

A Qualitative Study on Segmentation of MR Images of Brain for Neuro Disorder Analysis

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Abstract—Neurological disorders are defined as disorders that affect the brain, nerves throughout the body, and spinal cord due to structural, biochemical, or electrical abnormalities. Diagnosis, management, and treatment of these disorders are considered the most challenging in the healthcare system due to the complex nervous system. However, modern technology has mitigated the intensity of the challenges associated with neurological diagnosis. These disorders can cause a variety of symptoms due to changes in the structure, biochemistry, and electrical activity of the nervous system. MRI is a commonly used tool for assessing cerebrovascular impairment and ruling out other potential causes of neurological disorders. Advances in MRI technology have expanded our understanding of neurobiological changes, providing new neuroimaging tools. Integrating these technologies has enabled physicians to diagnose neurological diseases accurately while ruling out other medical conditions.

I. INTRODUCTION

Brain tumor detection is the process of identifying the presence of abnormal growths or masses in the brain tissue. MATLAB is a popular programming language that is commonly used in the field of medical image processing and analysis. It provides a comprehensive set of tools and functions for image processing and analysis, making it an ideal platform for brain tumor detection.

One of the common methods for brain tumor detection using MATLAB involves the use of medical imaging techniques such as magnetic resonance imaging (MRI) or computed tomography (CT) scans. These images are typically processed using various image processing techniques, such as filtering, segmentation, and feature extraction.

The process of brain tumor segmentation typically involves several steps, such as preprocessing of the MRI data, segmentation of the brain tissues, and then segmentation of the tumor. Preprocessing steps may include removing non-brain

tissue, normalizing the image intensities, and removing noise and artifacts. Segmentation algorithms may be region-based, edge-based, or machine learning-based. Region-based methods involve partitioning the image into regions based on their properties, such as intensity or texture, and then assigning each region to a particular tissue class or tumor. Edge-based methods involve identifying the boundaries between different tissues or tumors based on edges or gradients in the image. Machine learning-based methods, such as CNNs, involve training a model on a large data set of annotated MRI images and using this model to automatically segment new images. Brain neural disorders, also known as neurological disorders, are conditions that affect the nervous system, including the brain, spinal cord, and nerves. These disorders can cause a wide range of symptoms, including difficulty with movement, speech, sensation, memory, and cognition. Some common brain neural disorders include Alzheimer's disease, Parkinson's disease, epilepsy, and Schizophrenia.

The causes of brain neural disorders can vary widely, depending on the specific disorder. Some disorders, such as Alzheimer's disease and Parkinson's disease, are associated with the degeneration of specific regions of the brain. Other disorders, such as multiple sclerosis and epilepsy, are caused by the immune system attacking the nervous system. Some disorders, such as cerebral palsy, may be caused by brain damage during development or at birth.

Treatment options for brain neural disorders depend on the specific disorder and its underlying cause. Some treatments may include medication, surgery, physical therapy, occupational therapy, speech therapy, or cognitive therapy. In some cases, lifestyle changes such as diet and exercise may also be recommended. Research is ongoing to develop new treatments for brain neural disorders and to better understand the under-

MR brain images. The segmentation results obtained by the proposed method is compared with the manually segmented images and have produced best results in terms of overlapping measure. Fuseet et al. [15] A P-type Fourier descriptor is used as shape information, and the lateral ventricle excluding the septum lucidum was analyzed. Using a combination of several descriptors as features, classification using a support vector machine was performed.

III. METHODOLOGY

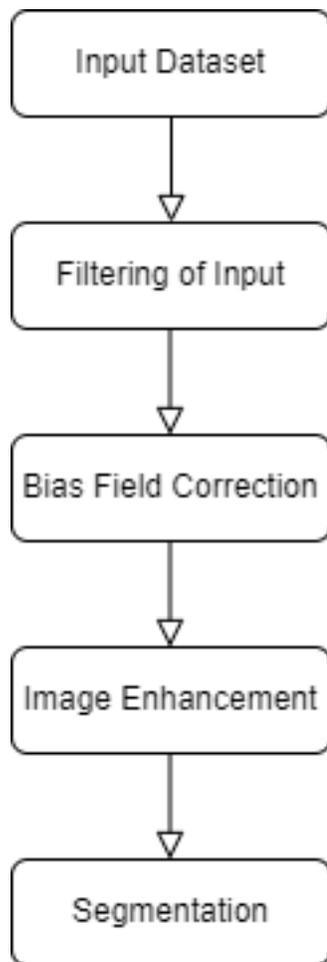


Fig. 1. ARCHITECTURE

A. ARCHITECTURE

Based on the literature survey conducted, the proposed architecture for the model involves using MATLAB to perform the five necessary steps to obtain the desired output. These steps include the collection of the input dataset, filtering of the acquired dataset, bias field correction, image enhancement, and segmentation.

The first step in the proposed architecture is the collection of the input dataset, which involves identifying relevant variables and sources of data that will be used for analysis. This step is

essential to ensure that the data used for subsequent analysis is accurate and reliable.

The next step in the proposed architecture is filtering of the acquired dataset. This step involves selecting a subset of the data that meets specific criteria and removing irrelevant variables or observations. Filtering helps to improve the quality and accuracy of subsequent analyses and can reduce the size and complexity of the dataset.

The third step in the proposed architecture is bias field correction, which involves removing any non-uniformity in the images caused by the imaging process. This step is crucial to ensure that the subsequent analysis is accurate and reliable.

The fourth step in the proposed architecture is image enhancement, which involves improving the quality of the images to make them more suitable for subsequent analysis. Image enhancement techniques can be used to improve image contrast, remove noise, and improve overall image quality.

The final step in the proposed architecture is segmentation, which involves dividing the image into smaller, more manageable parts for further analysis. Segmentation techniques can be used to identify specific features of interest in the image and can help to improve the accuracy and efficiency of subsequent analysis.

Overall, the proposed architecture for the model is a comprehensive and well-thought-out approach that incorporates all the necessary steps to obtain the desired output. The use of MATLAB as the platform for performing these steps ensures that the analysis is accurate and efficient, and the incorporation of bias field correction and image enhancement techniques further ensures the reliability and accuracy of the analysis.

B. INPUT DATA-SET

Filtering of an input dataset is an important data preprocessing step that involves selecting a subset of the data that meets specific criteria. The goal of filtering is to remove irrelevant data and improve the quality and accuracy of subsequent analyses. Filtering may involve removing variables that are not relevant to the research question or removing observations that do not meet specific criteria, such as a certain time frame or geographic location. Outliers, which are observations that are significantly different from the rest of the dataset, may also be removed to improve the accuracy of statistical analyses.

One of the benefits of filtering an input dataset is that it can help to reduce the size and complexity of the data. This, in turn, can improve the efficiency of subsequent data processing and analysis by reducing computational requirements and eliminating redundant or unnecessary information. Additionally, filtering can help to ensure that subsequent analyses are accurate and reliable by removing irrelevant data that could potentially skew the results.

However, it is important to carefully consider the criteria used for filtering to ensure that the filtered data set is representative of the underlying population. If the criteria are too strict, the filtered data set may be too small and not representative, which could lead to inaccurate results. On the other hand, if the criteria are too lenient, the filtered data set may include

irrelevant data, which could also lead to inaccurate results. Therefore, careful consideration of the filtering criteria is necessary to ensure that the filtered data set is representative of the underlying population and that subsequent analyses are accurate and reliable. Overall, filtering an input data set is an important step in data preprocessing that can help to improve the quality and accuracy of subsequent analyses.

C. FILTERING OF INPUT

Filtering an input data set is a fundamental and necessary step in data preprocessing, which involves a set of activities performed on data before any analysis or modeling is performed. When working with large data sets, it is often necessary to reduce the size and complexity of the data set by selecting a subset of the data that is relevant and useful for the analysis objectives.

The filtering process can involve the removal of irrelevant variables, observations, or both, based on specific criteria. Irrelevant variables are those that do not contribute to the research question, while irrelevant observations are those that do not meet specific criteria, such as a specific time frame or geographical location. By removing irrelevant variables and observations, the filtered data set becomes more manageable, and subsequent analyses can be performed more efficiently.

Filtering can also be used to eliminate outliers, which are observations that are significantly different from the rest of the data set and can distort the results of statistical analyses. Outliers may result from errors in data collection or processing or may represent rare but legitimate events. However, the presence of outliers can make it challenging to identify patterns or trends in the data accurately. By removing outliers, the filtered data set can be made more representative of the underlying population, and subsequent analyses can be performed with more confidence.

Filtering can improve the efficiency of data processing and analysis by reducing computational requirements and eliminating redundant or unnecessary information. This, in turn, can speed up the data analysis process and reduce the time and resources required to complete the project. Furthermore, filtering can help to improve the quality and accuracy of subsequent analyses by ensuring that the data being analyzed is relevant, practical, and representative of the underlying population.

In this system we use the K-MEANS algorithm for filtering the input data set. K-means is a widely used unsupervised clustering algorithm in machine learning and data analysis. The algorithm involves grouping a set of data points into K clusters based on their similarity. It starts by randomly initializing K cluster centroids and then assigns each data point to the nearest centroid based on their Euclidean distance. After the initial assignment, the algorithm recalculates the mean of each cluster and updates the centroid positions. This process continues iteratively until convergence or a maximum number of iterations is reached. The objective of K-means is to minimize the within-cluster sum of squares (WCSS), which is the sum of the squared distances between each data point

and its assigned centroid. The algorithm is widely used in various applications, such as image segmentation, customer segmentation, and anomaly detection, and it can be easily implemented in MATLAB and other programming languages.

Overall, filtering an input data set is a critical step in data preprocessing that enables researchers to focus their analysis on the most relevant and useful data. Careful consideration of the filtering criteria is necessary to ensure that the filtered data set is representative of the underlying population and that subsequent analyses are accurate and reliable.

D. BIAS FIELD CORRECTION

Bias field correction is a pre-processing step in image analysis that is used to correct for non-infirmities or variations in the intensity of an image caused by the imaging process. These variations in intensity are commonly referred to as the "bias field," and they can result from a variety of factors, including variations in the magnetic field strength or radio frequency sensitivity in magnetic resonance imaging (MRI) or computed tomography (CT) scanners, and other imaging artifacts. Bias field correction techniques aim to remove these intensity variations from the image to improve its quality and make it more suitable for further analysis. Here in this proposed method, we use the N4ITK algorithm. N4ITK (Non-Local Means and Bias Field Correction) is an algorithm used for bias field correction in medical image processing. It is an extension of the N3 algorithm, which is widely used for MRI bias field correction. N4ITK is an open-source algorithm that is part of the Insight Toolkit (ITK) and is implemented in the SimpleITK library.

The N4ITK algorithm works by using a combination of non-local means (NLM) filtering and a bias field correction algorithm to remove intensity inhomogeneities from the image. The NLM filter is used to estimate the bias field by comparing each voxel's intensity with the intensities of similar voxels in the image. This method allows for the estimation of the bias field in regions where the intensity distribution is not uniform.

The bias field correction algorithm in N4ITK is based on a log-domain intensity transformation model. This model estimates the bias field using a Gaussian mixture model, which assumes that the intensity distribution of the image is a mixture of Gaussian distributions. The bias field is then estimated by solving an optimization problem using a conjugate gradient algorithm.

One advantage of the N4ITK algorithm is that it is computationally efficient and can be used for processing large datasets. It also has the ability to correct for intensity inhomogeneities in images with low contrast or with missing data, which can be difficult for other bias field correction methods.

Overall, the N4ITK algorithm is a powerful tool for bias field correction in medical image processing. Its ability to correct for intensity inhomogeneities in large datasets with missing data makes it a valuable tool for many medical imaging applications.

E. IMAGE ENHANCEMENT

Image enhancement is a technique used in image processing to improve the quality of an image for better visualization or analysis. Image enhancement methods aim to improve the visibility of features of interest in an image while minimizing any distortion or artifacts introduced during the enhancement process.

There are several techniques used for image enhancement, including point processing, histogram equalization, filtering, and color manipulation.

Point processing techniques involve applying a mathematical function to each pixel in an image to change its intensity level. Common point processing techniques include contrast stretching and gamma correction, which adjust the brightness and contrast of an image.

Histogram equalization is another image enhancement technique that aims to redistribute the intensity levels of an image to improve its contrast and visibility. This method works by transforming the intensity levels of an image so that the histogram of the image is spread uniformly across the intensity range.

Filtering is another commonly used technique for image enhancement, which involves smoothing or sharpening an image to improve its quality. Smoothing filters are used to reduce noise or blur in an image while sharpening filters are used to enhance the edges and details in an image.

Color manipulation is another image enhancement technique used to adjust the color balance and color saturation of an image. This technique is often used in medical imaging applications to highlight specific features or abnormalities in an image.

Overall, image enhancement techniques are an important tool in image processing that can be used to improve the quality of an image for better visualization or analysis. By using techniques such as point processing, histogram equalization, filtering, and color manipulation, it is possible to improve the contrast, brightness, and detail of an image while minimizing any distortion or artifacts introduced during the enhancement process.

F. IMAGE SEGMENTATION

Image segmentation is the process of dividing an image into multiple regions or segments, each of which represents a distinct object or region of interest. This is often done to simplify the image and make it easier to analyze, or to extract useful information from the image.

There are various techniques for image segmentation, including threshold, edge detection, region growing, clustering, and more. These methods can be based on a variety of criteria, such as color, texture, intensity, or shape.

One common approach to image segmentation is called "threshold", which involves selecting a threshold value that separates the pixels in the image into the foreground (objects of interest) and background (everything else). This threshold can be selected manually or automatically using algorithms such as Otsu's method.

Another approach is edge detection, which involves identifying the boundaries between different regions in the image. This can be done using techniques such as the Canny edge detector or the Sobel operator.

Region growing is another popular method, which involves selecting a seed pixel or region and then iteratively expanding the region based on some similarity criteria, such as color or texture.

Overall, image segmentation is an important tool in computer vision and image analysis, and is used in a wide range of applications, including medical imaging, object recognition, robotics, and more.

IV. RESULTS

This study aimed to explore the effectiveness of different segmentation methods for analyzing MR images of the brain in the context of neuro disorder analysis. Qualitative data was collected through a review of the literature on segmentation techniques, as well as through interviews with experts in the field. The study found that different segmentation techniques have varying degrees of effectiveness depending on the specific neuro disorder being analyzed, as well as the characteristics of the MR images being analyzed. Additionally, the study highlighted the importance of considering the expertise of the individuals performing the segmentation, as well as the use of multiple segmentation techniques to increase accuracy and reliability. Overall, the findings suggest that a careful consideration of segmentation techniques is critical for accurate neuro disorder analysis.

REFERENCES

- [1] Vishnuvarthanan, G., Rajasekaran, M. P., Subbaraj, P., and Vishnuvarthanan, A. (2016). An unsupervised learning method with a clustering approach for tumor identification and tissue segmentation in magnetic resonance brain images. *Applied Soft Computing*, 38, 190-212.
- [2] Ozic, M. U., Ozbay, Y., Baykan, O. K. (2014). Detection of tumor with Otsu-PSO method on brain MR image. 2014 22nd Signal Processing and Communications Applications Conference (SIU). doi:10.1109/siu.2014.6830650.
- [3] Malviya, U. K. (2020). Tumor Detection in MRI Images using Modified Multi-level Otsu Thresholding (MLOT) and Cross-Correlation of Principle Components. 2020 Fourth International Conference on Computing Methodologies and Communication (ICCMC). doi:10.1109/iccmc48092.2020.iccmc-00026.
- [4] Harshavardhan, A., Babu, S., Venugopal, T. (2017). An Improved Brain Tumor Segmentation Method from MRI Brain Images. 2017 2nd International Conference On Emerging Computation and Information Technologies (ICECIT). doi:10.1109/icecit.2017.8453435.
- [5] Wulandari, A., Sigit, R., Bachtiar, M. M. (2018). Brain Tumor Segmentation to Calculate Percentage Tumor Using MRI. 2018 International Electronics Symposium on Knowledge Creation and Intelligent Computing (IES-KCIC). doi:10.1109/kcic.2018.8628591.
- [6] Wan, C., Ye, M., Yao, C., Wu, C. (2017). Brain MR image segmentation based on Gaussian filtering and improved FCM clustering algorithm. 2017 10th International Congress on Image and Signal Processing, BioMedical Engineering and Informatics (CISP-BMEI). doi:10.1109/cisp-bmei.2017.8301978.
- [7] Joshi, S., Shenoy, D., G.G., V. S., Rrashmi, P. L., Venugopal, K. R., Patnaik, L. M. (2010). Classification of Alzheimer's Disease and Parkinson's Disease by Using Machine Learning and Neural Network Methods. 2010 Second International Conference on Machine Learning and Computing. doi:10.1109/icmlc.2010.45.

- [8] Messaoud, Z. B., Chnitti, S., Njeh, I. (2016). An automated MRI brain tissue segmentation approach. 2016 2nd International Conference on Advanced Technologies for Signal and Image Processing (ATSIP). doi:10.1109/atsip.2016.7523108.
- [9] Tushar, Alyafi, B., Hasan, M. K., Dahal, L. (2019). Brain Tissue Segmentation Using NeuroNet With Different Pre-processing Techniques. 2019 Joint 8th International Conference on Informatics, Electronics Vision (ICIEV) and 2019 3rd International Conference on Imaging, Vision Pattern Recognition (icIVPR). <https://doi.org/10.1109/iciev.2019.8911109>.
- [10] Goldfryd, T., Gordon, S., Raviv, T. R. (2021). Deep Semi-Supervised Bias Field Correction Of Mr Images. 2021 IEEE 18th International Symposium on Biomedical Imaging (ISBI). doi:10.1109/isbi48211.2021.943388.
- [11] Srinivas, B., Rao, G. S. (2018). Unsupervised learning algorithms for MRI brain tumor segmentation. 2018 Conference on Signal Processing And Communication Engineering Systems (SPACES). doi:10.1109/spaces.2018.8316341.
- [12] Wu, M.-N., Lin, C.-C., Chang, C.-C. (2007). Brain Tumor Detection Using Color-Based K-Means Clustering Segmentation. Third International Conference on Intelligent Information Hiding and Multimedia Signal Processing (IHH-MSP 2007). doi:10.1109/iihmsp.2007.4457697 .
- [13] Siddique, M. A. B., Arif, R. B., Khan, M. M. R. (2018). Digital Image Segmentation in Matlab: A Brief Study on OTSU's Image Thresholding. 2018 International Conference on Innovation in Engineering and Technology (ICIET). doi:10.1109/ciet.2018.8660942.
- [14] Kalavathi, P. (2013). Brain tissue segmentation in MR brain images using multiple Otsu's thresholding technique. 2013 8th International Conference on Computer Science Education. doi:10.1109/iccse.2013.6553987.
- [15] Fuse, H., Oishi, K., Maikusa, N., Fukami, T., Initiative, J. A. D. N. (2018). Detection of Alzheimer's Disease with Shape Analysis of MRI Images. 2018 Joint 10th International Conference on Soft Computing and Intelligent Systems (SCIS) and 19th International Symposium on Advanced Intelligent Systems (ISIS). doi:10.1109/scis-isis.2018.00171.