MEDICAL IMAGE ENHANCEMENT BASED ON AN EFFICIENT APPROACH FOR ADAPTIVE ANISOTROPIC DIFFUSION

Shokhan Mahmoud Hama[1] and Muzhir Shaban Al-Ani[2]
University of Al-Anbar, Collage of Computer, Anbar, Iraq

ABSTRACT

Digital Medical images are often affected by unwanted noise, blurriness and suffer from lack of contrast and sharpness which sometimes results in false diagnosis. Main target of this paper is to process a medical image so that the result is more suitable than the original image for a medical diagnosis. This is achieved by applying an efficient approach for an adaptive anisotropic diffusion algorithm. In this paper a color images and medical images are enhanced using a new edge –stopping function for an efficient adaptive anisotropic diffusion algorithm to improve the performance of the an efficient adaptive anisotropic diffusion filter. Experimental results show that the anisotropic diffusion filter with the new function can effectively remove noise from a medical images with minimum edge blurring. Our paper emphasis on eliminating these problems there by makes the diagnosis disease easy.

KEYWORDS: *anisotropic diffusion, medical imaging, medical image enhancement.*

I. INTRODUCTION

With the rapid increase in the usage and applications of medical images, it has become a necessity to develop tools and algorithms for medical image processing. Improvement of the quality of images has always been one of the central tasks of medical image processing. In modern terms, improvements in sensitivity, resolution and noise reduction have equated higher quality with greater informational throughput. Medical Image noise is an unwanted feature, which is either contained in the relevant light signal or is added by the medical imaging process and it compromises a precise evaluation of the light signal distribution, which should be measured.

Medical image processing has traditionally dealt with problems like image enhancement in cases where the data can be expressed as a single- or vector valued image function defined on an *n*-dimensional image domain. Anisotropic diffusion filtering is widely used for medical image enhancement. However, the anisotropic filter is non-optimal for medical images with spatially varying noise levels, such as images reconstructed from sensitivity-encoded data and intensity inhomogeneity-corrected images. Many semantic interpretations of these image functions rely on the enhancement of geometric features such as edges, corners and ridges. Determining at which scale of resolution these medical image features should be measured has emerged as a fundamental problem especially in cases where the image is affected by noise or any type of spurious artifacts that introduce unwanted variations of the image intensity. In this paper we briefly review proposed a new adaptive anisotropic diffusion filtering for generating images at different scales of resolution and explain how this schemes can be modified to achieve a more meaningful feature enhancement image.

II. LITERATURE REVIEW

The field of medical image enhancement is an important aspect of medical image processing, because of their huge applications in many areas of our live special in the medical diseases diagnosis. Many articles and Literature Review are published in this field and we will explain some of these works.

Nir A. Sochen et al. (2000) The Beltrami diffusion-type process, reformulated for the purpose of image processing, is generalized to an adaptive forward-and backward process and applied in localized image features' enhancement and denoising. Images are considered as manifolds, embedded in higher dimensional feature-spaces that incorporate image attributes and features such as edges, color, texture, orientation and convexity. To control and stabilize the process, a nonlinear structure tensor is incorporated. The structure tensor is locally adjusted according to a gradient-type measure. Whereas for smooth areas it assumes positive values, and thus the diffusion is forward, for edges (large gradients) it becomes negative and the diffusion switches to a backward (inverse) process. The resultant combined forward-and-backward process accomplishes both local denoising and feature enhancement [1].

Bogdan smolka et al. (2002) in this paper a novel approach to the problem of edge preserving smoothing is proposed and evaluated. The new algorithm is based on the combined forward and backward anisotropic diffusion with incorporated time dependent cooling process. This method is able to efficiently remove image noise, while preserving and enhancing its edge [2].

Alexei A. Samsonov et al. (2004) in this work, a new method for filtering MR images with spatially varying noise levels is presented. In the new method, a priori information regarding the image noise level spatial distribution is utilized for the local adjustment of the anisotropic diffusion filter. Our new method was validated and compared with the standard filter on simulated and real MRI data. The noise-adaptive method was demonstrated to outperform the standard anisotropic diffusion filter in both image error reduction and image signal-to-noise ratio (SNR) improvement. The method was also applied to inhomogeneity corrected and sensitivity encoding (SENSE) images. The new filter was shown to improve segmentation of MR brain images with spatially varying noise levels [3].

Julio Martin-Herrero et al. (2007) this paper reviews recent advances in anisotropic diffusion for multivalued images, analyzes their application to hyperspectral images, and proposes a new diffusion method which takes advantage of the recent improvements and conforms to the specificities of hyperspectral remote sensing. Some examples are provided using both a noisy image and a clean image with added noise [4].

LI Yueqin et al. (2008) this paper provides a new speckle reduction and image enhancement anisotropic diffusion method based on wavelet technology. An anisotropic diffusion model has been established based on wavelet transform. We analyze the characteristic of the model and discuss the model's mechanism of action for removing speckle and enhance image edge of the underwater ultrasonic image. A compare experiment for real underwater ultrasonic image has been done using the method and other traditional methods. The experimental result indicates that the method proposed have strong speckle reduction and enhancement image ability [5].

Ovidiu Ghita et al. (2010) this paper is concerned with the introduction of a new gradient vector flow (GVF) field formulation that shows increased robustness in the presence of mixed noise and with its evaluation when included in the development of image enhancement algorithms. In this regard, the main contribution associated with this work resides in the development of an adaptive image enhancement framework that couples the anisotropic diffusion models with the adaptive median filtering that is designed for the restoration of digital images corrupted with mixed noise. To further illustrate the advantages associated with the proposed GVF field formulation, additional experiments are conducted when the proposed strategy is applied in the construction of anisotropic models for texture enhancement [6].

Umamaheswari et al. (2012) presented hybrid method to improve the image quality of Digital Imaging and Communications in Medicine (DICOM) images. The idea of image enhancement technique is to improve the quality of an image for early diagnosis. Then followed by a noise reduction using speckle reduction anisotropic filter. This suggests the use of contrast enhancement methods as an attempt to modify the intensity distribution of the image and to reduce the multiplicative noise. The performance of the proposed study is compared with the existing traditional algorithm and real time medical diagnosis image [7].

Yuanfeng Jin el at. (2012) this paper concerns about the applications of the Partial differential equation (PDE) in image restoration and image enhancement. We mainly assay traditional methods of image analysis, study applications of the variational method and diffusion equations in image restoration, as well as their improved algorithm for image enhancement [8].

S.M. Chao et al. (2012) presented a modified method that considers also the variance of the brightness levels in a local neighborhood around each pixel was presented. However, the problem of the

automatic estimation of the crucial parameters was not addressed [9]. A modified diffusion scheme, suitable for images with low-contrast and uneven illumination, was described in [10].
Qasima Abbas Kazmi et al. (2013) The given Approach is to generalize the diffusion process further into forward-and-backward process. Further the Forward - and Backward diffusion process could again be used in Enhancement of the resolution of the given image. A single image is being used for enhancement of resolution of that image by using interpolation and a forward-and-backward nonlinear diffusion post-processing provides suppression of ringing. Process is found to be very productive in distinguishing those medical images which gives similar images for two or more dangerous diseases. The process respects the boundaries between the edges [11].

III. THE PROPOSED AN EFFICIENT APPROACH FOR ADAPTIVE ANISOTROPIC DIFFUSION ALGORITHM

Anisotropic diffusion filtering schemes based on nonlinear diffusion, developed for image enhancement. Since first proposed by Perona and Malik in 1990 [12], anisotropic diffusion has been developed and applied to different areas of image processing. To avoid blurring at the edges, instead of using the constant diffusion coefficients based on the original linear anisotropic diffusion, an edge stopping function was proposed to estimate the diffusion coefficients, which ensures the diffusion process taking place mainly inside of the regions rather than at their boundaries and thus the smoothing happens only in the interior of regions without crossing the edges.
The main target of an efficient adaptive anistropic diffusion algorithms in medical image processing is to remove noise via exponential diffusion function based on proposed a new edge –stopping function as shown in the figure (1), In the method, an anisotropic coefficient k_{mp} is used to stop the diffusion over the edges of the image, it is called "new edge-stopping function". The efficient adaptive Anisotropic Diffusion Algorithm is:

<u>Algorithm: a new adaptive Anisotropic Diffusion</u>

For each pixel m

Find $k_{mp} = \sqrt{2} * \sqrt{\sigma_m{}^2 + \sigma_p{}^2}$

$\Delta t = exp(\frac{1}{0.9 * K^2} * (1 - s^2))$

$P \in \{I, n, i, j\}$

End

$I^{(0)}$ = *Noisy Image .*

For $t = 0$ *to Number of Alterations -1*

For each pixel m

Calculate $G_{mp}{}^{(t)} = I_p{}^{(t)} - I_m{}^{(t)}$

Calculate $D_{mp}{}^{(t)} = g(G_{mp}{}^{(t)}\ k_{mp})$

Create new estimate of pixel m:-

$I_m{}^{(t+1)} = I_m{}^{(t)} + \Delta t * \sum_{p \in \{I,n,i,j\}} G_{mp}{}^{(t)} * D_{mp}{}^{(t)}$

end

end

As we are interested in enhancing a noise image, we want to find values for k over the boundaries of every neighboring pixel that, after the application of the evolution equation, preserve image boundaries and eliminate as much noise as possible, therefore, in our case $k = k(\Delta t)$. With this in mind, an alternative considering only two possible values of k was studied, so $k, s \in \{0, 1\}$. Figure (1) below illustrates the main steps of the proposed an efficient approach for adaptive anisotropic diffusion for enhancing medical image.

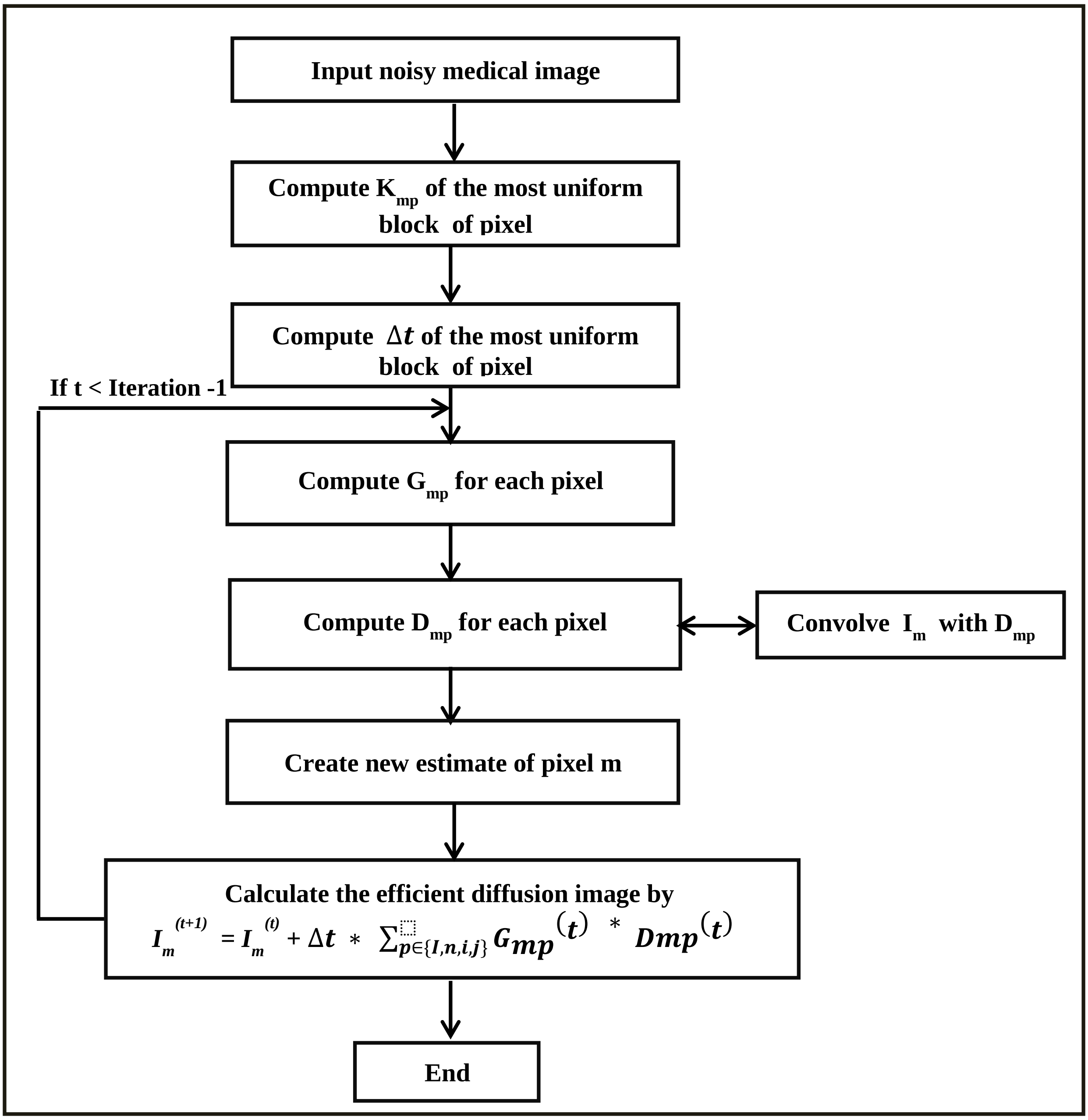
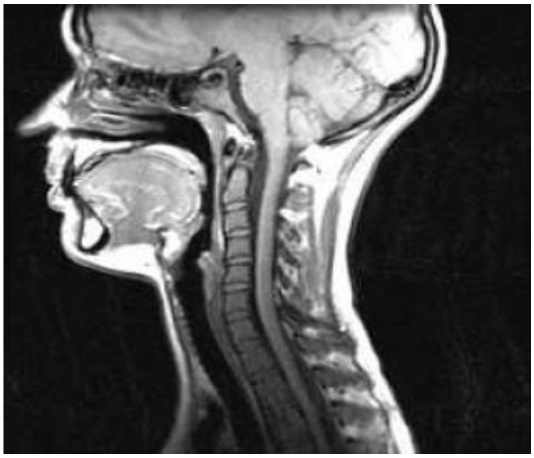
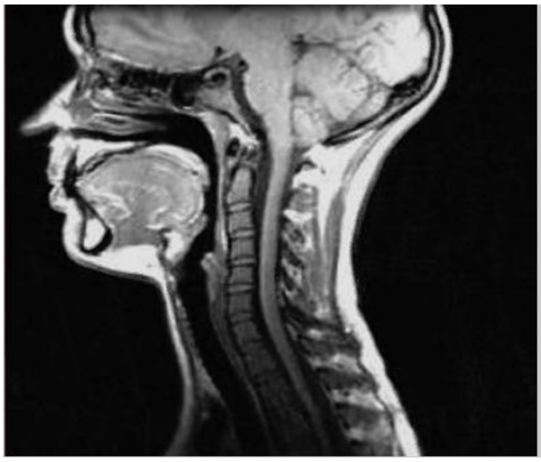


Figure (1) Block diagram of the efficient approach for adaptive anisotropic diffusion algorithm

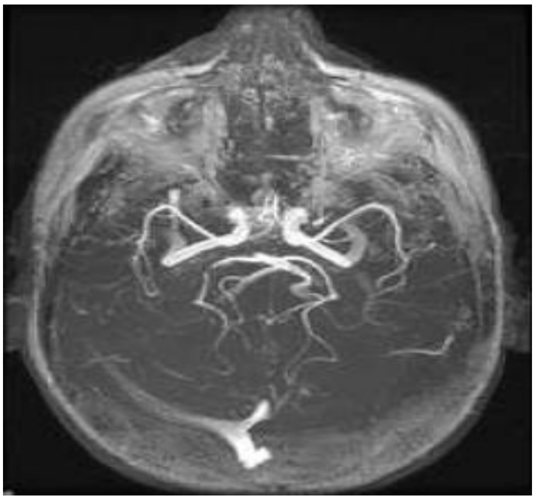
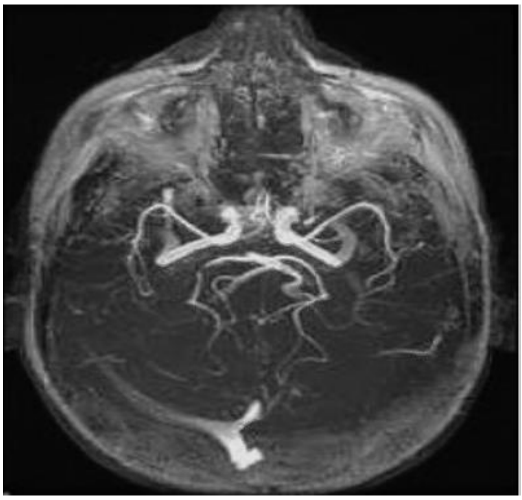
IV. THE EXPERIMENTAL RESULT

The aim of medical image enhancement is to eliminate as much sharpness and noise as possible but preserving image characteristics. The exponential diffusion function can be used as an indicator function to determine where the diffusion has to be stopped so as to prevent the lose of edges in the presence of diffusion. As diffusion in all the directions will produce a considerable lose of information and edges definition, we want to find the places of the image that should present no diffusivity so as to preserve this details. In this case the tests correspond to the MRI, angiography and Lena images as shown in the figure (2). After the processing the noise in both images is considerably reduced yet preserving the image boundaries.

Original image **After applied our a proposed approach**

(a) Neck MRI (256x256)

Original image **After applied our a proposed approach**

(b) Angiography (256x256)


Original image **After applied our a proposed approach**

(c) Lena (256x256)

Figure (2) Test images used with the algorithm. All the images are 256 level Grayscale

V. CONCLUSION

In this paper, a medical image was enhanced by denoising it using a new adaptive anisotropic diffusion filter. The behavior of the new adaptive anisotropic diffusion depends heavily on the choice of the "new edge-stopping function". The function is a nonnegative monotonically decreasing function, which should result in low coefficient values at image edges that have large gradients, and high coefficient values within image regions that have low gradients. The experiments revealed that better results of noise reduction using the new edge-stopping function were achieved with much smoother in the flat areas and sharper in the edgy regions after a small number of iterations. Therefore the behavior of the proposed function is the best. The main advantages of this filter with new function is that it will work for most types of noise (besides additive Gaussian noise, it also gave good results on multiplicative speckle noise and Poisson noise), also it gives significant improvement of image denoising, edge enhancement with little number of iterations over previous schemes.

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AUTHORS

Muzhir Shaban Al-Ani has received Ph.D. in Computer & Communication Engineering Technology, ETSII, Valladolid University, Spain, 1994. Assistant of Dean at Al-Anbar Technical Institute (1985). Head of Electrical Department at Al-Anbar Technical Institute, Iraq (1985-1988), Head of Computer and Software Engineering Department at Al-Mustansyria University, Iraq (1997-2001), Dean of Computer Science (CS) & Information System (IS) faculty at University of Technology, Iraq (2001-2003). He joined in 15 September 2003 Electrical and Computer Engineering Department, College of Engineering, Applied Science University, Amman, Jordan, as Associated Professor. He joined in 15 September 2005 Management Information

System Department, Amman Arab University, Amman, Jordan, as Associated Professor, then he joined computer science department in 15 September 2008 at the same university. He joined in 15 September 2009 Computer Sciences Department, Al-Anbar University, Anbar, Iraq, as Professor.

Shokhan Mahmoud Hama has received B.Sc in Computer Science, Al-Anbar University, Iraq. M.Sc student (2011- tell now) in Computer Science Department, Al-Anabar University. Fields of interest: 3D visualization , medical image processing and related fields. Shokhan taught many subjects such as Information Retrieval, computer vision, image processing.