IMPACT OF TRUNCATION AND ALIASING ARTIFACTS IN DETECTION OF CEREBELLAR LESION FROM MRI IMAGES

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ABSTRACT

Magnetic Resonance Imaging (MRI) is a medical imaging technique employed by radiologists to investigate the anatomy and physiology of the body. The dynamic growth in the computer aided medical image segmentation playing a very important part in technical and scientific research. It helps the doctors to diagnose the disease in an easy manner there by promoting quick decision making. MRI usually contains artifacts. Cerebellum lesion segmentation is very demanding topic. This is because of magnetic resonance images (MRI) may be affected due to extraneous noise, artifacts and intensity non-uniformity. Manual MRI segmentation is a very monotonous, time lingering and user-dependent job. The presence of artifacts reduces the quality of analysis and hence results in poor evaluation. To avoid diagnostic errors, artifacts ought to be removed or minimized. In this proposed work, we have used methods and algorithms to minimize the truncation and aliasing artifacts from the brain MR images and also, we have used segmentation using Modified Fuzzy C-Means with level set method to improve the segmentation result.

Keyword : - *Artifacts, Magnetic Resonance Imaging, MFCM and Level Set Method*

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1. INTRODUCTION

MRI is one of the most powerful and extensively used imaging techniques in diagnostic radiology as shown in figure1. The images have excellent contrast between different soft-tissues because MRI is sensitive to the chemical environment of the atomic nuclei within the body. Because of its superior high spatial resolution and soft tissue contrast, MRI is used in clinical investigations of the nervous, muscle-skeletal, cardiovascular and other systems. Because of its unique sensitivity spectrum of physiological and biological parameters such as flow, chemical composition, and molecular configuration, MRI is also suitable for functional and metabolic studies. The investigation has a wide range of imaging settings to choose from: tissue contrast, image resolution, and anatomical coverage, all of which are optimised for a particular application. Both two-dimensional (2D) and three-dimensional (3D) images can be produced regardless of image orientation. The most significant aspect is that, ionising radiation is not used in MRI, thereby making it safe for continuous comparable investigation. The MRI signal is generated by a strong magnetic field created by a superconducting coil, radiofrequency fields, and several weaker magnetic fields generated by the three gradient coil combinations.

Figure 1: MRI image of human brain

1.1 Segmentation:

Image segmentation is a process of dividing an image into several smaller parts, and depicting it in a way that is easy to express and study. Image segmentation is crucial for meaningful medical image analysis and interpretation. Segmentation is a sophisticated technique that divides or segments a digitalized image into numerous segments or parts based on pixel values. It is a dangerous and crucial part of the image exploration system. In image segmentation process the image is first divided into semantically interpretable regions for a specific application. Then homogeneous regions within the image are identified as discrete and belonging to distinctive objects.

1.2 Tumor:

A brain tumour is growth of irregular brain cells as shown in figure 2. Brain tumours can either be noncancerous or cancerous (malignant). Brain tumours can begin in the brain cells themselves or can begin elsewhere and spread to the brain. As the tumour grows, it puts pressure on the brain and alters the function of the surrounding brain tissue. It leads to symptoms such as headache, queasiness and balance issues. The rate of growth of a brain tumour along with location, determine how it affect the function of your nervous system.

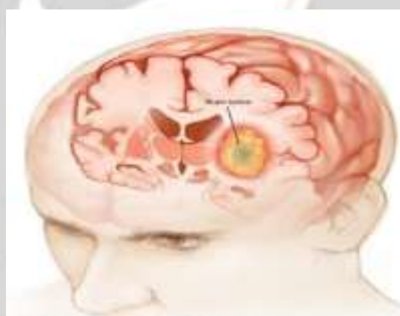

Figure 2: Image of brain tumor

1.3 Artifacts:

There is no specific definition of an MRI artefact in the literatures, because of abundance of artefacts. Also, in some cases, the artefact can be harmful to image diagnosis, whereas in others, it can be beneficial. We would accept an artefact definition that includes any image content or object that does not correspond to the arrangement of the scanned object, as well as occasional noise.

Artifacts can appear during an MRI scan as a result of hardware or software issues, human physiologic phenomena, or physical limitations. Some can have a significant impact on diagnostic image quality, whereas others can mimic or be confused with different pathology. Artefact can also be defined as an attribute that appears in an image but is not there in the original object. It is critical to recognise these artefacts based on a fundamental understanding of their origin, especially those that mimic pathology, as they can lead to incorrect diagnosis and have serious consequences for the patient's health and outcomes.

MRI is prone to artefacts similar to any other type of diagnostic imaging. They are caused by a violation of one or more imaging principles of assumptions. A number of varieties of artefacts are frequently found in a single image or sequence. Few artefacts can be eliminated by adopting appropriate scanning techniques. Even the customised scanning protocols with well-maintained and calibrated systems will not prevent them all. So it is needed to adopt a series of remedial procedures to eliminate or reduce artefacts.

1.3.1 Aliasing artifacts

The most common MRI artefact is aliasing or wrap-around, which occurs when the FOV is smaller than the body part being imaged. The part of the body that is outside of the FOV's scope is projected onto the images opposite side. Oversampling the data can be used to correct this. In the frequency domain, this is accomplished by sampling the signal twice as fast. The number of phase-encoding steps must be increased as a result of the phase direction, resulting in a longer study. Even though the FOV and matrix size (phase-encoding steps) are increased, the number of excitations (or number of signal averages) is reduced to half. During this the imaging time can be kept constant while aliasing is corrected. When anatomical structures located beyond the field of view aliasing artefacts occur. The aliasing artefact causes the nose and other facial features to contaminate the posterior part of the brain, which can be eliminated by increasing the field of view (FOV). Case 1 shows axial T2-weighted images of the brain that show aliasing. Because the phase- encoded direction is anterior-posterior and the FOV is too small, the primary image is a wrap-around with the back of the head projected over the front. The phase and frequency directions are reversed in the second image, resulting in the absence of the aliasing artefact. To eliminate aliasing, oversampling was used in the frequency direction. They appear when the field of view (FOV) is smaller than the scanned portion of the body, causing the excess portion of the image to project onto another part of the image.

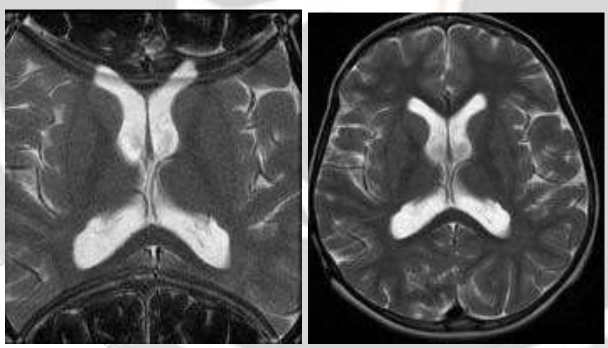

Figure 3:- a) MRT axial projections. b) Aliasing artefact visible.

Artefact correction can be accomplished by either increasing the FOV or by increasing data selection in the frequency direction (standard) and gradually increasing phase in the phase decoding direction – phase compensation (time or Signal to Noise Ratio loss) or by changing the phase and frequency direction so that the phase is in a narrower direction or by using surface coils to avoid signal behind FOV boundaries.

1.3.2 Gibb’s artefact

Truncation, Gibb's, and ringing artefacts appear as a series of lines in the MR image caused by parallel steep or intensive alterations. Such an artefact is not readily visible in ordinary objects. This artefact is caused by Gibb's

phenomenon, which is characterised by ringing at the Fourier sequence's rupture. Truncation artefacts are common in the spine as well as the cranium/cerebrum. This Gibb's artefact is corrected by employing softening filters, a larger acquisition matrix, and a smaller FOV. Gibbs artefacts are caused by the use of Fourier transforms to reconstruct MR signals into images. However, because we are limited to sampling a finite number of frequencies in MR imaging, we must approximate the image by using only a few harmonics in its Fourier representation. As a result, the Fourier series is cut short or truncated, hence the name of this artefact. Gibbs artefact is a type of MRI artefact that is also known as truncation artefact or ringing artefact. It is a series of lines in an MR image that run parallel to abrupt and intense changes in the object at this location, such as the CSF-spinal cord interface or the skull-brain interface. More the encoding lesser intense and narrow the artefacts become.

Figure 4:- MRT sagittal projections. Ringing artifacts are visible.

Artifacts can be corrected by resolving with softening filters (Lanczos Sigma Factor, 2-D exposure filtration, Gegenbauer reconstruction, etc.), using a larger acquisition matrix, or using a smaller FOV.

2. PROPOSED SYSTEM

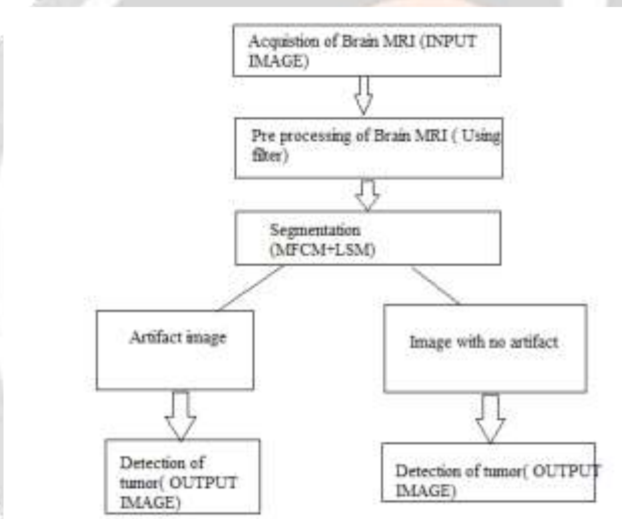

Figure 5: Flow chart of proposed work

The two algorithms which used in our proposed models in order to get more accurate results as follows:

2.1 Fuzzy C means clustering*:*

Clustering is the process of categorizing data points into homogeneous classes, in such a way that items within the same class are as similar as possible and items between classes are as dissimilar as possible. It is another way of data compression technique that involves reducing a large number of samples to a small number of representative prototypes or clusters. Depending on the data and the application, different types of similarity measures may be used to identify classes, with the similarity measure controlling how the clusters are formed. Distance, connectivity, and intensity are some examples of values that can be used as similarity measures. It is a soft clustering technique that allows pixels to belong to more than one cluster. Membership functions are used to calculate this partial membership. For any given data point, the sum of all membership degrees equals 1. This method is more suitable for segmentation applications than the hard clustering algorithm. These have the following advantages like: i) Provides the best results for overlapping data sets and outperforms the k-means algorithm ii) Here, each cluster centre assigns a membership to each data point, as a result of which a data point may belong to more than one cluster centre.

2.2 Level-Set Method (LSM):

LSM is a conceptual framework for using level sets as a numerical analysis tool for surfaces and shapes. The level-set method simplifies the tracking of shapes that change topology, such as when a shape splits in two, develops holes, or reverses these operations. Because of these factors, the level-set method is an excellent tool for modelling time-varying objects. Level Set Methods are designed for problems where the speed function can be positive in some places but negative in others, allowing the front to move forward in some places but backward in others. The level set approach can be used as a powerful tool for 3D segmentation of a tumor in order to estimate its volume accurately. It has gained popularity in a variety of fields, including image processing, computer graphics, computational geometry, and optimization. The important advantages are: i) they are capable of performing numerical calculations including curves and surfaces on a fixed Cartesian grid ii) handling of slightly tilted lines and corners, as well as simple surface normal calculation

3. METHODOLOGY USED IN PRESENT INVESTIGATION

3.1 A Hybrid Technique using Fuzzy C – Means and Level Set Method

The methodology proposed inclusive of several steps, beginning with the collection of brain MRI images. Enhancement, Contrast enhancement, Mid-range Stretch, Double thresholding and region filling are the main steps in this hybrid technique. All of the preceding steps are involved in the testing phase, which involves the use of a new set of MRI images and the categorization of brain MRI images. The dataset consists of 100 patients' MRI brain images that are classified as tumor or non-tumor. To overcome the drawbacks of individual methods and obtain more accurate results, both fuzzy and level set methods are combined.

The main goal of this research work is to detect the tumor affected region of brain by considering artifact images and artifact free images with MFCM and LSM.

3.2 MFCM Clustering Algorithm

Step1: In the MRI scan, the imaging results are the DICOM (Digital Imaging and Communication in Medicine) image format which is unreadable format by many software. The images are converted into standard image file formats .jpg or .gif. Since, the conversion of the images is necessary for further analysis.

Step 2: The preprocessing is done by removing the noise with the Gaussian filter to remove the white noise. Since, the clustering is based on the pixels values.

Step 3: Implementing the traditional fuzzy c- means algorithm to segment the images and to detect the tumor affected region of the axial and coronal side of the MRI brain slices.

Step 4: Generating the histograms values before and after for the images and record the computational time. Since comparing the histogram values with the cluster center values of theimages.

3.3 Level Set Algorithm

Step 1: The given image is subjected to a new level set matrix function..

Step 2: The images are then filtered to remove noise. To estimate the mean and standard deviation of a local image, a neighborhood of size m by n is used, and the Wieners filter is used to filter the image pixel by pixel.

Step 3: The size of the image is now determined by the pixel values of the rows and columns, and the final image is resized using the resize command.

Step 4: Finally, the Objective level set function is used, and the matrix values are changed exponentially until the centre of the contour converges. At each iteration of the new objective function, the distance matrix and new centre are calculated until convergence.

4. RESULTS

4.1 Evaluation Metrics: To assess the performance of the proposed model, we have considered following evaluation metrics

Precision:- Precision is the proportion of accurately anticipated positive information tests to the all-out anticipated positive information tests.

Recall:- It is the fraction of effectively anticipated positive information tests to the all information tests in real class.

F1 score:- F1 score is the weighted normal of exactness and recall execution metric. Hence, this score thinks about both false positives and false negatives into account. For the most part, F1 score is very hard to comprehend, is not always as trustworthy as precision, but F1 score is generally more treasured than exactness, especially at the off chance you have an uneven class distribution. Exactness performs better if false positives and false negatives have comparative expense.

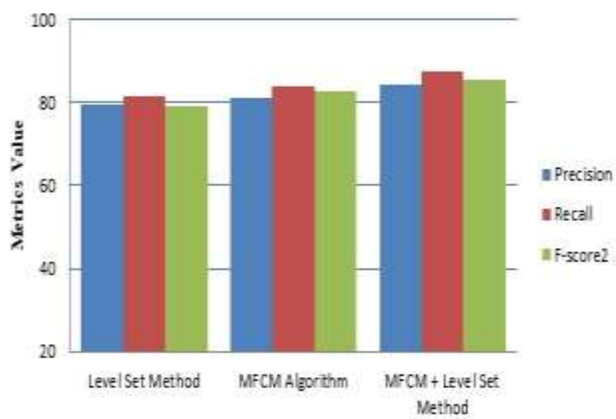

Chart 1: Segmentation metrics with Artifacts

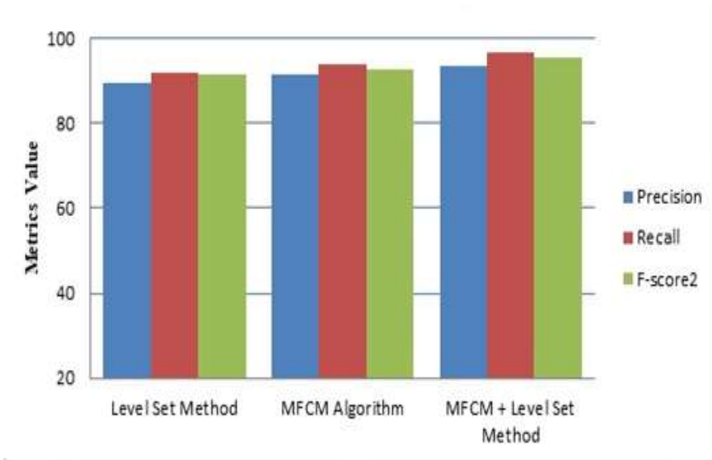

Chart 2: Segmentation metrics without Artifacts

4. CONCLUSIONS (Font-11, Bold)

The proposed technique of brain tumour detection of brain utilizing available MRI images is a significant and efficient way to detect the brain tumor with artifacts and without artifacts. The hybrid methodology is used gives accurate result for identifying the tumor, which also shows how artifacts play a role in exacting tumor.

5. REFERENCES

[1]. TD Vishnumurthy, H S Mohana, VA Meshram, Pramod Kammar, " Suppression of Herringbone Artifacts in MR Images of Brain Using Combined Wavelet and FFT Based Filtering Techniques".

[2]. Pramod Kammar, TD Vishnu murthy, H S Mohana, AM Vaibhav, " A Novel Algorithm for Removal of Herringbone Artifact in Brain MR Images using FFT and Canny Edge Detector".

[3]. Heena Hooda, Om Prakash Verma, Tripti Singhal, "Brain Tumor Segmentation: A Performance Analysis using K-Means, Fuzzy C-Means and Region Growing Algorithm".

[4]. Dr. M. Karnan, T.Logheshwari "Improved I MRI image Segmentation using Ant Colony System", IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), pp.1-4, Dec.2010.

[5]. Steven Eschrich, JingweiKe,H all and Goldgof, "Fast accurate fuzzy clustering through data reduction", IEEE transactions on fuzzy systems, vol.l l,pp:262-270,2003.

[6]. Kwon.M,etal., "Segmentation of brain MR image using template matching and hierarchial fuzzy C- means", Proceedings of the International Society for magnetic Resonance in Medicine, vol.ll, pp:904,2003

[7] .H. S Mohana, Prathibha G, " Qunatitative and Qualitative Measurement of K – means and FCM, the detection and extraction of MRI Cerebellum lesions", IJERT, Volume 8, issue 3, September 2019.

[8]. Prathibha G, H S Mohana, "Transvaluate of Machine Learning algorithms in dissecting of cerebrum tumor in MR Images", IJARET, volume 12, issue 7, July 2021.