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Role of Gabor Filter in Various Image Processing Techniques

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Abstract

Most of the destructive diseases like tumour, tonsillitis, etc. can be cured easily when detected at an early stage. Hence the accurate detection of these diseases becomes more important. For this, the usage of Gabor filters with reduced power consumption, less memory usage, high data transfer rate are discussed in this paper. Gabor filters have the optimal localization properties in both spatial and frequency domain and can be successfully used in a number of applications. An MRI scan is used as one of the extremely accurate methods for detecting the diseases throughout the body. This proposed paper illustrates the usage of Gabor filters in image processing techniques such as image segmentation, image enhancement, image compression, edge detection to improve the quality of the chosen MRI scan image. MRI scan is keen in presenting the accurate pictures of the body that are surrounded by bone tissue, so the technique becomes more suitable when treating the brain and spinal cord.

Keywords: Gabor filter, MRI Image, image segmentation, image enhancement, image compression, edge detection.

INTRODUCTION

MRI images are more suitable for examining the more crucial areas in the human body such as brain and spinal cord, it is also more important to maintain that those images should not be affected by noises. Hence filteringbecomesunavoidable to obtain the noise free MRI images. Gabor filter is a local and linear filter,it is more preferred than the other filters.The features that are obtained from the output image of the Gabor filter is used to provide the local spectrum relationship.

Gabor filter: A Gabor filter is a filter whose impulse response can be defined by a sinusoidal wave which can be a plane wave for the case of a two dimensional Gabor filter multiplied by a Gaussian function. TheGabor filter consists of the real and imaginary components to represent the orthogonal directions. Gabor filter gains much importance as it has the ability to approximate the visual cortex of the living beings.Fig.1shows the two dimensional view of the Gabor filter.

Image segmentation: Image segmentation is a process in which the output is the attributes extracted from the input images. Segmentation subdivides an image into its constituent regions or objects. The level to which the subdivision of the image can be carried out depends greatly on the image. One of the difficult task in image processing is the segmentation of the non-trivial images. Image segmentation strongly depends on the two properties of intensity values discontinuity and similarity. Image segmentation based on discontinuity deals with segmenting the image due to abrupt changes in the intensity level that is the edges in an image. Image segmentation based on similarity deals with segmenting the image into regions which are similar according to some predefined criteria. These include segmentation based on region growing, region merging, region splitting etc. For image segmentation, the Gabor filter uses the CORDIC algorithm which reduces the complexity and makes the system fast. The input image is given to the Gabor filter and the output segmented image is obtained in 2D array. Depending on the output of the image segmentation, it is possible to detect if the disease is present in the input image or not. The same image can be used to identify the stage of disease by identifying the intensity value of pixel in each segment. Fig.1.a shows the input MRI image which given as input to the Gabor filter.Fig.1.b shows the output segmented image obtained as output from the Gabor filter. The segmented output image from the Gabor filter provides more details about the input image.

Image compression: Image compression is a process used to reduce irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form. Image compression may be of two types as lossy and lossless compression. Lossless compression is more suitable for medical imaging applications. Lossy compression methods, produce compression artifacts when used at low bit rates. Hence lossy methods are only suitable for natural images such as photographs where minor loss of fidelity is acceptable. The Gabor filters have a non-zero mean they can be easily affected by DC components. Hence for compression process, log Gabor filters are used. Log Gabor filters do not have DC components, they yield a uniform coverage of the frequency domain.

The output compressed image will be a result of log Gaborfilter. LogGabor filters generally remove the colours which are not recognised by the human visual system. The output filtered image maintains the pixel

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energy and the compression level gets increased. LogGabor filter maintains the image quality by eliminating the redundancy in the image. Thus the filtered output image has increased compression ratio. The filtered output image occupies less memory space while comparing to that of the original image. This leads to the maximum degree of compression in the input image. For this process, the input image has to be read and the input parameters have to be provided. The input parameters such as frequency, orientation has to be analysed. The Gabor filter matrix for the selected frequency has to be calculated. The Gabor filter matrix has to be sided over our input image. Now the JPEG compression has to be applied to the filtered output image. To verify the results, the output filtered image compression ration can be compared to that of the original input image. From this it is clearly understood that the use of log Gabor filter before the compression techniques increases the compression ratio. Also in addition to retaining the quality of the image, high compression ratio is also achieved.Fig.2.a shows the input MRI image given as input to the Gabor filter.Fig.2.b shows the compressed output MRI image obtained from the Gabor filter. It is clear from the output of the Gabor filter that the compressed output image yields high compression ratio while comparing to that of the input image.

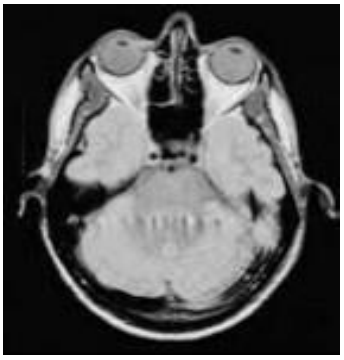

Fig.1.a:Input MRI image

Fig.1.b: Segmented MRI output image

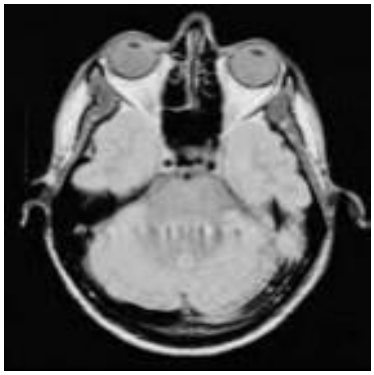

Fig.2.a:Input MRI image

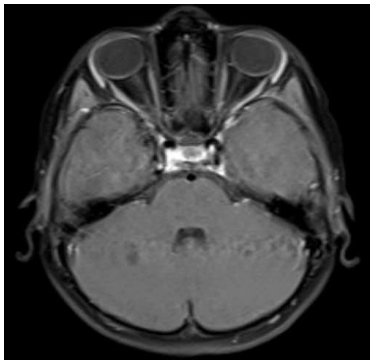

Fig.2.b: Compressed MRI output image

Edge detection: Edge detection is defined as a set of mathematical methods which aim at identifying points in a digital image at which there will be a sharp change in the brightness of the image. The points at which image brightness changes sharply are called as edges. In the areas like feature extraction and feature detection, Edge detection technique acts as a fundamental tool. The need for capturing the sharp changes in the image brightness is to identify the important changes in properties of the image. It should be noted that the discontinuities in image brightness corresponds to the discontinuities in depth, discontinuities in surface orientation of the image. The boundary effect of the Gabor filters can be analysed using the edge detection technique. For this analysis it is fed the input image to the Gabor filter multichannel system. This analysis does not need a post processing method. In order to understand the effects of the Gabor filter in detail, the same input image can be filtered using a low pass filter and the resultant output images can be compared. It is obvious that the Gabor filters can successfully capture the variations along the edges of the image. The reason behind the success of Gabor filters is that they only go for the high frequency

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information from the input images so that the edges gets maximized and different objects can be easily separated. The Gabor filter works by differentiating the image and its background to two different intensity levels and then highlight the border of the image. While comparing the edge detected output image of the Gabor filter with that of the other filters, the output images of the Gabor filters will be more accurate since they successfully capture even the weak borders of the images also. Gabor filters are more capable of optimizing the differences along the edges of the images, they also become a suitable tool for image segmentation. The Gabor filters are also efficient in eliminating the noisy signal while maintaining the originality of the input MRI image. The Gabor multichannel filtering system is more efficient in providing immune to the noise signals. The reason for this is that the Gabor filters multichannel system selects only the essentially needed signals from the input image and eliminates the other noisy signals.Fig.4.a shows the input MRI image given to the Gabor filter.Fig.4.b shows the output edge detected MRI image obtained from the Gabor filter.

Image enhancement: The principal objective of image enhancement is to process a given image so that the output image is more usable than the original input image for a specific application such as blur reduction, image sharpening, etc. Image enhancement sharpens the image characteristics. The enhancement technique only increases the dynamic range of the chosen characteristics so that they can be identified easily. Image enhancement is the improvement of input image quality without prior knowledge about the source of degradation in the image. Many different techniques are used to improve the quality of the image. But the problem with these techniques is that there is no objective measure for the quality of the images. Hence, all these techniques used to improve the image quality are purely image oriented. The parameters such as correlation coefficient, signal to noise ratio and similarities in structures are used to verify the output image quality after enhancement process using Gabor filter. The input MRI image is given to the Gabor filter and the Gabor filtered output image is obtained.

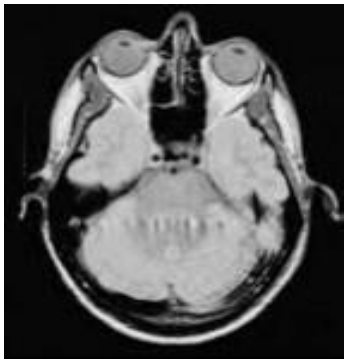

Fig.3.a: Input MRI image

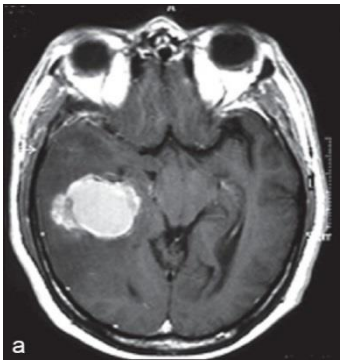

Fig.3.b: Enhanced MRI output image

It is clearly proved from the Gabor filtered output MRI image that the input image's noise can be significantly reduced by using the Gabor filter.Fig.3.a:shows the input MRI image given as input to the Gabor filter.Fig.3.b:shows the enhanced output MRI image of the Gabor filter.Fig.4 shows the compression ratios of the input MRI image and the gabor filtered output MRI image.

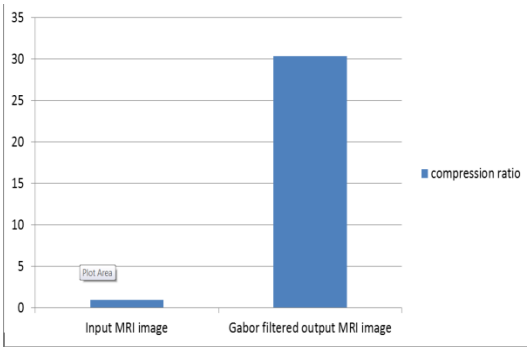

Fig.4.Comparison of compression ratio for the input MRI image andgabor filtered output MRI image.

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The following table states the advantages of using the Gabor filter for various image processing techniques.

Image Segmentation	The advantage of the Gabor filter is that Gabor filters uses the CORDIC algorithm which reduces the complexity and makes the system fast.
Image Compression	Gabor filter produces the maximum degree of compression in the input image.
Edge detection	Gabor filters are more successful in capturing the variations along the edges of the image
Image Enhancement	The input image noise can be significantly reduced by using the Gabor filter.

CONCLUSION

The applications of Gabor filters are increasing at an alarming rate.Theimportance of using Gabor filter for various image processing techniques on the MRI image is illustrated in this paper.This paper clearly states that the Gabor filters produce best filtered output results than the other low pass filters.

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