Spinal Cord Image Processing Using Enhanced Multi-Scale Retinex Algorithm

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Abstract

This paper proposes a development of novel enhanced multiscale retinex algorithm for medical image enhancement in light of multi-rate testing. The proposed work embraces HSV color space, since HSV color space separates color from power. The enhancement of medical image is accomplished by down testing the original image into five forms, in particular, minuscule, little, medium, fine, and typical scale. Further, the contrast stretching and multiscale retinex (MSR) techniques are taken advantage of to improve the scaled forms of the image. At last, the image is reconstructed by joining every one of these scales in a efficient manner to get the composite enhanced image. The efficiency of the proposed algorithm is approved by directing various experiments on spinal cord images. Reconstructed image utilizing proposed technique features the subtleties (edges and tissues), decreases image noise (Gaussian and Speckle) and works on the general difference. The proposed algorithm likewise improves sharp edges of the tissue encompassing the spinal cord regions which is valuable for diagnosis of spinal cord lesions.

Keywords: *Medical Image Enhancement, Spinal Cord, Magnetic resonance imaging, spinal cord injury*.

1. INTRODUCTION

With medical imaging engineering and computer technology proceeds to development, there have been many high level imaging equipment, which gives an assortment of clinical diagnostic modality medical images. Different medical images give information connected with various organs, these images reflect on human organs and lesions of various information and for instance: CT image has serious areas of strength for a goal and math, the bone image is extremely clear, it can give a decent reference to injury confinement, be that as it may, the difference of delicate tissue is somewhat low; MR images can plainly reflect the delicate tissues, organs, blood vessels and other physical structures, the image can be utilized to decide the scope of the sore, yet its image are not touchy deep down tissue and the calcification .The images of MR can't no reflect the information of human tissue, and they can be susceptible to magnetic interference geometric which distortion happens.

Medical imaging techniques, like MRI and CT, are a vital piece of regular medical practices. They give a detailed metabolic and anatomical depiction of organs empowering diagnostics and prescription preparation. Be that as it may, foundations for misshapenness in the resultant scans are complex. For instance, movement artifacts bring about worldwide distortions in MRI. Moreover, nearby twists are normal peculiarities because of multiple reasons like selective reconstruction of data, restricted fields of view or the superposition of unfamiliar bodies. Obviously, the information held inside the privately mutilated locales is lost from a diagnostic perspective. In any case, auto-finish of medical images by means of in painting would empower the usage of ruined scans in post-handling undertakings. For this reason, just the worldwide image properties are of interest rather than the point by point diagnostic information. For instance, fulfillment of restricted twists in MR scans because of metallic implants would empower thorough portion calculation in radiotherapy arranging as well as more accurate division and volume-calculation of organs. One more model is PET weakening correction in PET/MRI. For this situation, auto finished MR scans can be used to ascertain the constriction coefficients as opposed to for diagnostic purposes.

Water in white matter axons of the spinal cord has specific diffusion properties. To be sure, Brownian movement actuated water diffusion is restricted to the plane perpendicular to axon bundles. Along these lines, diffusion magnetic resonance imaging (dMRI) can be used to check this anisotropy. The essential idea of dMRI is to get a few volumes, every one of them weighting the diffusion along a given space unit vector. Handling this dataset depends on fitting a tensor model to give admittance to diffusion quantification at each voxel through different metrics, like the fractional anisotropy (FA). Utilizing this tensor guide, one can then perform tractography, or connect each voxel with neighbors having a comparative greatest diffusion direction, to give a portrayal of axonal bundles. Consequently, dMRI is a painless device which can be utilized to survey axonal disturbance with the expectation of assessing changes that might happen after some time, for instance, axonal versatility following spinal cord injury.

Spinal cord injury (SCI) is supposed to achieve morphological changes in the spinal cord both at the injury site and all through the cord. At the injury site, cell death and the ensuing local inflammatory reaction diminishes the cell populace and effectively brings about dramatic shrinkage of the cord in rodent models of SCI. In humans, the morphological changes in the spinal cord following SCI are less very much portrayed. Since morphological depictions of the spinal cord following SCI might be helpful for predicting motor function and would give significant information to the possible surgical mediations pointed toward fixing the cord, we tried to recognize the morphology of the injury site in SCI utilizing magnetic resonance imaging (MRI) and a three-dimensional segmentation strategy.

2. Literature Survey

1. Alizadeh et.al proposed Segmentation of spinal cord in the pediatric spinal Diffusion Tensor MR Imaging. Classification and segmentation of little structures, for example, spinal cord is incredibly difficult. In this paper, a multi stage segmentation algorithm is proposed and attempted to precisely and dependably section the spinal canal and spinal cord from the establishment in the pediatric

spinal Diffusion Tensor MR images. In the first place, middle channel and image pressure techniques were applied to relieve the amplitude of the noise and work on the homogeneity of the image. Then, mathematical morphological handling was applied to segment and name the regions credited to the spinal canal. These segmented regions were requested into the spinal canal and establishment using a Euclidean metric got by Centroid directions of segmented regions in the volumetric DTI data. In the beyond quite a long while, Diffusion Tensor Imaging (DTI) has been created as an effective functional imaging strategy for painless, in-vivo assessment of the spinal cord. Notwithstanding, DTI of the spinal cord is restricted by different factors, for example, lower SNR as a result of the size of the cord, ghost artifacts caused by CSF pulsation and blood flow, image obscuring caused by respiratory and cardiac movement and susceptibility artifacts caused by various tissue interfaces like bone, soft tissue, or fluid. In pediatric imaging, motion artifacts can be more prevailing than different sorts of artifacts. The proposed technique was effective in segmenting the spinal cord in DTI b0 images. Complete approval analysis was applied to consider the presentation of the proposed segmentation algorithm in contrast to manual segmentation results delivered by an independent board confirmed neuroradiologist.

2. T. Y. Chan et.al proposed Identify myelopathic cervical spinal cord using diffusion tensor image: A data-driven approach. Fractional anisotropy (FA) from DTI is normally used to analyze the degree of cervical spondylotic myelopathy (CSM). In any case, the exclusively utilization of FA esteem doesn't think about a full information of 3D multiple lists of diffusion from DTI. This review proposed to utilize a classification in light of machine learning to extract and decide the myelopathic cord in CSM. A classification in light of support tensor machine (STM) was applied on eigenvalues extracted from DTI at compressive levels of the cervical spinal cord. As the most well-known sort of degenerative and congenital spinal cord disorders, CSM has been outraged a ton of patients. The normal agreement of the treatment selection is the surgical decompression assuming the patient showed moderate to extreme functional impairment and matched images. The level determination is vital for make the most proper surgical plan. Be that as it may, determination is troublesome on the grounds that the side effects are conflicting, and there are no way gnomonic findings. Myelopathy in the cervical spinal cord is an extremely mind boggling problem. The way physiology of CSM stays hazy yet is known to incorporate static factors, dynamic factors, and ischemia. Anatomical compression of the spinal cord in CSM might be pictured utilizing traditional MRI. This mechanical compression might cause ischemia of spinal cord tissue, prompting apoptosis of neural cells and demyelization of axons.

3. S. Setty et.al proposed Details enhancement of MRI image using illumination and reflectance estimation. This paper presents new subtleties enhancement of Magnetic Resonance Imaging (MRI) image utilizing illumination reflectance estimation. The illumination is assessed utilizing cost parameter connected with the luminance function. The assessed illumination is piecewise spatially smoothed that disposes of the halo artifacts in the MRI images. The illumination dynamic correction and subtleties improvement are accomplished through edge protecting low pass filter. The proposed technique is changed to such an extent that the difference of the spinal cord images is improved and helps the radiologists

in settling on correct choices. The inside parts and assignments of the organs of the body are generally undetectable to the humans. Nonetheless, with the utilization of technology human parts can be pictured with actual structure and subtleties. These images might be taken on by different medical experts to analyze abnormal circumstances. Among different diseases, cancer likewise called as neoplasm is an illness where abnormal cells partition without control and can go after neighboring tissues with the assistance of blood and lymph frameworks. This paper presents the adaptive Retinex strategy to upgrade the spinal cord images in light of illumination and reflectance estimation. The illumination estimation is achieved by embedding the expense function into the luminance. Assessed illumination is piecewise spatially smooth to dispense with the halo artifacts of the Retinex algorithm.

4. W. Yang et al proposed Predicting CT Image from MRI Data through Feature Matching with Learned Nonlinear Local Descriptors. Attenuation correction t for PET/MR hybrid imaging systems and portion anticipating MR-based radiation treatment stay testing due to lacking high-energy photon lessening information. The nonlinear local descriptors are gained by extending the direct descriptors into the nonlinear high-dimensional space using an unequivocal component guide and low-rank estimate with managed complex regularization. Magnetic resonance imaging (MRI) is alluring for both the attenuation correction (AC) in positron emission tomography (PET) and the dose calculation in current radiotherapy (RT) treatment planning, attributable to its non-ionizing radiation and superior soft tissue characterization. Customarily, the AC guides can be gotten by converting the computed tomography (CT) images to attenuation in cm-1 at 511keV. The electron densities got from these CT images can likewise be utilized for dose calculations in a MR-based RT workflow. In any case, particularly in PET/MRI studies, extra CT scans are not helpful to diminish the radiation dose to patients. In this review, we propose an element coordinating technique with gained local descriptors for predicting CT from MR image data. These descriptors are upgraded by embracing a better SDL algorithm.

3. Proposed Methodology

This section presents the proposed design methodology for the spinal cord medical image enhancement. Input image of goal 256 × 256 pixels read from RGB color space is converted into Hue-Saturation-Value (HSV) color space since HSV space separates color from intensity. The value channel of HSV is scaled into five variants specifically; tiny scope (16 × 16 pixels), limited scope (32 × 32 pixels), medium scale (64×64 pixels), fine scale (128×128 pixels) and normal scale (256×256 pixels) to accelerate the MSR based image enhancement process. The hue and saturation are safeguarded to keep away from distortion. Each of these scaled image forms might have a random pixel range. Consequently, contrast extending activity is accomplished for each of the scaled renditions of the value direct to decipher the pixels in the showcase range of 0 to 255.

Enhanced Multi-Scale Retinex Algorithm

Various image enhancement algorithms introduced before are utilized by numerous researchers. Anyway, the most notable one is the MSR image improvement algorithm since this plan offers better image enhancement diverged from various methods. Accordingly, in this work MSR technique has been adjusted all together achieve spinal cord medical image enhancement. The Gaussian surrounds function has been utilized in the proposed work for each scaled variant of the value channel. The size of Gaussian function utilized is 16 × 16 for the tiny version, 32 × 32 for the little version, 64 × 64 for the medium version, 128×128 for the fine version and 256×256 for the normal version of the value channel respectively. The overall articulation for the Gaussian surround function is given by Eqn. (1)

$$G_n(x, y) = K_n \times e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (1)$$

And K_n is given by the Equation (2)

$$K_n = \frac{1}{\sum_{i=1}^{M}\sum_{j=1}^{N} e^{-\frac{x^2+y^2}{2\sigma^2}}} \quad (2)$$

Where x and y imply the spatial coordinates, M × N addresses the image size, n is liked as 1, 2 and 3 since the three Gaussian scales are utilized for each down examined versions of the image. Then, to accomplish medical image enhancement the SSR algorithm is followed by MSR techniques. The Single Scale Retinex (SSR) for the value channel is given by Eqn. (3)

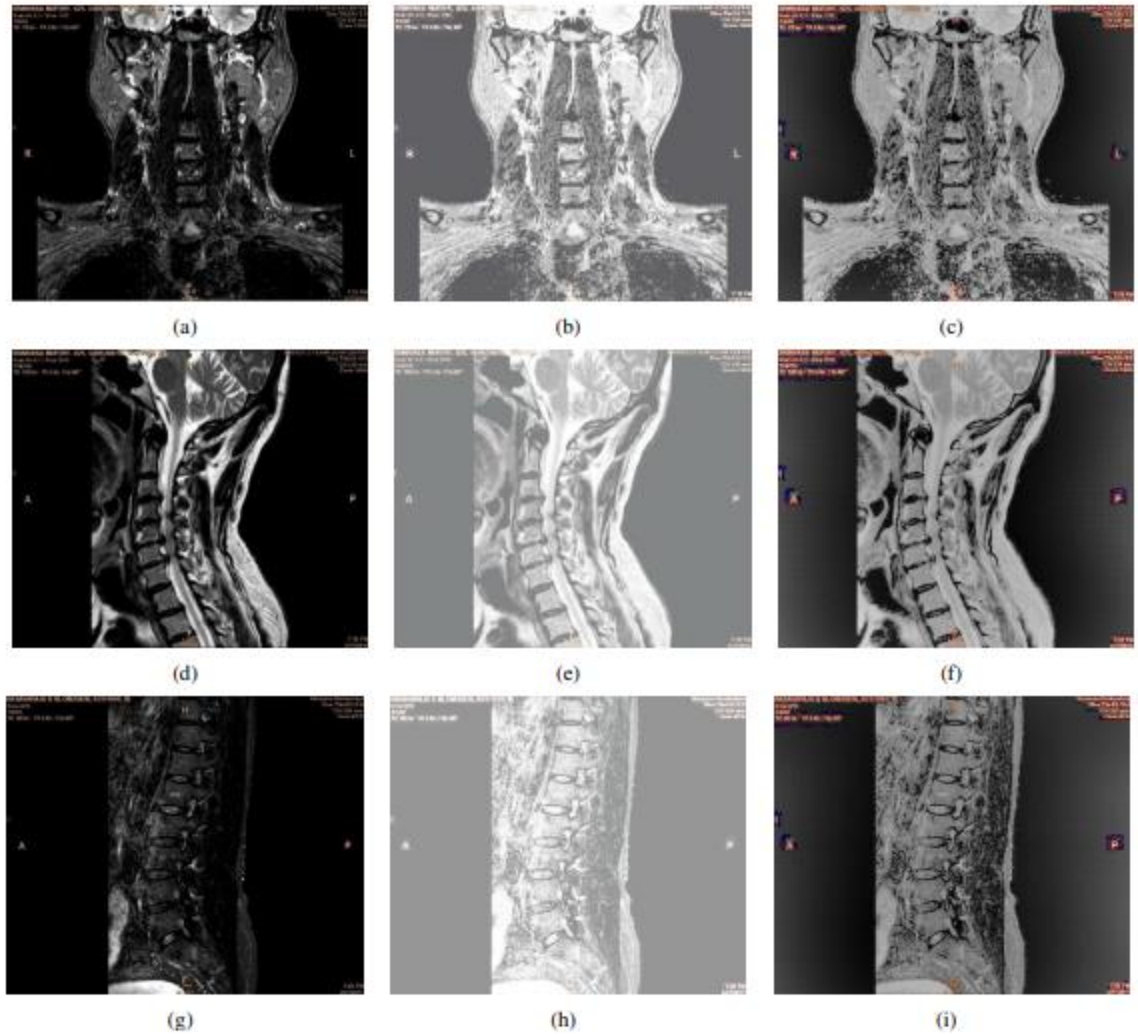
$$R_{SSRni}(x, y) = \log_2[V_i(x, y)] - \log_2[G_n(x, y) \otimes V_i(x, y)] \quad (3)$$

Where $R_{SSRi}(x, y)$ shows SSR output, $V_i(x, y)$ addresses value channel of HSV, $G_n(x, y)$ demonstrated Gaussian Surround function, ⊗ means convolution operation. The Multi-Scale Retinex (MSR) procedure on a 2-D image is finished by using Eqn. (4)

$$R_{MSRi}(x, y) = \sum_{n=1}^{N} W_n \times R_{SSRni}(x, y) \quad (4)$$

Where $R_{SSRi}(x, y)$ shows MSR output, Wn is a weighting factor which is expected to be as 1 3 and N demonstrates number of scales. The medical image enhancement is achieved by applying the MSR algorithm for each down examined versions ensuing to SSR operation. The new value channel is reconstructed from the individual enhanced images by consolidating tiny, small, medium, fine and normal versions of the image in a proficient manner. The MSR enhanced image of tiny version with resolution of 16×16 pixels is up examined by two to coordinate with the resolution of 32×32 pixels of the small variant. Nonetheless, the up testing and reconstruction tasks adjusted by Chao et al. technique present zeros between alternative pixels. Although an image enhanced by this scheme is satisfactory, it has actually brought about appearance of dots in the enhanced image and subsequently affects overall image quality. The current work defeats this trouble in a capable manner. The new small scale version of the image is acquired as follows. The pixel of the small scale variant is retained for the zeros experienced in the up tested tiny version of the image. Assuming there are no zeros in the up examined tiny version image than the pixel normal is computed between up tested tiny form and small version. This is illustrated by the detailed flow chart introduced in Fig. 3(a) the new medium scale, fine and normal scale versions of the image is gotten likewise as that for the small scale rendition and is displayed in Figs. 3(b), (c) and (d) respectively. Finally, the composite enhanced image is reconstructed by joining new value channel with that of hue and saturation channels and converting back into RGB color space.

Figure 3.A Two Dimensional Axial Views of Spinal Cord Images



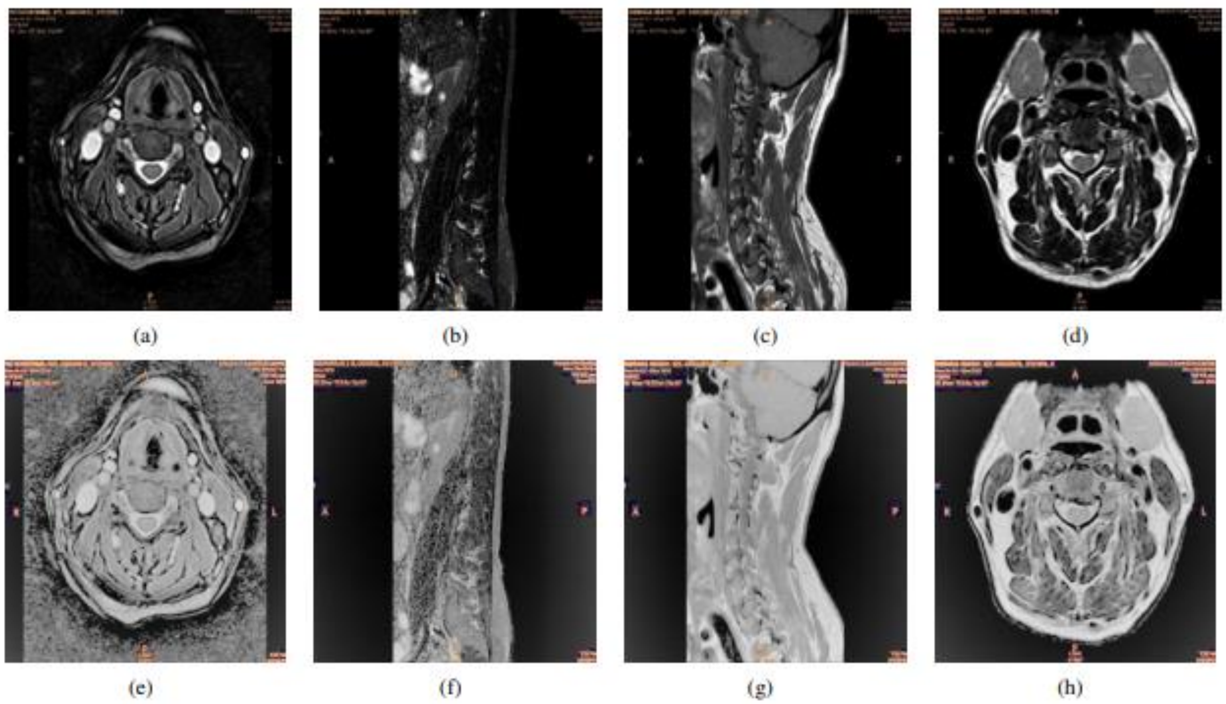
First Column: Original Image of Resolution 256 × 256 pixels.

Second Column: Image enhanced utilizing Histogram Equalization.

Third Column: Image enhanced utilizing Proposed Method.

4. Experimental Result

Figure 5. Spinal Cord Images



First Row: Original MRI of Thoracic Spine Showing Disc Herniation of Resolution 256 × 256 pixels.

Second Row: Reconstructed Images utilizing the proposed method

5. Conclusion

The novel enhanced multiscale retinex algorithm for medical image enhancement in light of multi-rate testing has been introduced. The speed of the proposed enhanced multiscale retinex algorithm has basically improved, since the different analyzed versions of significant worth redirect are taken care of in equal. The reconstruction scheme adjusted in this work is an effective contrasted with different methods. This is confirmed by conducting elaborate experiments on more than twelve varieties of spinal cord medical images. The results introduced show that the proposed method out performs different approaches.

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