

Detection of Brains Tumors in MRI Images by Using MATLAB

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DOI: <https://doi.org/10.30880/eeee.2023.04.02.091>

Received 14 July 2023; Accepted 03 September 2023; Available online 30 October 2023

Abstract: Detecting brain tumors is a critical task in the medical industry, and magnetic resonance imaging (MRI) is frequently used to find them. However, detecting early-stage brain tumors in MRI images can be challenging due to the size and location of the malignant tissue. This work suggests utilizing MATLAB to apply image processing methods including the median filter, segmentation, feature extraction, and classification to this problem. In the suggested method, images are preprocessed using the median filter, features are extracted using the gray level co-occurrence matrix (GLCM), and the results are then classified using a Support Vector Machine (SVM). As part of the work, a Graphical User Interface (GUI) will be developed for the identification and classify of brain tumors using MRI images. The MATLAB created GUI can be used to identify disorders and support the early expose and management of brain tumors. Through the use of image preprocessing techniques and classify models, high accuracy in the identification and categorization of brain tumors has been attained.

Keywords: Magnetic Resonance Imaging (MRI), MATLAB, Gray Level Co-occurrence Matrix (GLCM), Graphical User Interface (GUI), Support Vector Machine (SVM)

1. Introduction

Brain tumors are abnormal cell growth that can be benign or malignant and are categorized into primary and secondary tumors. Primary tumors begin in the brain or Central Nervous System, while secondary tumors migrate from other body regions into the brain [1]. Brain tumors are categorized into four grading categories based on the severity of the abnormalities of the brain tissue, with low-grade tumors having grades 1 and 2 and high-grade tumors having grades 3 and 4 [2]. Magnetic resonance imaging (MRI) is commonly used for brain tumor detection due to its ability to provide detailed images.

Brain tumors will be difficult to identify, however, they have been identified utilizing image processing procedures such as the median filter, segmentation, feature extraction, and classification

using MATLAB [3, 4]. The suggested method seeks to accurately classify images of brain tumors and distinguish between the detection of tumors and the absence of tumors [5 – 8]. The proposed method is user-friendly because layout design is done using a Graphical User Interface (GUI). The suggested technique can help radiologists and doctors correctly identify various types of brain tumors [9, 10]. This goals of this work are to evaluate feature extraction methods for brain tumors, categorize whether a brain is healthy or has a brain tumor, and assess how well the system designed for detecting brain tumors performs [11, 12]. For the study, feature extraction can be carried out by transforming the data into manageable numerical features that retain the information using the MATLAB software. Finally, performance evaluation is the main focus through accuracy and specification calculations to produce the desired results.

2. Materials and Methods

2.1 Materials

For the reason of developing machine learning models for the detection of brain tumors, the dataset of brain MRI images is crucial. The dataset includes brain MRI images that have been divided into the categories “Tumors” and “No Tumors”. It was posted to Kaggle; however, the publishing date is not given. The dataset is helpful in the development of machine learning models that can precisely identify brain tumors from MRI scans. This study uses the Brain Tumors detection MRI dataset to create a machine learning model for identifying brain tumors in MRI images. The model will go through several processes, including feature extraction, segmentation and classification of the data. The GUI will offer a user-friendly interface for uploading an MRI image and will display the outcomes of each processing step as well as each classifier classification choice to demonstrate whether an image identifies “tumors” or “No Tumors”. The GUI will be used to diagnose disease and aid in the early recognition of brain tumors.

2.2 Methods

As shown in Figure 1, several steps were used to complete this work. Pre-processing is a crucial step in detecting brain tumors from MRI images. It helps to enhance the quality of the image and remove noise and artifacts that can interfere with the segmentation process. The pre-processing technique is used to involve segmentation. Segmentation is the process of dividing an image into multiple segments to identify the regions of interest. Noise removal is the process of removing unwanted noise from the image. By using these pre-processing techniques, the quality of the MRI images is enhanced, and the segmentation process is carried out more accurately. Next, Feature Extraction is the process of extracting relevant features from the image to classify the image into different categories. In this work, the Gray Level Co-occurrence Matrix (GLCM) was used for feature extraction. GLCM is a statistical method that calculates the co-occurrence of pixel values in an image.

By using GLCM, relevant features are extracted from the segmented image, which are then used for classification. Furthermore, Support Vector Machine (SVM) is a machine learning algorithm used for classification part. In this work, SVM was used for the classification of brain tumors detected from MRI images. SVM works by finding the best hyperplane that separates the data into different categories. By using SVM, the MRI images are classified into two classes which are “Tumors” and “No Tumors”. In summary in this work, pre-processing techniques such as segmentation, and noise removal enhance the quality of the MRI images. GLCM was used for feature extraction, and SVM will used for the classifier of the brain tumors detected from MRI images. By using these methods, the accuracy of brain tumor detection from MRI images can be improved, which can help in the early awareness and treatment of brain tumors.

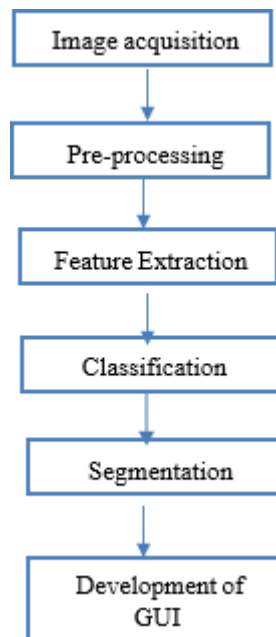


Figure 1: The block diagram of the work

3. Results and Discussion

3.1 MRI Image Pre-Processing

Pre-processing is a series of actions carried out on an image at the lowest level of abstraction to raise its quality by enhancing or removing features that are important for further processing. Pre-processing is intended to enhance or reduce undesirable distortions in original image data that will be used for additional analysis activities. As shown in Figure 2, grayscale conversion can significantly improve an image's visibility. Due to its higher denoising capabilities and computing power, median filtering is successful at minimizing impulsive noise or salt and pepper noise, as shown in Figure 3. In this stage, it is usual practice to quantify the image quality using Mean Squared Error (MSE) and Peak Signal-to-Noise Ratio (PSNR). The mean squared difference between two images or MSE is a measurement. It is determined by subtracting the original images of pixel value from the difference. The MSE stands for the mean square error between the true image and the noisy image. The better image quality, the lower the MSE value, and the higher of PSNR value.

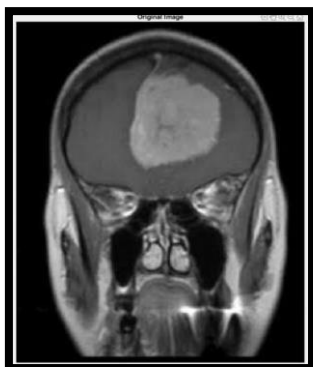


Figure 2: Original image

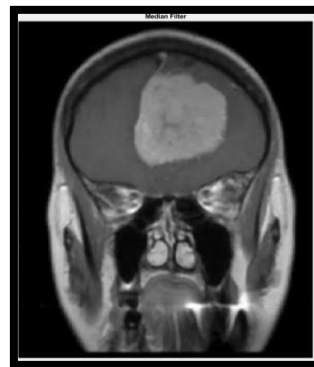


Figure 3: Filtered image using median filter

3.2 Discussions

A popular texture analysis method in image processing include the Gray Level Co-occurrence Matrix (GLCM). The spatial relationship between pairs of pixels with certain intensity levels in an image is represented by the GLCM matrix. GLCM can be used to derive several statistics matrixes,

including contrast, correlation, homogeneity and energy. The “Tumors” and “No Tumors” categories of the bar graph of feature extraction using GLCM are shown in the figure below. By calculating the correlation between the intensities of two pixels, meaning the reference and nearby pixels, with a specific distance and direction, GLCM can reflect extensive information from the image region. The ability to measure fundamental patterns that are unseen to the human eye is the strength of feature extraction.

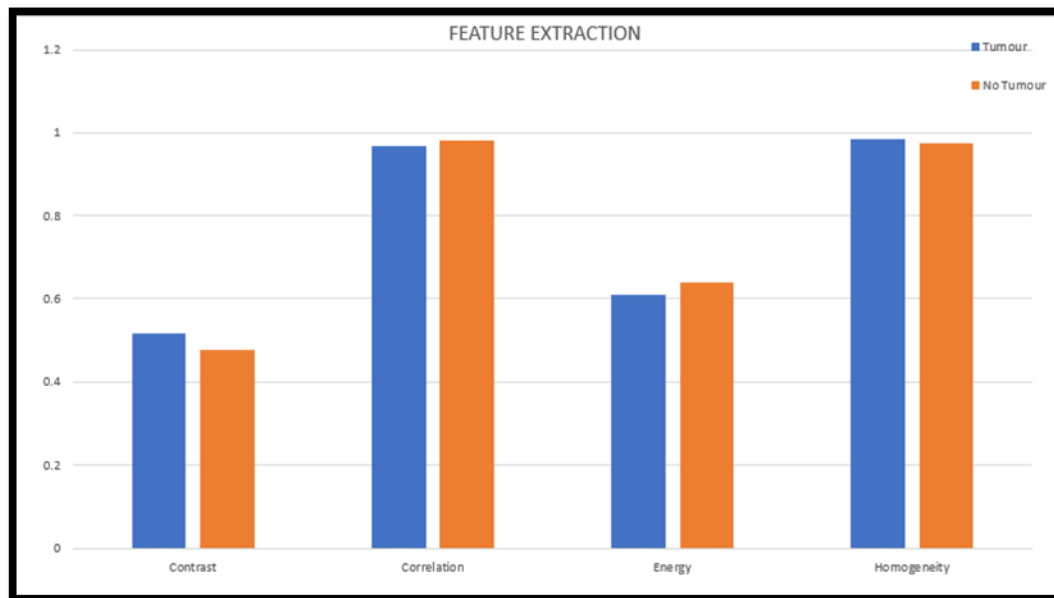


Figure 4: Bar graph of feature extraction

Graycomatrix can be used to create the GLCM, and graycoprops may be used to get several statistics from it. These numbers reveal details about the texture of an image. Contrast is a statistic that we extracted from the GLCM that may be used to quantify local differences in the matrix of gray-level co-occurrence. It also derives other statistics including homogeneity, energy, and correlation. These statistics can provide details about an image’s texture and are employed as classification features. Microsoft Excel can be used to rewrite the contrast, correlation, energy and homogeneity values shown in Figure 4.

3.3 Classification

For the categorization of brain tumor detection using MRI images, the SVM classification was utilized. SVM is a supervised learning technique used in regression and classification studies. The SVM operates by identifying the hyperplane that maximizes the margin between the two classes, “Tumors” and “No Tumors”, as shown in Figure 5 and Figure 6, respectively. Utilizing the GLCM approach, the MRI image characteristics were brought out from the images and used to train the SVM to classify. The SVM classifier employed the feature derived from the MRI images as a process to identify the detection of “Tumors” and “No Tumors”. A dataset of MRI images was used to test the performance of the SVM classifier, and the results revealed that the suggested approach utilizing SVM performed better than other methods in terms of accuracy.

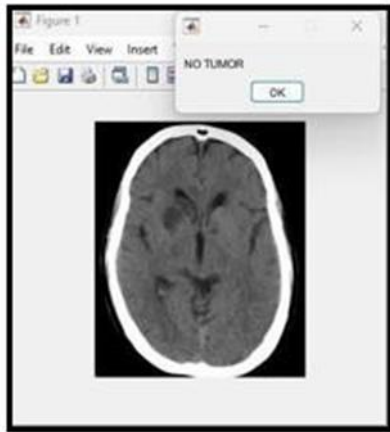


Figure 5: Output SVM detects “No Tumors”



Figure 6: Output SVM detects “Tumors”

3.4 Figures

In this work, an evaluation tool for classification model performance is a confusion matrix. It lists the model’s total number of accurate and inaccurate predictions. As shown in Table 1, a confusion matrix will be used to quantify how effectively each class can identify “Tumors” vs. “No Tumors” when the recommended method is being used to classify the data. Several performance parameters, including accuracy and sensitivity, can be determined using the confusion matrix. The number of correctly identified samples is represented by the values in the confusion matrix diagonal. The proposed method for this research also allows for the use of a confusion matrix to assess performance in precisely identifying brain tumors.

Table 1: Confusion Matrix

	Actual Tumor – Yes	Actual Tumor – No
Predicted Tumor – Yes	True Negative (TN) 15	False Positive (FP) 5
Predicted Tumor – No	False Negative (FN) 3	True Positive (TP) 17

Calculation of accuracy:

$$Accuracy = \frac{TN + TP}{TN + FP + FN + TP}$$

$$Accuracy = \frac{15 + 17}{15 + 5 + 3 + 17}$$

$$Accuracy = \frac{32}{40}$$

$$Accuracy = 80 \%$$

Calculation of sensitivity:

$$Sensitivity = \frac{TP}{FN + TP}$$

$$Sensitivity = \frac{17}{3 + 17}$$

$$Sensitivity = \frac{17}{20}$$

$$Sensitivity = 85 \%$$

The work used the SVM classifier, a suggested technique for the categorization of brain tumors that will be detected from MRI images. By using the dataset, it was determined that the suggested method’s accuracy is 80% and its sensitivity is 85%. The significance of accuracy as a criterion for assessing

classification models was explored and the accuracy of the suggested method's performance was assessed by comparing it to other research in the literature.

3.4 Development of GUI

An algorithm was created to identify brain tumors from MRI images, and Figure 7 and Figure 8 show the results. With the use of preprocessing, segmentation, feature extraction and classification, the research created an algorithm for spotting brain cancers in MRI images. The technique was put into practice using a Graphical User Interface (GUI), which allowed the user to send an MRI image and observe the outcome of each processing step as well as the classification choice made by each classify, which indicated whether the image detected "Tumors" or "No tumors". A diagnostic tool, the GUI can help in early awareness and treatment of brain tumors.

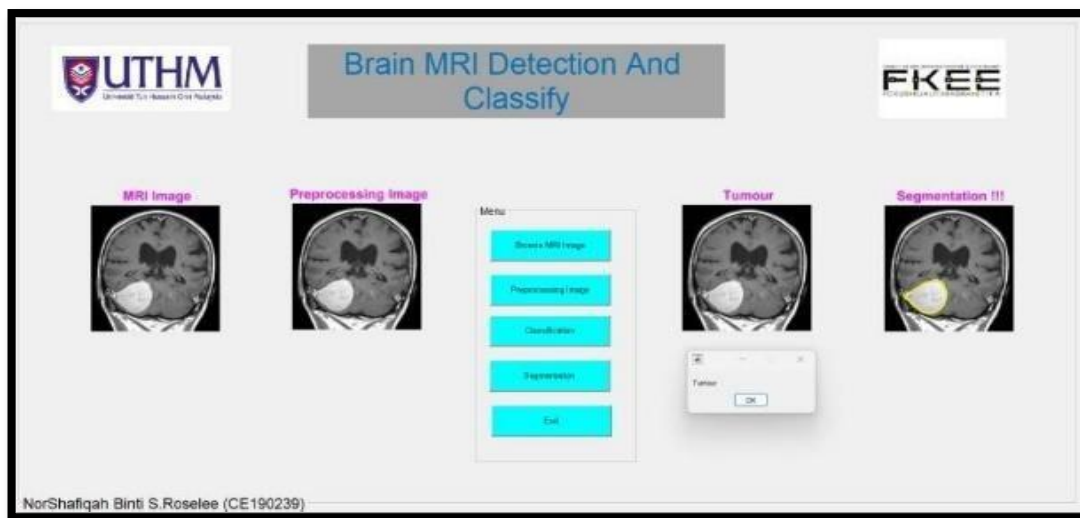


Figure 7: Output GUI of tumors detection

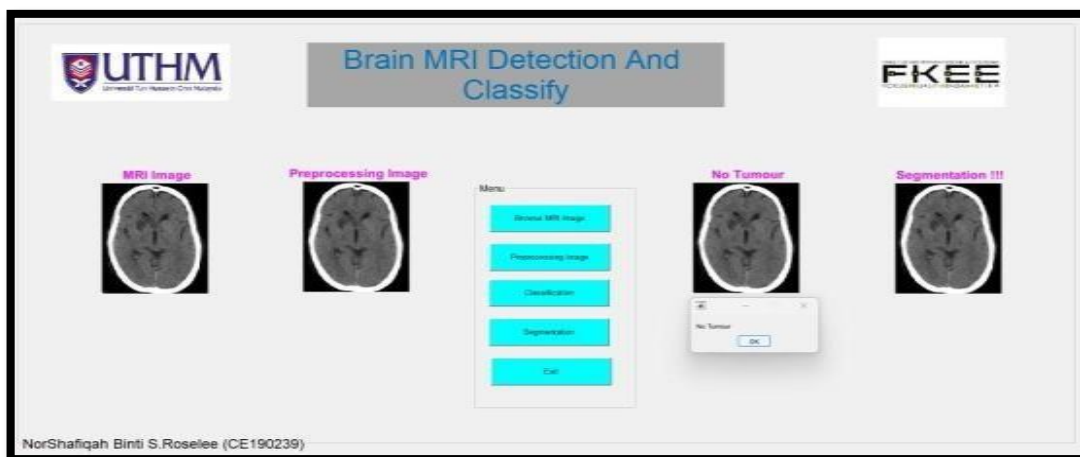


Figure 8: Output GUI of no tumor detection

4. Conclusion

An interactive platform for users to react to the process and acquire the outcome of the categorization detection for brain tumors from MRI images is made possible by the implementation of a Graphical User Interface (GUI) in MATLAB. The GUI offers a user interface for uploading the MRI image and viewing the classification model and processing outcomes. Several studies have been conducted on the identification and classification of brain tumors from an MRI image by using

MATLAB and GUI. The suggested approach can be applied as a diagnostic tool and help with the early recognition and guidance brain of tumors. Through the use of various combinations of image processing techniques, including filtering, segmentation and classification models like the Support Vector Machine (SVM), these studies have categorized the detection of “Tumors” and “No Tumors”. The identification and classification of brain tumors have improved dramatically with the introduction of image preprocessing methods and classification algorithms.

Acknowledgement

The authors would like to thank the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia for its support.

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