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MRI Image Processing Method on Brain Tumors: A Review

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Abstract. Magnetic resonance imaging (MRI) is a technological development in the medical field that produces images with high resolution to detect and then can classify diseases that are found in the organs of the patient's body. One condition that can be identified from reading an MRI image is a brain tumor. MRI technology is beneficial for medical for early detection of brain tumor disease. However, the weakness of detecting brain tumor disease with MRI images performed by doctors is still manual. It certainly requires a long process due to the complexity of the structure of the human brain. Of course, the slow process of detecting and classifying brain tumor disease in patients can cause delayed medical treatment for the patient's recovery. For this reason, based on the need for medical information needed by doctors to treat patients quickly and accurately, an image processing technique or method for reading MRI images is developed, the aim is to assist in processing medical images. In this research, we will review various techniques or methods that have been used to detect brain tumors on MRI images, and are expected to provide information on different techniques or methods in image processing as a basis for image processing MRI.

INTRODUCTION

Current technological support is undoubtedly beneficial for various fields of life, not least in the medical area that develops magnetic image resonance technology, namely MRI. MRI produces high relational images of different internal organs of the human body in the form of the brain, tissues, and so on. Various internal organs of the human body are detected to detect the presence of disease. One of the conditions that can be identified by MRI images is a brain tumor. In the medical world, the detection of brain tumors by reading MRI images is still done manually by doctors and radiologists. This situation resulted in the reading of MRI images being a difficult task even though performed by medical experts because relying on human visual vision alone was deemed insufficient to detect quickly and accurately from these MRI images. And usually in reading MRI images by doctors and radiologists requires at least 1 to 2 weeks before the results are given to patients. Besides the challenge that exists is the complexity of the structure of the human brain so that to detect brain tumors manually is very vulnerable or delicate because there could be a brain tumor that blends with the patient's healthy brain tissue [1] [2] [6].

However, with the development of digital image processing or image processing, it is possible to be able to help doctors and radiologists to read MRI images faster in the detection of brain tumors [2]. Image processing or image processing is a technique or method of processing digital images with specific objectives that can be in the form of image improvements, image quality improvements, and objects in the picture that can be processed as needed. In this case, MRI image processing to detect brain tumors can be further processed with various techniques or methods of image processing to obtain essential data or information related to the detection of brain tumors and then their classification [3]. Understanding brain tumors themselves are an uncontrolled division of brain cells. They can be formed from groups of abnormal cells that are in the brain, where the brain tumor itself can be divided into two, namely benign and malignant brain tumors. The various types of brain tumors that can be detected using MRI are metastasis of bronchogenic carcinoma tumors, glioblastomas, and sarcomas. Perfect MRI images and automatic classification are essential for medical analysis and interpretation of brain disorders. The most common brain disorders that occur include brain tumors, for that through reading MRI images, can diagnose brain tumors more quickly and can provide appropriate and quick medical treatment to patients in need [4] [5].

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Magnetic Resonance Images (MRI) is a medical imaging technology other than Computer Tomography (CT), which is quite complicated that is most commonly performed to detect brain tumors. Because it can provide detailed information, MRI is also a sophisticated technology in medical imaging techniques that have been proven to be a useful tool for learning about the human brain [1] [2]. So MRI has no doubt the benefits of its use in the medical field. The MRI image processing usually displayed healthy tissue, tumor tissue, blood vessels, and background elements in the image, which can later be further processed using various techniques or methods to read by doctors and radiologists [6]. The purpose of this study is to discuss or summarizes the different image processing techniques or methods available for how to detect brain tumors in MRI images because in the medical world today is highly dependent on medical imaging technology and medical images [1].

LITERATURE REVIEW

MRI image processing for detecting brain tumors is an area of interest in medical image processing, as evidenced by the many studies that discuss the detection and classification of brain tumor disorders in patients. Because the brain is the most complex vital organ, consisting of millions or even billions of cells, it is necessary to obtain a technique or method that is fast to be able to detect the layout of brain tumors in patients by reading MRI images [4][6]. So from reading, these MRI images can detect the presence of brain tumors and classify as benign brain tumors or malignant brain tumors [4] [9].

In the medical field, the MRI image processing for the detection and classification of brain tumors is a challenge. If the discovery of brain tumors can be made quickly and precisely, it can significantly help the process of initial treatment of patients, which is providing remedial measures that must be done as an initial step in healing. Also, MRI image processing can be beneficial for medical performance so that medical performance is more efficient and effective in inpatient management processes [8] [13] [15] [18] [21].

In various studies, there are various kinds of algorithms and steps in the form of MRI image processing in the form of pre-processing, where the MRI images with not too good quality. The MRI images may be too dark or bright, and so on so that the medical will have difficulty determining parts of the brain affected by the tumor. The solution is that the MRI images improving the image or improving image quality so that it is easy to read by the medical. The segmentation process conducted to separate the parts of the object in the MRI image with its background, aiming to obtain the information needed from those objects. Some studies also provide an overview of the various methods and techniques used to detect brain tumors through MRI image segmentation. [1] [18]. Because segmentation is one of the medical image processing that helps analyze that image. So the MRI image must be done accurately before making a proper diagnosis by first dividing the image into various equal parts to obtain the object in question [1] [3] [25]. In addition to the MRI image segmentation process, feature extraction or features used for MRI image reading are also carried out to obtain certain features or features of the MRI image processed for detection of brain tumors, and also the classification developed by MRI image segmentation using various tools and techniques different.

Brain tumors for detection and classification in MRI images can be implemented using various techniques or preprocessing methods, namely wavelet transformation, filtering, extraction of Gray level co-occurrence matrix (GLCM) for texture features, object labeling [2][4]. While the segmentation used is using unsupervised learning is clustering algorithms such as fuzzy c-means, Otsu thresholding, and others [11]. Classification of brain tumors with MRI images can use SVM (Support Vector Machine) and Radial Basis Function Neural Network (RBF NN) rather than Deep Neural Network (DNN) [16]. These algorithms are used to create and maintain patterns that are formed. To get a model, one must first know the features to practice SVM by referring to the texture and color features. [2][5][9]

MRI image processing can also be performed with data mining techniques. These techniques consist of four phases, which are the pre-processing for the first step, image segmentation for separating objects, feature extraction for color or shape or texture, and classification to identify the brain tumor. And the existing system will be able to locate the type of tumor based on the support vector machine because SVM is a machine learning model [8] [10]. Various features were extracted from MRI image segmentation in the form of shape, intensity, and texture-based features [22] [26].

It can be seen that the detection of brain tumors by using MRI image processing will continue to develop to help the medical field to deal with efforts to manage patients more quickly and precisely. The detection of brain tumors itself uses MRI technology because MRI images themselves have high resolution and can clearly show the structure, size, and location of brain tumors [26].

STAGE OF MRI IMAGE PROCESSING METHOD

Image processing methods or MRI image processing, according to the literature review summary of various previous studies can be explained by several means below:

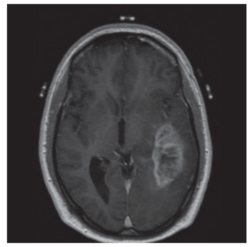

FIGURE 1. MRI Image of Brain [24]

Figure 1 is an example of MRI image processing to detect brain tumors. There is the tissue that looks abnormal; for that reason, it needs to be discovered by brain tumor detection through the exact size and location of the image. Brain tumors can change parts of the brain because they have different intensities [24].

Preprocessing

Pre-processing is the first step that is usually done in image processing, where MRI images that will be further processed for the detection of brain tumors. The MRI images that are too large will be resized by specific pixels according to image processing needs, then improve image quality by adjusting brightness, contrast, and so on. Improving the image if the resulting MRI image is not so good, then it can also eliminate noise or noise in the MRI image because noise or noise will make it difficult when processing these images, and other necessary pre-processing [7] [26].

Following are the steps in preprocessing:

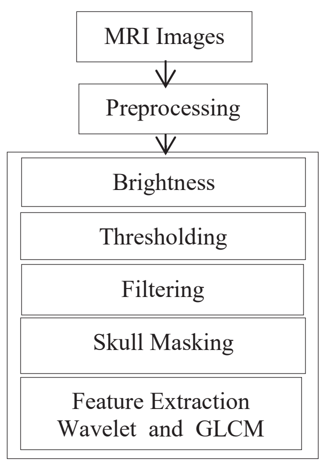

FIGURE 2. Preprocessing Stage

Based on several stages of preprocessing in the image above, it can be explained the advantages and disadvantages of each preprocessing used in MRI images.

TABLE 1. Preprocessing MRI Image

Preprocessing	Aim	Merits
Increased Image Brightness	To improve image brightness on dark MRI images	To increase the brightness of the image in the MRI image for the next process
Threshold Value	Change a grayscale image to binary	Find out which objects and backgrounds are included, usually indicated by pixel values of 1 and 0.
R Filtering - Median - High Pass	Refine, sharpen, change, and eliminate noise from images so that we can extract the information needed to sharpen edges, calculate the boundaries of each hole in a particle, and make the contrast between elements and background.	Can extract the information needed to sharpen edges, calculate the boundaries of each hole in a particle, and make the contrast between elements and background.
Skull masking	Control object boundaries	Know the edge information from the region (ROI).
Feature Extraction: Different discrete Wavelet - Haar - Morlet, - Daubechies	The purpose of feature extraction is to collect image data in the form of shape, texture, color, and contrast as well	Wavelet is able to eliminate noise in the image by maintaining essential features. Haar (accurately analyzing images), Daubechies (multi-dimensional signal processing), Morlet, and symmetrical shape and no scaling function
Grey Level Cooccurrence Matrix (GLCM)	Eliminating noise in images by applying different wavelets, namely Haar, Morlet, and Daubechies [4][9].	GLCM can characterize image textures by calculating how often pairs of pixels with specific values and in certain spatial relationships occur in an image and extract statistical size from a matrix

Image segmentation

MRI images need segmentation to make it easier to get accurate information. Because with digital MRI image segmentation, it can obtain pixels or objects according to their texture or color to separate objects and backgrounds or MRI images can also be divided into several segments so that the processed image is easier to analyze [2][5]. Image segmentation consists of pixel-based, edge-based, and region-based segmentation, where segmentation is done based on the three types of segmentation according to the purpose of obtaining information related to the digital image being processed [3].

TABLE 2. Segmentation MRI Image.

Segmentation Techniques	Consists of	Explanation
Pixel Based	Thresholding : -Otsu	Grayscale images are converted to binary images by selecting a threshold value
	Clustering: - K – means - Fuzzy C-Mean	Clustering where objects are put together into groups based on their characteristics [3].
Edge Based -	Edge Detection, Gradient Mode, Active Contours, Level Sets.	The edge detection technique is to determine the pixel value at the boundary. Segmentation. The result is an image in the binary form [3]
Region-Based	Region Growing, Split/Merge, Graph Cut (hybrid)	Region-based segmentation groups pixels by region [3]

In MRI image segmentation, various image segmentation techniques can be used based on pixels, lines, and regions. Where pixel-based segmentation consists of two segmentation techniques, namely Thresholding and Clustering. Clustering segmentation is a grouping of pixels with similar characteristics. Pixels that are closer to the center of the cluster show that the region can be segmented or recognized as a tumor. Still, if not verified, the area shows that the pixels are not close to the center of the cluster, then the comparison can be repeated, and the tumor can be segmented.

MRI Image Classification

The classification of MRI images using Support Vector Machine (SVM) is one of the most effective machine learning algorithms, both in practical and theoretical terms. SVM will train large data sets and explore the data model. SVM functions to get accurate data predictions. The following is data on the accuracy of using Support Vector Machine.

MRI image classifications are summarized from various studies using a machine learning algorithm, i.e., Support Vector Machine (SVM) and learning algorithm, i.e., Radial Base Function Neural Network (RBF NN). SVM is one of the most effective machine learning algorithms, both in practical and theoretical terms, while RBFNN is a learning algorithm used to classify. Usually, this algorithm is also called a hybrid algorithm because it uses two methods of learning at once, which are guided and not guided. Also, the RBNFF consists of input, hidden, and output layers.

The classification must determine the pattern in advance of the image to be processed. SVM trains large data sets and explores these data models. SVM functions to get accurate data predictions, while the RBNFF output results depend on the activation function and the weight contained in the hidden layer. Backgrounds or MRI images can also be divided into several segments so that the processed image is easier to analyze [2][5]. Image segmentation consists of pixel-based, edge-based, and region-based segmentation, where segmentation is done based on the three types of segmentation according to the purpose of obtaining information related to the digital image being processed [3].

The following is the accuracy data for using Support Vector Machine and Radial Basis Function (RBNFF) in the classification of MRI images to detect brain tumors :

TABLE 3. classification accuracy MRI image

Segmentation	Features Extraction	Classification and accuracy
K-means clustering	Gray level Cooccurrence Matriks (GLCM)	SVM (Support VectorMachine) 98,51%
Otsu thresholding	Gray level Cooccurrence Matriks.	SVM (Support VectorMachine) 83%
Histogram Gradian	Filter median	SVM (Support VectorMachine) 86,6%
Fuzzy C-Means	Discrete Wavelet Transform (DWT)	Radial Basis Function and Deep Neural Network are Accurate
Fuzzy C-Means	Discrete Wavelet Transform (DWT) and GLCM	Radial Basis Function Neural and Deep Neural Network are Accurate
Fuzzy Clustering Means	Filter median	SVM (Support Vector Machine) 98.86%
Fuzzy C-Means	GLCM	SVM (Support Vector Machine) 91%
Wavelet Berkeley	Discrete Wavelet	SVM (Support Vector Machine) 97.2%

Based on table 3 classification accuracy with a combination of segmentation, extraction features and classification algorithms used show the results obtained accuracy ranges from 83% to 98.86%

CONCLUSION

MRI image processing methods for detecting and classifying brain tumors are the right solution in the medical field. It can help the medical team to identify and classify brain tumors using MRI images. And from the existing algorithm, it can be seen that the Support Vector Machine is the best method for classifying brain tumors based on MRI images supported by some preprocessing and feature extraction as well as the Radial basis function (RBNFF) method. It is hoped that in the future MRI image processing can combine various existing image processing methods to obtain the best results for reading MRI images for the detection and classification of brain tumors.

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