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Brain Tumour Detection Using Convolutional Neural Network

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ABSTRACT

In the early stages of life, identifying a brain tumour can be a challenging task. The problem of brain tumours is now a common occurrence. A lot of people are interested in automatic identification. Patients' data, such as MRI pictures of the brain, are used to detect brain tumours. Our task is to determine whether or not a tumour exists in the brain of the patient. For a patient's health to be preserved, it is critical to discover malignancies at an early stage. Deep learning will aid in the health business of medical diseases imaging in the Medical Diagnostic of all disorders, according to a recent field of this study. This machine learning method heavily relies on CNN. We presented a technique for extracting information.We suggested a convolutional neural network-based technique for extracting brain tumours from 2D magnetic resonance images (MRI). The experiment was conducted on a real-time dataset with a wide range of tumour sizes, locations, forms, and image intensities. The Convolutional Neural Network technique was used to determine the severity of brain tumours, which provided more accurate findings than the old pre-trained models.

KEYWORDS: Deep learning, Convolutional Neural Network, Machine Learning, Magnetic Resonance Image..

1.INTRODUCTION

The brain is a large and complicated organ with 50–100 billion neurons. It is made up of a great number of cells, each of which has distinct purpose. The majority of cells that are produced in the body divide to develop new cells in order for the human body to function properly. Aged or damaged cells die as new natural cells grow. Then, in their place, new cells appear. When the body does not require new cells, they are produced. Furthermore, cells that are old or damaged do not die as they should. Extra cells are produced by the body, which form a mass of tissue known as a tumour. The delicate functioning of the body is harmed when a tumour is implanted in the brain region. Because of its location and tendency to spread, it is extremely difficult and dangerous to cure. The two most common types of brain tumours are benign and malignant. Non-cancerous tumours are called benign tumours, while cancerous tumours are called malignant tumours.

In biological sciences, such as tumour detection and classification, cancer detection and classification, and testing and inspecting vital sections of the human body, digital image processing (DIP) is a developing topic. In medical science, automatic brain tumour detection is extremely important. The brain (also known as the body's processor) plays a crucial role in the human body, which is made up of various types of cells. The brain is the most important part of our nervous system. The brain is a complex organ that controls thought, memory, emotion, touch, motor skills, vision, breathing, temperature, hunger and every process that regulates our body. Together, the brain and spinal cord that extends from it make up the central nervous system, or CNS.

In 2020, an estimated 251,329 persons will have died from primary malignant brain tumours around the world. A brain tumour is an abnormal cell growth or mass in the brain. There are many distinct types of brain tumours. Some brain tumours are benign (noncancerous), while others are cancerous (malignant). Brain cancers can start in the brain (primary brain tumours), or they can start elsewhere in the body and spread to the brain (metastatic brain tumours). After breast cancer, brain tumours are the second leading cause of death in cancer patients. Women are more likely than men to be impacted by brain tumours in all circumstances. In numerous nations, the incidence of brain tumours has continued to rise for the past decade.in cancer patients. Women are more likely than men to be impacted by brain tumours in all circumstances. In numerous nations, the incidence of brain tumours has continued to rise for the past decade. Medical imaging is critical for detecting and diagnosing brain cancers, as well as preventing more serious disorders.

Researchers use magnetic resonance imaging (MRI) to detect brain malignancies. Because it does not involve ionising radiation, MRI is one of the most extensively used medical imaging procedures for brain tumours. A powerful magnet and radio waves are used in magnetic resonance imaging (MRI) to examine organs and structures inside your body. MRI scans are used by doctors to diagnose a wide range of diseases, from torn ligaments to malignancies. For evaluating the brain and spinal cord, MRIs are quite beneficial. It's a non-invasive imaging technique that generates three-dimensional anatomy images. It's frequently used to detect diseases, diagnose them, and track their progress. It is based on cutting-edge technology that excites and detects changes in the rotational axis of protons in the water that makes up biological tissues.

Experts use manual methods to detect a brain tumour. However, there are several drawbacks, such as the fact that it takes a long time and that the segmentation of an MR image by different experts can differ greatly. Furthermore, the findings of tumour detection by the same physician can vary depending on the conditions, and the brightness and contrast of the display screen can affect the segmentation results. The automatic detection of brain cancers becomes important for these reasons. Automatic detection of brain cancers can improve a tumour's chances of survival.

In this paper, we introduced an efficient and skilled technique based on Convolutional Neural Networks that aids in the segmentation and detection of brain tumours without the need for human intervention.

2. LITERATURE SURVEY

According to the World Health Organization, cancer is the second greatest cause of human death. Because of its aggressive nature, complex traits, and low survival rates, brain tumor is regarded as one of the most lethal cancers. The type of brain tumor discovered has a significant impact on the treatment options and the patient's survival. Because Haman-based identification is frequently erroneous and imprecise, there has been a surge of interest in employing convolutional neural networks to automate this process (CNN). Because CNN does not fully exploit spatial relations, it may result in inaccurate tumor classification. We have added freshly updated Caps Net in our technique to overcome this problem. The biggest benefit is that CapaNet will have access to moments near the tumor without detracting from the primary goal. As a result, an improved CapiNet architecture for brain tumor classification is provided, which includes the coarse tumor boundaries as an extra input within its pipeline for accelerating the CapaNet's emphasis.

Szegedyet al.2015 proposed a deep convolutional neural network architecture codenamed Inception, In the ImageNet Large-Scale Visual Recognition Challenge 2014, which was responsible for setting the new state of the art for classification and detection (ILSVRC14). The enhanced usage of computing resources within the network is the fundamental feature of this architecture. This was accomplished by a well-thought-out architecture that permits the network's depth and width to be increased while keeping the computational budget constant. His findings appear to support the idea that using easily available dense building blocks to approximate the expected optimal sparse structure is a viable strategy for developing neural networks for computer vision.

Brain Tumour Segmentation Using Convolutional Neural Networks in MRI Images, Malignant tumors are the most aggressive and prevalent type of brain tumor, resulting in a shorter life expectancy. For assessing malignancies, MRI is a widely utilized imaging modality. Because of the large amount of data generated by MRI, manual segmentation takes a long time, limiting the application of precise quantitative measurements in clinical settings. To solve this, a CNN-based automatic segmentation technique that explores tiny kernels is presented. Because the network has a small number of weights, using small kernels allows for a more detailed architecture while also providing an edge against overfitting. The use of intensity normalization in pre-processing with data augmentation for brain tumor segmentation in MRI images has been shown to be effective.

R. B. Dubey used the Gaussian filter to reduce noise from the input of an MRI picture in his research. The Weierstrass Transform is very similar to the Gaussian filter, which uses a Gaussian Function to convolve data. The Gaussian filter is used to turn an image into a smooth image. The image has the appearance of being viewed through a translucent screen. The Gaussian filter is a form of low pass filter that removes noise from images by passing it through the high frequency regions. However, the process takes longer to finish, and there are fewer details provided.

SVM and BWT image analysis approaches were proposed by Bahadure et al. for MRI-based brain tumor identification and classification. For the goal of detection, skull stripping was used, which removed all non-brain tissues.

For segmentation of MRI brain images, Joseph et al. offered the K-means clustering algorithm, as well as morphological filtering for tumor detection. Alfonse and Salem suggested a Support Vector Machine for automatic brain tumor categorization of MRI images.

3. EXISTING METHOD

We used a machine learning technique to segment and detect brain tumours in our first prospective model, and we compared the classifiers for our model delineated. In our existing method, we have a technology that can segment images of the brain. There are seven stages to this process: skull stripping, filtration, and analysis. Fuzzy C Means algorithm enhancement, segmentation, Tumour counting, morphological operations. Traditional classifiers are used to extract and categorise information. Our efforts yielded positive outcomes. The major steps of our existing model (Figure 1) will be depicted the sections that follow.

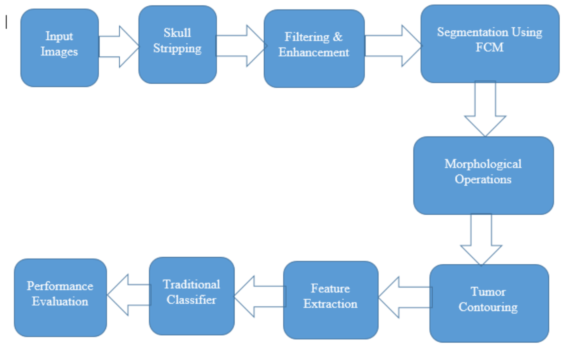

Fig.Existing Method

1)Skull stripping: Skull stripping is a critical step in medical image processing because the MRI picture's backdrop contains no relevant information, and it just adds to the processing time. We eliminated the skull section of the MRI scans in three steps in our research. These are the three steps:

a) Otsu Thresholding: To remove the skull, we first utilized Otsu's Thresholding approach, which calculates the threshold value and divides the image into background and foreground automatically. The threshold chosen in this method minimizes intra-class variance, which is defined as the weighted sum of the two classes' deviations.

b) Connected Component Analysis: We performed connected component analysis to recover only the brain region at the end of our skull stripping step, which resulted in the skull part being removed.

2)Filtering and Enhancement: Because brain MRI images are more sensitive to noise than any other medical imaging, we need to maximize the MRI image quality with minimal noise for better segmentation. In our research, we employed a Gaussian blur filter to reduce Gaussian noise in brain MRI, which improved segmentation performance.

3)Segmentation using FCM: For segmentation, the fuzzy C-Means clustering algorithm was employed, which permits one piece of data to belong to two or more clusters. At this point, we had the fuzzy clustered segmented image, which ensured superior segmentation.

4) **Morphological Operation:** We just need the brain component of the tumor to segment it, not the skull part. We used morphological operations on our photos to achieve this. At first, erosion was used to separate the

MRI image's weakly linked sections. After erosion, our photographs will have several disconnected sections. After then, dilation was used.

5) Tumour Contouring: Description Tumor cluster extraction was done using a thresholding-based intensity-based technique. The highlighted tumor area with a dark background is the result of this photograph.

6)Feature Extraction: For categorization, two types of characteristics were extracted. Texture-based parameters such dissimilarity, homogeneity, energy, correlation, and ASM, as well as statistical features like mean, entropy, centroid, standard deviation, skewness, and kurtosis, were retrieved from segmented MRI images.

7) Traditional Classifiers: To determine the accuracy of our proposed model's tumor identification, we applied six classic machine learning classifiers: K-Nearest Neighbor, Logistic Regression, Multilayer Perceptron, Nave Bayes, Random Forest, and Support Vector Machine.

8)Evaluation Stage: Using various region-based segmentation approaches and comparing them to our proposed segmentation strategy, we found that our model accurately divides the ROI and separates the tumor component. The entire procedure is illustrated in a diagram. We used six classification techniques after segmenting and extracting features from the tumor. We obtained the best result from SVM out of all of them.

4.PROPOSED METHOD

In the domain of medical image processing, the convolutional neural network is widely used. Many academics have tried over the years to develop a model that can more accurately detect tumors tried to come up with a model that could accurately classify a tumor from 2D images.MRI scans of the brain. Although a fully linked neural network may detect the tumour. We choose CNN for our model because of parameter sharing and connection sparsity. A Five-Layer System the Convolutional Neural Network is introduced and used to detect tumors. The aggregated model, which consists of seven stages and includes the hidden layers, gives us the tumor's apprehension yielded the most notable result.

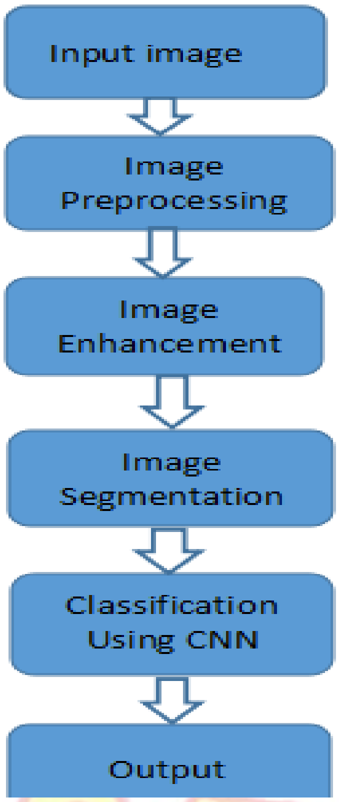

Fig. Block diagram of Proposed model

1. **Input image:** The input image or image Acquisition is the MRI (Magnetic Resonance Image). The MR Images is taken from the scanner and the design flow goes to the image preprocessing. The main reason we are choosing MR Images is there is non-radioactive and harmless to humans compared to x-ray and CT scan. And also, there is another advantage of clear image of the particular organ like brain.

2. **Image Preprocessing:** For a perfect input, the basic procedures in the pre-processing stage include image scaling and clear image for quick image identification. Pre-processing is the first and most important step in improving the quality of a brain MRI image. The elimination of impulsive sounds and image scaling are crucial processes in pre-processing. In the first phase, we transform the brain MRI image to its gray-scale. The adaptive bilateral filtering approach is used to reduce the distorted noises that are present in the brain image. This enhances the accuracy of classification and improves diagnosis.

3. **Image Enhancement:** Image Enhancement is the next step of the preprocessing. In this stage the image quality is increase by using the software for better accuracy. Image enhancement aims to increase the interpretability

or perception of information in images for human viewers, as well as to give 'better' input for other automated image processing approaches.

4. Image Segmentation: Image segmentation is the process of partitioning a digital image into several image segments, also known as image regions or image objects, in digital image processing and computer vision (sets of pixels). The purpose of segmentation is to make an image more intelligible and easier to examine by simplifying and/or changing its representation. Objects and boundaries (lines, curves, etc.) in images are often located via image segmentation. Image segmentation, to put it another way, is the process of giving a label to each pixel in an image so that pixels with the same label have similar features.

5. Convolutional neural network: A convolutional neural network is a type of deep neural network that is most typically used to evaluate visual imagery in deep learning. The Convolutional Neural Network (CNN) is a type of Neural Network+. When we think about neural networks, we usually think of matrix multiplications, but this isn't the case with ConvNet. It employs a technique known as Convolution.

The block diagram for Convolutional Neural Network as shown below.

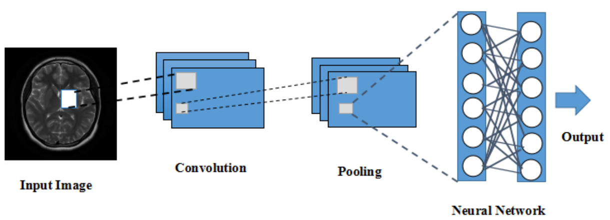

Fig. Block diagram of CNN

A) Convolution: The convolutional layer is the most important component of a CNN because it is where the majority of the computation takes place. It requires input data, a filter, and a feature map, among other things. The Convolution operation reduces the size of the image by creating a feature map, which aids in easier and faster processing of the image, as seen in Figure 3. Every image has its unique set of characteristics; hence the convolution procedure recognizes those characteristics of the picture. Convolutional layer uses a filter to apply a convolution operator to the input data and provides a feature map as an output. The convolution technique is used to extract high-level characteristics from the input image, such as edges.

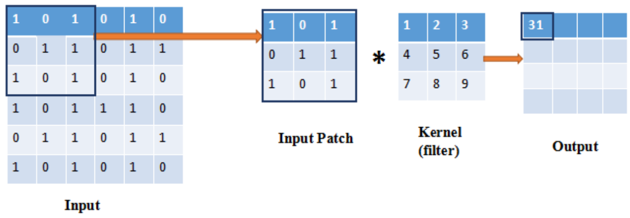

Fig.Operation of convolution

B) Pooling: Pooling is frequently done after a convolution layer to minimize dimensionality. This allows us to limit the number of parameters, reducing training time and avoiding overfitting. Each feature map is down sampled independently using pooling layers, lowering the width and height while maintaining the depth. The most frequent sort of pooling is max pooling, which takes the maximum value in each window. There are no parameters for pooling. It simply reduces the size of the feature map while maintaining the essential information.

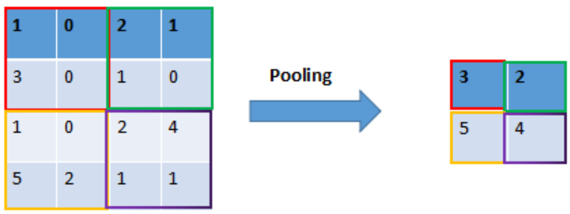

Fig. Operation of Pooling layer

5.RESULTS

Fig. Input image

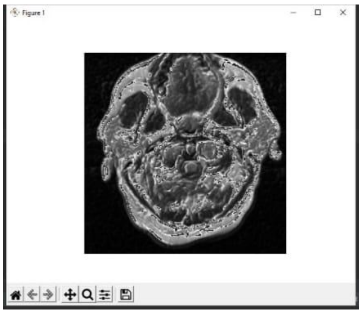

Fig. Image Preprocessing

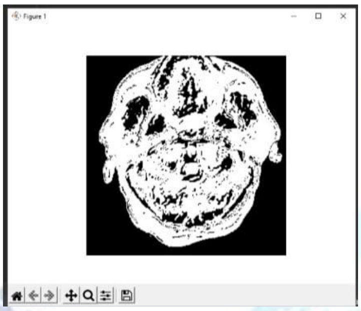

Fig. Image Enhancement

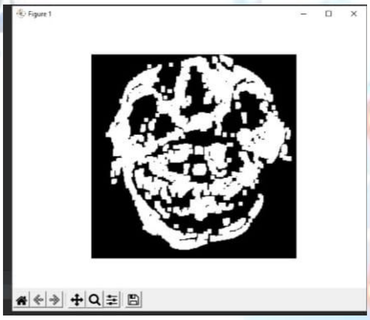

Fig. Image Segmentation

6. CONCLUSION

Using the Convolution Neural Network, we suggested a computerized technique for segmenting and identifying a brain tumor. Using the file location, the input MR images are read from the local device and transformed to grayscale images. For the removal of sounds contained in the original image, these images are pre-processed using an adaptive bilateral filtering technique. The denoised image is subjected to binary thresholding, followed by Convolution Neural Network segmentation, which aids in the identification of the tumor location in MR images. The proposed model has an accuracy of 89 percent and produces promising results with no errors and a significantly reduced computational time.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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