN programs that interact with MATLAB. It includes facilities for calling routines from MATLAB, calling MATLAB as a computational engine and for reading and writing MAT-files.

5.5 MATLAB Working Environment:

5.5.1 MATLAB Desktop:

MATLAB desktop is the main MATLAB application window. The desktop contains five sub windows, the command window, workspace browser, current directory window, command history window, and one or more figure windows which are shown only when the user displays a graphic.

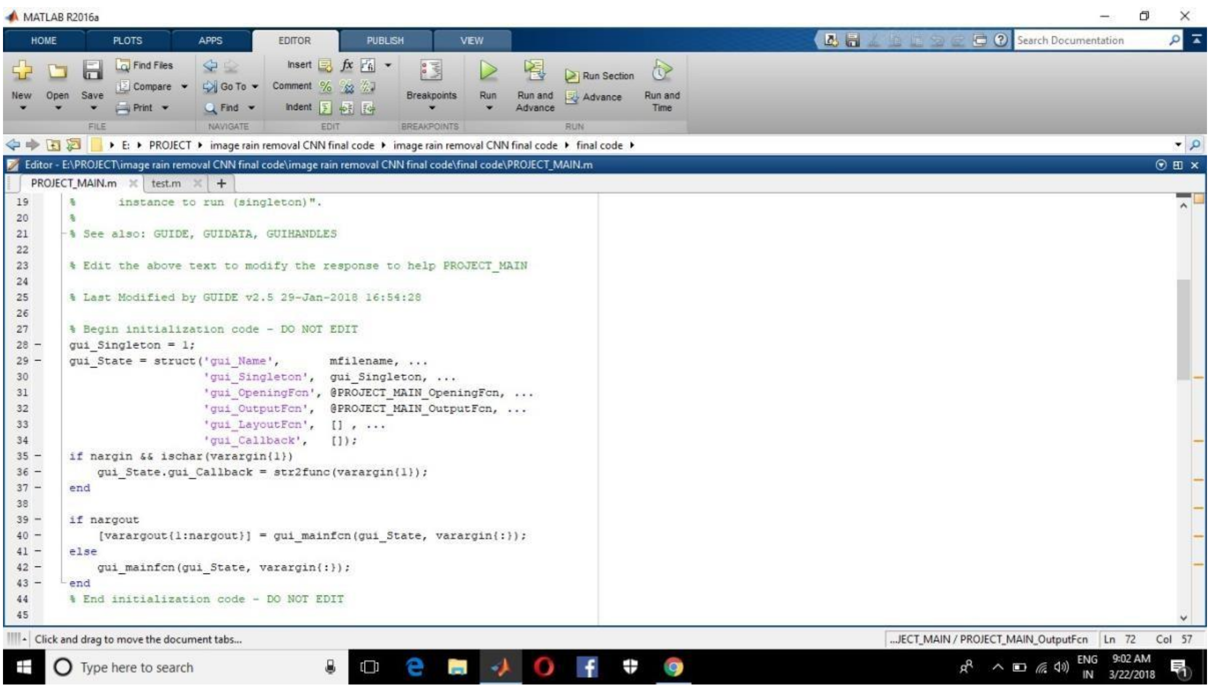


Fig-5.5 : Representation of MATLAB window

The command window is where the user types MATLAB commands and expressions at the prompt (>>) and where the output of those commands is displayed. MATLAB defines the workspace as the set of variables that the user creates in a work session. The workspace shows these variables and some information about them. Double clicking on a variable in the workspace browser launches the array editor, which can be used to obtain information and income instances edit certain properties of the variable.

The current directory tab above the workspace tab shows the contents of the current directory, whose path is shown in the current directory window. For example, in the windows operating system the path might be as follows C:\MATLAB\work, indicating that directory work is a subdirectory of the main directory MATLAB which is installed in drive. Clicking on the arrow in the current directory window shows a list of recently used paths. Clicking on the button to the right of the window allows the user to change the current directory.

MATLAB uses a search path to find M-Files and other related files, which are organize in directories in the computer file system. Any file run in MATLAB must reside in the current directory that is on search path. By default, the files supplied with MATLAB and math works toolboxes are included in the search path. The easiest ways to see which directories is soon the search path or add to modify as search path is to select set path from the file menu the desktop and then use the set path dialog box. It is good practice to add any commonly used directories to the search path to avoid repeatedly having the change the current directory.

The command history window contains a record of the commands a user has entered in the command window including both current and previous MATLAB sessions. Previously entered MATLAB commands can be selected and re-executed from the command history window by right clicking on a command or sequence of commands.

This action launches a menu from which to select various options in addition to executing the commands. This is useful to select various options in addition to executing the commands. This is a useful feature when experimenting with various commands in a work session.

5.5.2 Using MATLAB Editor to Create M-Files:

The MATLAB editor is both a text editor specialized for creating m-files and a graphical MATLAB debugger. The editor can appear in window by itself, or it can be a sub window in the desktop. M-files are denoted by the extension.m.

The MATLAB editor window has numerous pull-down menus for tasks such as savings, viewing and debugging files. Because it performs some simple checks and also uses color to differentiate various elements of code, this text editor is recommended as the tool of choice for writing and editing m-functions.

To open the editor type, edit at the prompt opens the m-file filename in an editor window is ready for editing. As noted, that the file must be in the current directory or in a directory in the search path.

5.5.3 Getting Help:

The principal way to get help online is to use the MATLAB help browser, opened as a separate window either by clicking on the questions mark symbol on the desktop toolbar or by typing help browser at the prompt in the command window.

The help browser is a web browser integrated into the MATLAB desktop that displays a hypertext markup language document. The help browser consists of two windows, the help navigator window, used to find information and the display window, used to view the information. Self-explanatory tabs other than navigator pane are used to perform a search.

CHAPTER 6

SIMULATION RESULTS

6.1:

SGTD- Structural Gradient And Textural Decomposition results:

For input image 1 :

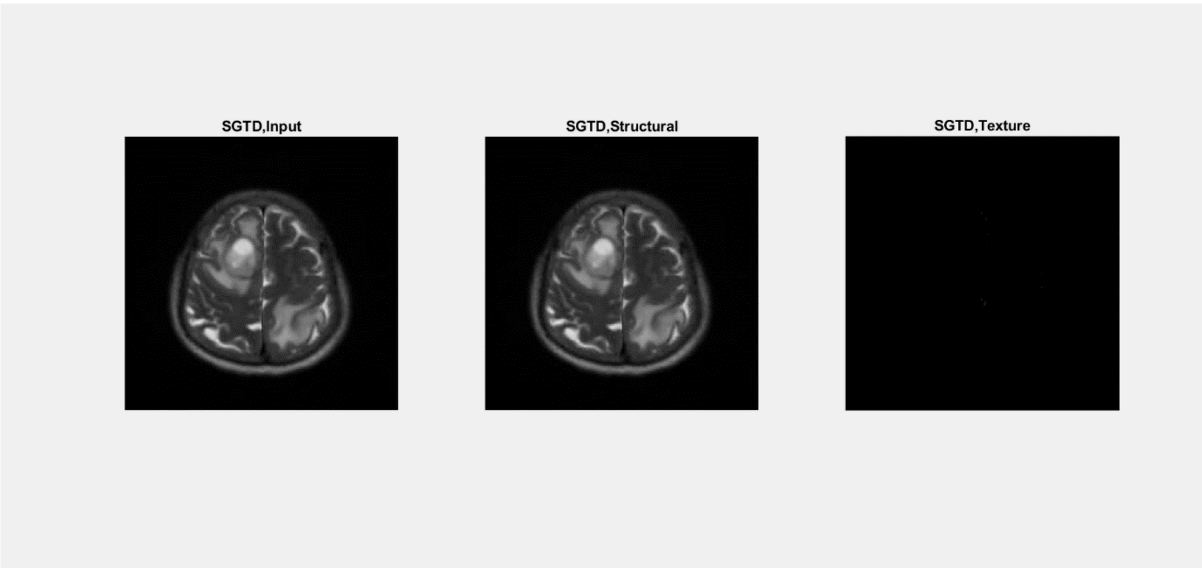


Fig 6.1: SDTD output for image 1

For input Image 2:

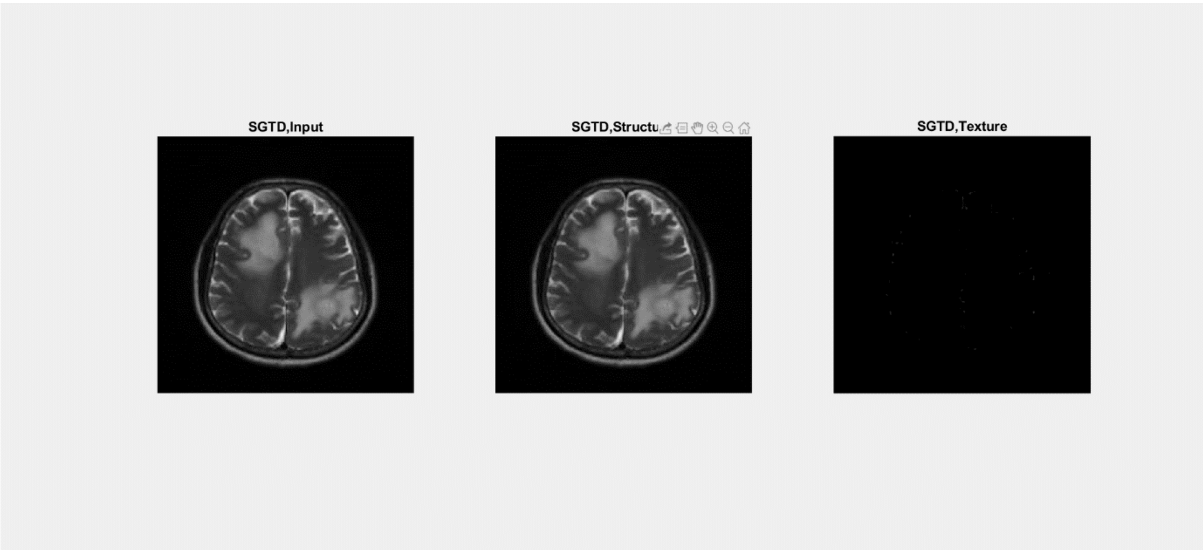
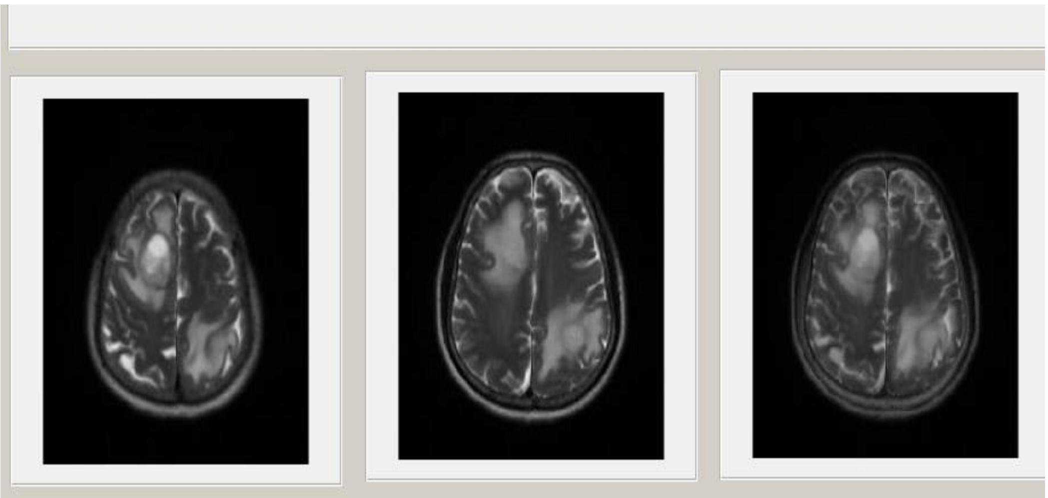


Fig 6.2: SGTD output for image 2.

6.2: Image Fusion result:



Input 1 **input 2** **fused image**

Fig 6.3: Fused Image Result.

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

7.1: CONCLUSON:

This article presents a medical image fusion in the SGTD domain. The proposed fusion scheme utilizes a feature-rich PCA -based structural layer fusion. Considering the visual characteristics of human vision, this method can handle the most sensitive and prominent features present in source images.

The proposed method presents a robust and better fusion performance than the several existing methods in terms of pixel contrast, enhanced feature details, fine edges, background, colour, noise suppression, and computational complexity. The proposed model is also able to maintain a complex representation of structural spectral details without any distortion and thus produces a better visual quality fused image.

7.2: FUTURE SCOPE:

Medical Image Fusion is a very crucial method followed in the medical field. For the purpose of Data saving and getting important only necessary information from the images, the medical image fusion plays a very important role.

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