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Medical Image Fusion for Brain Tumor Detection

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Abstract

Medical image fusion is an important task in medical diagnosis that aims to provide a complete representation of medical images by combining multiple imaging modalities. The fused image is then fed into deep learning algorithms for tumor classification. In this paper, we propose an approach for medical image fusion of CT and MRI scan images for brain tumor detection. This work proposes an algorithm for the fusion of several imaging modalities, such as MRI and CT, based on a classifier with a fusion rule. Several qualitative and quantitative evaluation metrics have been used to assess the performance of the proposed method and compare it to cutting-edge image fusion techniques. On the basis of metrics like standard deviation, entropy, mutual information, etc., the experimental findings are assessed. In terms of accuracy and training loss metrics, the experimental results show that the proposed approach outperforms the individual modalities. As a result, the suggested technique can be employed as an effective and accurate instrument for the detection of brain cancers. The method can be used to increase diagnosis precision and decrease the false-negative rate, which will ultimately improve patient outcomes.

Keywords: Image Fusion, Deep Learning, Computed Tomography (CT), Magnetic Resonance Imaging (MRI).

Introduction

The goal of medical imaging is to find abnormal growths in the brain that may be dangerous or otherwise harmful. Brain tumor identification is a critical step in this process. Brain tumors can now be identified sooner and with more accuracy because to advancements in medical imaging technology, which enables doctors to create more efficient treatment regimens and enhance patient outcomes**.** The use of computing technology in the medical industry has grown in significance throughout time. X-rays and scanning methods are two examples of how computer science is applied in the medical industry. Despite the fact that they are different innovations, they are used in conjunction with computer technology. Brain tumor identification was once considered impossible. Individuals that are identified

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with brain tumors and other disorders were considered dead. Certain illnesses have yet to be cured. Yet we can't say the same with Brain Tumor. Many Brain Tumor treatment methods have been developed. In order to find any abnormalities or unusual growths in the brain, medical images like magnetic resonance imaging (MRI) or computed tomography (CT) scans are frequently analysed in order to discover brain tumors. Medical experts must be very skilled and knowledgeable to complete this process, and they must also employ specialised software and algorithms to help with the interpretation of medical images.

For patients to have better outcomes and have a better chance of receiving symptomatic relief, early diagnosis of brain tumors is essential. As a result, current research in this area is concentrated on creating more sophisticated imaging tools and processing procedures that can more precisely and accurately diagnose.

The identification of brain tumors using image fusion is a cutting-edge method that integrates many imaging modalities to increase the precision and dependability of the diagnosis. Several sorts of information on the brain tissue and its anomalies are provided by medical imaging techniques includingCT, PET, and MRI. Doctors can gain a more complete knowledge of the anatomy of the brain and any possible tumor growths by combining these various types of imaging.

In image fusion, two or more pictures collected using various imaging modalities are combined to generate one composite image. Guided image filtration is a way to remove noise from MRI and CT images while preserving important features[7].The existence of brain tumors is then detected and their location, size, and kind are determined by analysing this composite picture. As each imaging modality offers a unique set of data that might complement one another, its combination enables medical professionals to diagnose brain cancers more precisely.

Due to its capacity to increase diagnostic precision, decrease false-positive findings, and offer a more thorough picture of the brain's anatomy, image fusion in the detection of brain tumors has grown in popularity in recent years. By assisting medical professionals in choosing the optimal way to proceed for patients with brain tumors, this approach can also help with treatment planning.

By giving precise and thorough information about brain tumors, image fusion's ability to identify brain cancers has the potential to greatly enhance patient outcomes. The goal of ongoing studies in this field is to create more sophisticated picture fusion methods and algorithms that will increase the precision and effectiveness of brain tumor detection and therapy.

Literature survey

1. S. Subashini et al., [1]examined on image fusion which may be utilized to detect brain tumors. The authors emphasise the need of integrating several imaging modalities, such as computedtomography(CT), magnetic resonance imaging (MRI) to increase tumor detection

accuracy. They cover the merits and limits of several image fusion approaches such as principal component analysis and wavelet transforms.

2. Shuai Zhang et al., [2] proposed an innovative approach for sensing and segmenting brain tumors in MRI images. It identifies and segments brain tumors using algorithms for image processing. The technique has been tested on a dataset of 15 brain tumor patients, and the findings indicate that the suggested system provides good precision in tumor segmentation and detection.

3. Anjitha P et al.,[3] had researched on brain tumor detection. In this, the median filter is used to pre-process the input images. Fusion is performed using the NSCT domain. SURF is used to extract features from the input CT and MRI images after they have been fused. The authors had used the SVM algorithm and yielded higher accuracy for brain tumor detection.

4. Gupta P et al., [4] had used Weighted Averaging, Wavelet Transform, PCA, and PSNR comprise the algorithms for multi-focus image fusion. It emphasizes the significance of image fusion in different applications and explores into the positive and negative aspects of computation for accomplishing high quality image fusion. It also evaluates the efficiency of every algorithm using metrics like PSNR and SSIM.

5.Patil, Ujwala et al., [5] has analysed the hierarchical PCA fusion process which begins by using a weighted average method to fuse the first level of attributes from all input images. The fused coefficients that results are utilized to reconstruct the first level fused image. When compared to other image fusion techniques, such as the wavelet transform, the proposed method produces better results in terms of image quality, sharpness, and preservation of important features.

6. Harpreet K et al.,[6] suggested a discrete wavelet transform-based tumor identification approach using Multi-Modality MRI Images Fusion. It merges FLAIR, T1 and T2-weighted MRI images. This technique may be used to find several tumor forms that show distinct features on various imaging modalities. They demonstrate that their suggested strategy delivers superior accuracy when compared to other established techniques. [8-16]

Problem Identification

A brain tumor can form within brain cells, but it may also form elsewhere and spread to the brain. Headaches, nausea, and balance issues are some of the indications and symptoms that the tumor can produce as it spreads because it puts stress on the surrounding brain tissue and alters how it functions. Thus, it needs to be treated at earlier stages.Both CT and MRI are frequently utilized imaging modalities for the diagnosis of brain tumors, and they both offer distinct insights into the architecture and function of the brain. Combining CT and MRI scans using image fusion techniques can improve the overall resolution and information richness of the images and give more thorough data. By Using Deep learningmethods,we can reliably retrieve information from medical pictures, such as fused CT and MRI scans, and create representations that are helpful for spotting brain tumors to make better predictions.

Methodology

The detection process of brain tumor involves several steps, the first stage is to getMRI and CT scans of the patient's brain.The next stage is to combine the MRI and CT images using an image fusion method. A deep learning technique, CNN is trained on the fused images of CT and MRI scans.

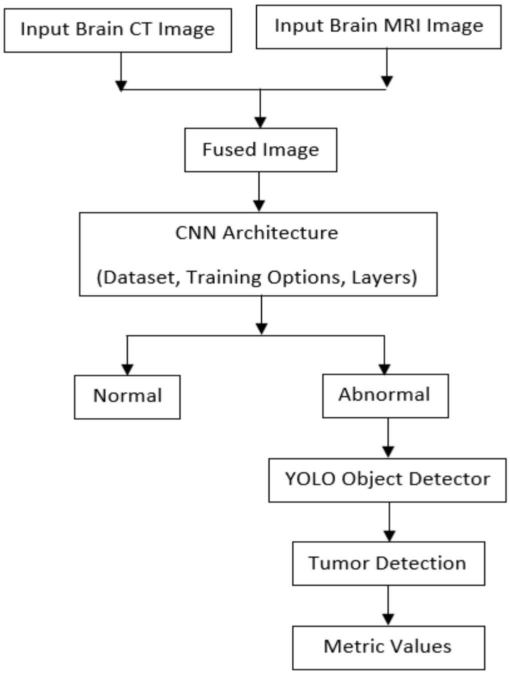

Fig.1. Methodology

After training, the fused image is passed through an object detection algorithm, such as YOLO, to detect the presence of tumors in the brain. The detected tumors are post-processed to remove false positives and improve the accuracy of the detection.Fig.1 represents the block diagram of methodology.

Implementation

YOLO is a famous object detection technique for identifying brain tumor detection, and also includes CNN which is frequently employed for image analysis and recognition tasks, such as the recognition of brain tumors from fused images of CT and MRI scans by using Image fusion.It involves collecting CT and MRI images of the patient in DICOM format such as Fig.2 and Fig.3.The images should be preprocessed to make sure they are consistent, high-quality, and the same resolution.

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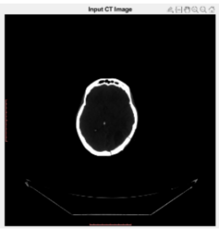
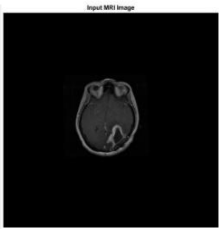

Fig.2.CT image Fig.3. MRI Image

Image Fusion:

Image Fusion is the process of combining information from CT and MRI scans to produce a single image that offers complimentary information for medical diagnosis and treatment planning. It takes two types of images the CT and the MRI as an input.The Matlab plays the main role of implementing the Image fusion in the application. The images are fused and results in a fused image altogether by using image fusion commands.

CNN:

A sort of artificial neural network well known as convolutional neural network (CNN) is intended primarily for image processing applications. Ituse a technique called convolution to extract local features from images.CNN architecture can handle fused pictures for object detection in an efficient manner. Convolutional layers, pooling layers, and fully linked layers should all be present in the design. The complexity of the work will decide the quantity and size of layers and the variety of activation functions employed.

YOLO:

This is an algorithm that detects and recognizes various objects in a picture. YOLO performs object detection as a prediction model and returns the class probabilities of such detected images. The MRI and CT scans should be preprocessed to make sure they are consistent, high-quality, and of the same resolution. To identify the existence of brain tumors, train a Classifier model using the labelled MRI images and CT images and then use them on new brain MRI and CT image data. The CNN is used to predict several bounding boxes and class probabilities.The number, quality, and architecture of the CNN determine how well the YOLO model performs. By modifying and refining the hyperparameters, the model's accuracy may be increased.

Result and Conclusion

In this work, the presence of brain tumor is predicted in the collected MRI and CT images. CT and MRI scan images are fused together and forms a fused image with the help of image fusion technique. The below Fig.4. is the resultant fused image.

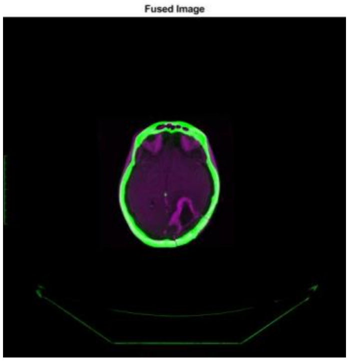

Fig.4. Fused Image

Later the fused image will be classified as either normal or abnormal. If the network is detected as abnormal, the part of the tumor region is localized. Fig.5. represents the region where the tumor is detected.

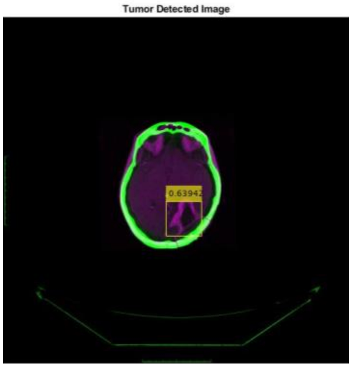

Fig.5. Tumor Detected Image

Also, the Matlab plots a graph showing the accuracy and depicting the Training loss.The Training loss (shown in Fig.6.) refers to the how the deep learning model fits in with the data.

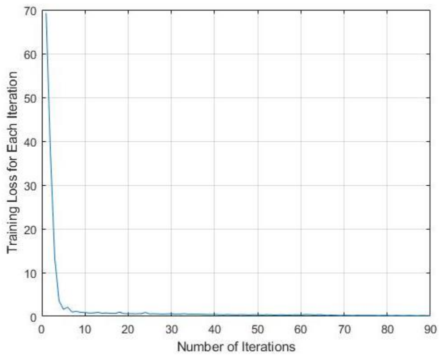

Fig.6. Training Loss Graph

Accuracy and training loss metrics are evaluated and produces best adequate outputs when compared to existing works. As shown in Fig.7.

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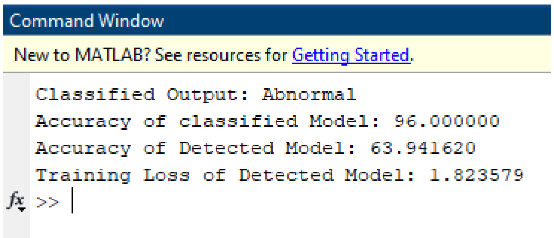

Fig.7. output

Different models have been tested regarding the accuracy for brain tumor detection. The accuracies are listed in below Table.1.

Algorithm	Accuracy
Image fusion	93.32
SVM	89.77
YOLO	96.01
CNN	93.07

Table.1. Accuracy comparison of models independently in the proposed model.

Future Scope

In Future, it may be extended to function with more medicaldatasets of images, real-time pictures, and various sorts of imaging techniques for body cancer or tumors or tumor types in the brain.

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