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Classification Of Brain Tumor Types Using Convolutional Neural Network (CNN)

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Abstract. Brain tumors are a group of tumors consisting of various elements with different elements. The incidence varies according to tumor type, sex, race and age. The classification of brain tumors is quite a challenging job in the field of medical image processing. The tumor classification model is important for assisting radiologists in detecting brain tumors. The brain tumor classification model using the Convolutional Neural Network has a high degree of accuracy. The proposed system has six feature extraction layers and two classification layers in three steps, Pre-processing that changes the image size, feature extraction and classification using Convolutional Neural Network (CNN) is proposed in this study. The application of feature extraction using Convolution Neural Network (CNN) can retrieve information from images and become a tool for classifying brain tumor image types into four classes, namely Glioma Tumors, Meningioma Tumors, Pituitary Tumors and Without Tumors which can produce better classification with accuracy amounted to 98.93%.

INTRODUCTION

Brain tumor is a group of tumors consisting of various elements with different properties[1]. The incidence varies according to tumor type, sex, race and age[1]. Age and gender vary the risk of brain tumors and several studies have shown ethnicity as a variation in risk[2]. One of the most popular research topics in the academic community today is brain tumors [3]. Brain tumor detection is an important process, which is based on doctor's knowledge and experience [4]. Brain tumor classification is a challenging job in the medical field in terms of image processing [5]. A popular technique for detecting brain tumors is using magnetic resonance imaging (MRI) analysis [6]. Many radiologists to analyze brain tumors using magnetic resonance imaging (MRI), to determine whether the brain is normal or abnormal can be analyzed on the results of MRI [6]. The tumor classification model is important for assisting radiologists in detecting brain tumors [4]. The classification of brain tumors can be determined using the Convolutional Neural Network (CNN).

Research related to the classification of Brain Tumors using the CNN Alexnet Algorithm using an MRI Brain Tumor image dataset of 400 images has been carried out. In a study conducted using the SDGM optimizer and obtained an accuracy of 96.25%, an error rate of 3.75 while using the Adam optimizer obtained a higher accuracy of 97.91%, a lower error rate of 2.08 [7]. Another study uses a dataset of more than 2000 images where 80% is used as train data and 20% is used as test data. The study classified MRI images into 2 classes, namely with tumors and the second without tumors. Brain tumor detection is done through classification by retraining the classifier using a technique known as transfer learning. CNN Alexnet algorithm produces an accuracy of 86.64% [8].Classification of brain tumor types into 3 classes, namely Glioma, Acoustic Neuroma and Meningioma with a total dataset of 120 types of brain tumors with different origin, location, size and characteristics of tumor tissue. By using 10, 50 and 60 iterations of the CNN Alexnet Algorithm, the accuracy is 93.33% [9].Classification (Glioma, Meningioma, and Pituitary) in the dataset used a total of 3064 images from 233 patients. The aim of this study is to classify MR images of brain tumors that are accurate and precise in clinical diagnosis and decision making for patient care. Classification was carried out using the CNN architecture and obtained an accuracy of 94.82% [10].

The brain tumor classification model using the Convolutional Neural Network has a high degree of accuracy [11][6]. The proposed system using Convolutional Neural Network was experimentally evaluated on augmented and original data and the results showed convincing performance compared to the existing methods [12]. The proposed system has six feature extraction layers and two classification layers. The application of feature extraction using the Convolution

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Neural Network (CNN) can retrieve information from the image and become a tool for classifying brain tumor image types into four classes, namely Glioma Tumor, Meningioma Tumor, Pituitary Tumor and Without Tumor so that it can produce a better classifier.

RESEARCH METHODOLOGY

The stages in this study include the stages of taking the database, the database used is the MRI Brain Tumor image database. After taking the dataset, the next stage is Pre-Processing, then Feature Extraction and Classification using a Convolution Neural Network (CNN). The stages of the research method can be seen in Figure 1.

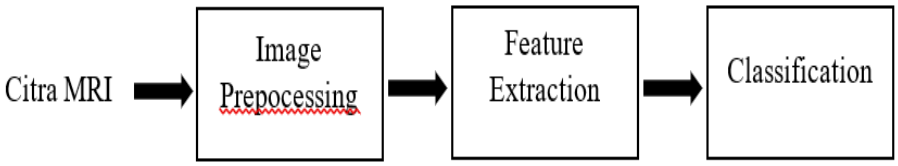


FIGURE 1. Stages of Research Methods

Dataset

The dataset used is a dataset of MRI images of a brain tumor or brain tumor. The dataset was obtained from Kaggle (https://www.kaggle.com/sartajbhuvaji/brain-tumor classification-mri). The brain tumor dataset contains MRI data consisting of 3264 brain tumor images which have been broken down into training data folders and data testing folders. Each folder has 4 sub-folders consisting of 4 image classes of brain tumor types including Glioma Tumors, Meningioma Tumors, Pituitary Tumors and No Tumors. A sample dataset of brain tumors can be seen in Figure 2.

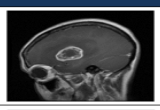
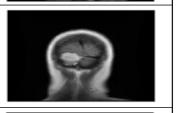
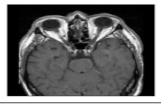
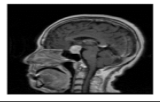
Nama Kelas	Citra
Glioma Tumor	
Meningioma Tumor	
No Tumor	
Pituitary	

FIGURE 2. Dataset of Brain Tumors

Pre-Processing

In this study, using a dataset of 1580 MRI images of Brain Tumors or brain tumors. The dataset used has a grayscale color type with different image dimensions, so that to facilitate the subsequent process all the dimensions of the brain tumor image are converted into 256 x 256 pixels. The data from the four classes are divided into three types of data groups, namely training data and testing data. The division of data groups for the training process is 90% and the data for the testing or test process is 10% of the total data. Then from the training data taken 10% as validation data.

The training data is used to carry out the network learning process, then evaluated. If the accuracy of the network model training process is not good, it is necessary to modify the CNN layer, network parameters and to the data sample. If the accuracy results are good, then the next process is carried out, namely testing with validation data. Validation data is data that is not used in the training process. If the accuracy of this validation data is not good, overfitting may occur, therefore the network needs to be modified again. If the results are good, it can be used to process test data. The test data contains a set of data samples for which you want to know the type of classification.

Feature Extracion and Classification

In this study, the implementation of deep learning in the classification of brain tumor types based on brain images using the Convolutional Neural Network (CNN). Broadly speaking, the way the Alexnet architecture system works is divided into two layer groups. The first is the feature extraction layer which is composed of the convolution layer and the pooling layer, and the second is the classification layer. To overcome the shortcomings in the high resolution image data training process, it is necessary to set up several layers and explore the parameters for training data so that the CNN model can display good performance and prevent unstable gradients, especially on deep networks. The structure of the proposed CNN model is presented in Figure 3 and Table 1. The network used consists of an input layer, 3 convolution layers, a fully connected layer, and an output layer.

At the input layer, the data used is training data. Then the input data is processed at the first convolutional layer using max pooling and the ReLU activation function. The output in the first convolution layer is used as input in the second convolution process. The convolution process continues until the third convolution. Then the results of the convolutional process are collected at the fully connected layer. In this layer, features that have a correlation with a certain class are determined so that the end result of this process is a feature that is classified into four classes.

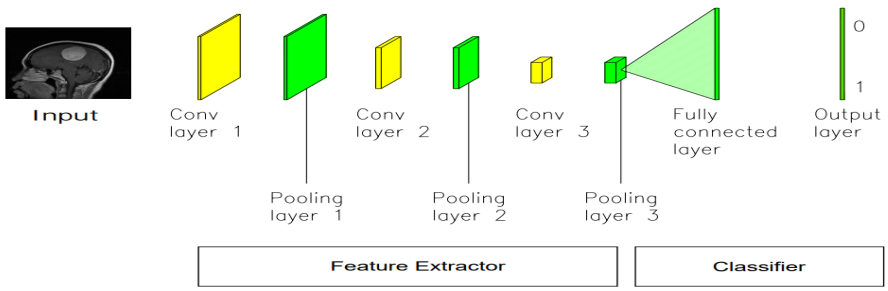


FIGURE 3. CNN architecture

Based on the CNN architecture, the proposed CNN architectural model structure is formed which consists of a Convolutional Layer, a Polling Layer and a Fully Connected Layer. The input image is 256x256x3, if the input image has a different size, the image size will be changed to 256x256x3. Convolutional layer and Polling Layer are feature extraction processes and Fully connected layer is a classification process that will produce 4 output classes with the same output image size as the input image, which is 256x256x3.

TABLE I. CNN Architectural Model Structure.

Layer	Pixel Size	Node
Input	256 x 256 x 3	
Conv 1	256 x 256 x 16	208
Max Pool 1	128 x 128 x 16	
Conv 2	128 x 128 x 32	2080
Max Pool 2	64 x 64 x 32	
Conv 3	64 x 64 x 64	8256
Max Pool 3	32 x 32 x 64	
FC		2004
Output	256 x 256 x 3	

RESULT AND DISCUSSIONS

There are three stages in implementing the Convolutional Neural Network (CNN) implementation, namely training, validation and testing. The training stage is the main stage for training the network to learn input data. Then the network is tested on validation data. If it gives good results, then the network can be used to classify data with test data.

The training data used were 2533 images. The training process uses the following parameters: Optimizr : Rmsprop , Batch Size : 32 , Epoch :10 . The training results are presented in Table 2. Network training provides good accuracy.

TABLE II. Results of CNN Network Training.

Epoch	Time (s)	Loss	Accuracy
1	100	1.3195	56.45%
2	98	0.5692	77.26%
3	99	0.3899	84.37%
4	98	0.2346	91.94%
5	99	0.1608	93.88%
6	101	0.0996	96.72%
7	102	0.0721	97.75%
8	99	0.0510	98.34%
9	97	0.0395	98.89%
10	96	0.0393	98.93%

Entering a sample of data that you want to know the type of classification on the network, then the network will issue a label for the type of brain tumor based on the data entered. The results of the classification label that comes out of the tissue can be used for consideration in determining the type of brain tumor that is difficult to distinguish visually. In this study, the test data scenario used 287 data. The classification results on the test data are depicted in Figure 4.

Based on the picture, the data sample is 32 images, for the correct data classification there are 29 data and the wrong sample is 3 data. The network predicted 3 errors, namely one Pituitary tumor type was predicted as Meningioma, one Glioma tumor type was predicted as Meningioma and one Meningioma tumor type was predicted as Glioma (can be seen in Figure 4 with red writing). The results of the classification of brain tumors resulted in an accuracy of 98.93%. The proposed method can perform the classification of brain tumors well. In related studies using the same dataset, the proposed model has the highest accuracy. Can be seen in table 3.

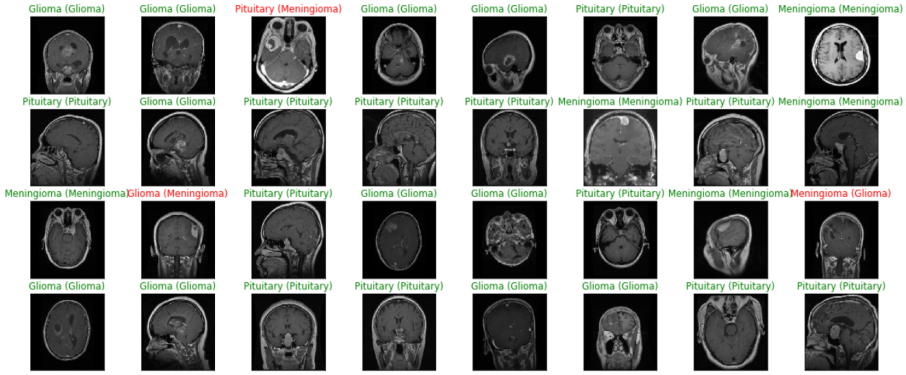


FIGURE 4. Classification of Types of Brain Tumors.

TABLE III. Comparison Results of Related Research.

Related research	Year	Accuracy
Chelghoum et al [13]	2019	98.55%
Srinivas and Rao [7]	2019	97.91%
Bhanumathi and Sangeetha [9]	2019	93.33%
Anil et al [8]	2019	86.64%
Nawab Khan Swati et al [10]	2019	94.82%
The proposed model	2021	98.93%

CONCLUSION

The results of the classification of brain tumor types using the Convolutional Neural Network (CNN) method can classify four types of brain tumors and automatically label the data. The work evaluation of the CNN network architecture yields an accuracy of 98.93%. The CNN method can provide fairly good results in the process of object recognition and classification of brain tumor types. In the next research, it can be done modification of the CNN layer and the parameters used in order to provide a faster computation time

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