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RESEARCH ARTICLE

Classification of Different Medical Images Using Neural Network Approach

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Abstract

Objectives: This work aims to design model for classification and selection of medical images by using the Convolution Neural Network technique with higher accuracy. **Methods:** Classification of the digital images into relevant categories like X-ray, CT, MRI is implemented using convolution neural network. At the initial stage total 7560 different medical images are given as input. These images are applied to the classifier. These images are passed through different levels of CNN. **Findings:** This method identifies medical images and separates into different categories i.e., X-ray, CT, MRI using convolution neural network. Accuracy calculated using this method is 99.01%. This method gives better results as compared to other machine learning methods i.e. Support vector machines. Program is written in python language using Jupiter Notebook. **Novelty:** Total 7560 images of different category are given as input. Convolutional Neural network approach gives good accuracy of 99.01% as compared to other machine learning approaches.

Keywords: Deep learning; Confusion matrix; Machine learning; Computer Tomography (CT); Magnetic Resonance Imaging (MRI)

1 Introduction

The classification of medical images plays an important role in the treatment of patient. Many traditional machine learning methods such as support vector machines (SVM) were used for medical image classification long ago. However due to certain disadvantages of these methods which is low performance rate as compared to practical standards, has led to the use of new emerging approaches. Feature selection and extraction using traditional method are very slow. The deep neural networks (DNN) are widely used for image classification due to its high performance. The convolutional neural network (CNN) shows the best results on image classification. It is hard to gather medical image datasets because professional expertise is needed to label them. For applications such as detection of tumors and their classification, detection of cancer, breast, chest etc., researchers have applied CNN.

In recent years, image understanding systems make use of machine learning (ML) techniques for classification of images and feature extraction. The various ML techniques involve clustering, k-means nearest neighbor (k-NN), SVMs and

random forests. The first step towards machine learning involves efficient extraction of discriminant features. Various researchers used ML, K-NN, SVM approaches to distinguish between different clinical images as mentioned below.

Classification of Xray images using wavelet transform is done using deep learning framework [1]. Image segmentation based on various Deep learning [2], transfer learning [3] approach is discussed [4] carried out classification of X-ray images using average pooling method while calculating convolution with accuracy of 97%. There are various methods to classify medical images using deep learning approach. CNN is the best method for proper classification of images [5,6], used CNN for classification of cancerous cells achieved 86% accuracy in classification. Correct diagnosis of disease based on Xray, CT, MRI images is most important. Based on correct classification and diagnosis treatment is decided. Deep learning using convolution neural network is the accurate method in terms of classification [7–9], classified MRI, CT images using CNN and achieved accuracy of 99% using five iterations. Several researchers used CNN for classifying images into relevant parts. Classification of images into correct class is done based on confusion matrix parameter [1,10]. Gradient descent optimization algorithm [11] is used for classification purpose. Confusion matrix parameter is used for comparison between predicted and actual image which are correctly classified.

One of the methods which solves our problem of classification is the convolutional neural network (CNN) model where automatic learning of the needed features takes place as well as its extraction. CNN is used in applications such as image and signal processing, data analytics. It is also used to classify medical images into different categories due to correct classification. This method gives more accurate result as compared with other available techniques. It also requires smaller number of iterations for classification. This method is also used to extract images and for reducing the size of image. For classification images are taken from Kaggle.

The main objective of this work is to classify medical images into six different categories. These categories are CT (Computer Tomography) Abdomen, MRI Breast, XRAY chest, CT Chest, XRAY Hand images. Input applied to the CNN classifier is different CT, MRI, XRAY images. After classification these images are automatically stored in different classes. The objective of this research is to offer the simplest model which provides accurate results by using the CNN methodology. The contribution of this work is summarized below.

1. Automatic storage of classified images in six categories
2. Increase the accuracy of predictions

Organization of this paper is given below. Section 2 explains CNN approach. In Section 3 implementation using CNN is given. Section 4 gives results.

2 Traditional Convolutional Neural Networks (CNN model)

CNN is a layered model as shown in Figure 1. It consists of basic blocks i.e., Input layer, hidden layer 1, hidden layer 2 and output layer. The input given to the classifier is samples of CT (Computer Tomography) Abdomen, MRI Breast, XRAY chest, CT Chest, XRAY Hand images. Then the processing is done on it and classification takes place according to the categories. Total 1260*6=7560 images are used for classification. This approach is useful for image recognition, object detection, image classification and face recognition applications.

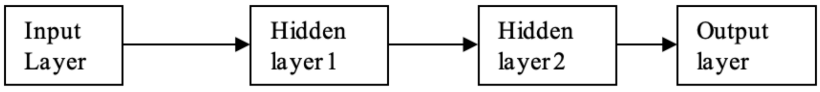

Fig 1. Convolutional Neural Network

CNN consists of Input, Convolution, Pooling, Fully Connected Layer, SoftMax/ Logistic layer and Output Layers. Details of these layers is given below.

2.1 Input Layer

The input layer must be an image data. Image data is in the form of a 3D matrix. It is required to reshape the input image into a single column. Suppose an input image is of dimension 32 x 32 = 1024, then using reshaping it is converted to 1024 x 1 before giving it as input.

2.2 Convolution Layer

This layer performs computational task in the network. The convolution operation can be explained as multiplying the original image data of different filters and the filtering matrix element by element. This layer is often called a feature extractor layer since it performs extraction of image features. In this 5 by 5 image is converted to 3 by 3 image using convolution operation. The result is a single integer.

2.3 Pooling Layer

The layer followed by the convolution layer is the pooling layer. There are two types of pooling layers i.e., Average and Max pooling layer.

Pooling is done in order to reduce the number of parameters of the input tensor, hence reducing overfitting, extracting significant features from the input, and reducing the computational time thus increases efficiency.

Pooling means a small portion of the input is taken and averaging of this portion is done. Maximum value of the small portion is called max pooling. In pooling, we are summarizing a single value over all the values present. Consider input image of dimension w1 x h1 x d1, then the output of pooling layer will have the following dimensions:

$w2 = (w1 - f)/ s + 1$ ……. (1)

$h2 = (h1 - f)/ s + 1$

$d2 = d1$

where, w2 = width of the output

h2 = height of the output

d2 = depth of the output

f = filter

s = stride

stride means movement of the filter across original image

2.4 Fully Connected Layer

The neurons present in a fully connected layer have connections to all the activations present in the previous layer. This layer involves neurons, biases, and weights. It is responsible for classifying the images in different categories by training. There is full connectivity between the neurons of the previous and next layer.

2.5 SoftMax / Logistic Layer

The main task of the SoftMax function is to generate a vector of n real values that sum up to 1 from the vector of n real values. The values of the input can be any negative, positive non-zero, zero or may be greater than 1. The function of the SoftMax is to transform these values between 0 to 1, hence providing probabilities.

2.6 Output Layer

This is the last layer of the network which consists of the labels.

3 Methodology

Separation of images using CNN approach is implemented in google Colab notebook using python programming. Following are the steps used to implement CNN algorithm.

3.1 Creating the dataset and loading

Gathering a medical dataset is a challenging task. Once the data is collected through various sources, the data needs to be trained after standardizing it. We have gathered images of various datasets present in Kaggle. These datasets are standardized to the same size.

Input images considered are CT of chest, CT of head, CT of abdomen, MRI image, X-ray of chest and X-ray of hand. Each image category contains 1260 images. For six categories total 7560 images used for classification.

3.2 Transforming the data and dividing it into training, testing and validation dataset

Some observations can be made from images present in the dataset. There are low quality images as well as high quality images. Few images with different scales therefore the background of the images is different. In order to increase the contrast, we need to resize every image and convert into pixels to range 0 to 1. Then convert the JPEG images into tensors. The data in a training set minimizes the loss function, and a separate validation set is evaluated during training.

The validation dataset can be used to change or modify the hyperparameters or even used to select the best model for each epoch. Another dataset called the testing dataset is created for evaluating the final state. Big datasets are provided to the model for the more accurate result and hence less data is given for validation and testing.

In PyTorch, the data is given in the form of a data loader to the model for training. The data loader basically helps in reading the data and feeding it to the model for training in batches since all the images are not given at once for training as it will cause the memory overload and this is not an optimized way for doing computation in deep learning. Similarly, the test images are used in batches.

3.3 Model Building

The first layer is the convolution layer where in channels, out channel and kernel size are provided then max pooling layer is added with kernel size which will reduce the height and width of convolutional output by a factor of kernel size. After applying inputs to these layers 2-3 times, fully connected layer is added to feed the number of input features which will be equal to the cost size of the convolution layer output. Cost function is given to all the input from the above layers. here the output of the ReLU layer is in matrix form. Reshape the matrix in vector shape. Now call the class in which feed the number of output classes. Send it to the device which is either cuda or cpu. Then call the optimizer function. For loss calculation use the cross-entropy loss function.

3.4 Training & Testing model

In the final step train the CNN network on the training data loader. Calculate training loss, training, and testing accuracy for each epoch. Then save the model for the epoch which gives the best testing accuracy. The results in terms of training accuracy are presented in the Table 1 shows two results. Data set is divided into two parts, one is the train data set and second is the test data set. Train accuracy is the accuracy which shows accuracy of the train data set. Epoch is the parameter by which accuracy can be increased or decreased. As the epoch is increased, accuracy of the train data set is increased and images can be perfectly classified. After some value of Epoch train accuracy is constant. In Table 1 iterations carried out for some epoch values are given.

Total three epoch values are taken for all the data sets.

Table 1. Iterations carried out for epoch values

Number of Epochs	3 Epochs
Loss for Epoch 1	0.096
Loss for Epoch 2	0.017
Loss for Epoch 3	0.043

The Figure 2 below shows the confusion matrix. This shows that target value of classification is same as the predicted value. This is 10 by 10 matrix. Rows and columns of this matrix indicates target and predicted classification categories. It indicates that maximum samples are accurately classified.

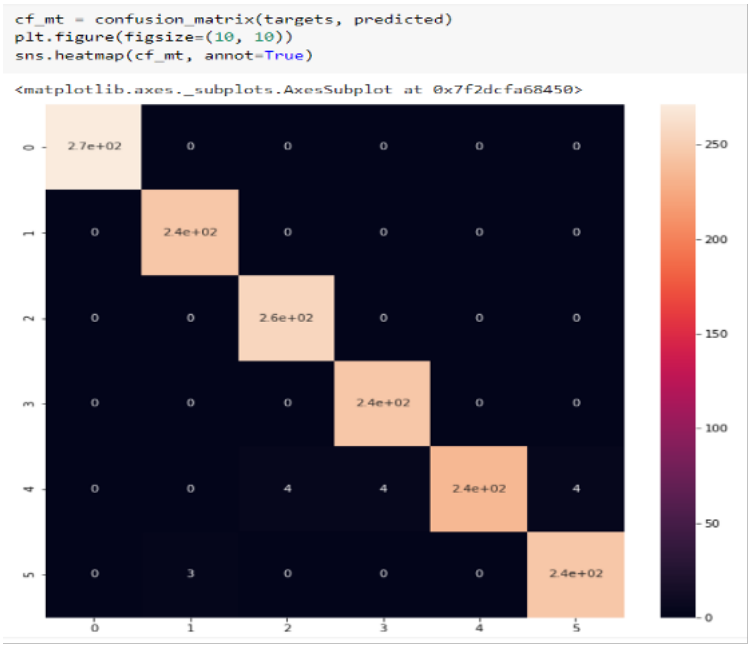

Fig 2. Confusion matrix

4 Result and Discussion

Comparative analysis of this method with existing available references is given in Table 2. Convolutional Neural Network is compared with the Ref.[6,9]. Percentage improvement of Ref.[6] in terms of accurately classifying images is 12.01% and for Ref.[9] it is 2.01%.

Table 2. Comparative Analysis

Ref	Classification Accuracy	Accuracy obtained using CNN	Percentage improvement in proposed method
[6]	87%	99.01%	12.01%
[9]	97%	99.01%	2.01%

The Figure 3 given below shows the images selected for total six classes. For each class 1260 images are selected.

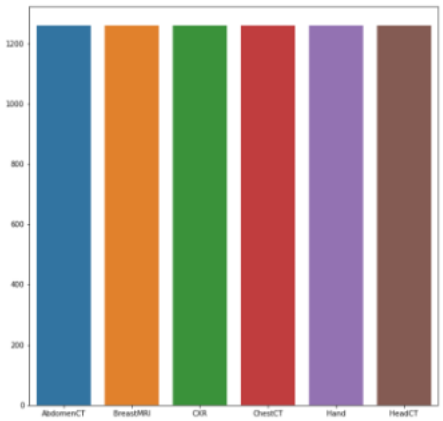

Fig 3. Images selected for each class

The results in terms of training accuracy are calculated. Two types of results are computed. One is Train accuracy which shows accuracy of the train data set. Second is Epoch parameter by which accuracy can be increased or decreased. By increasing Epoch value percentage accuracy of train data set is increased as given in Figure 5. By increasing train accuracy medical images are accurately classified into different categories. Several iterations are carried out for epoch. Figure 4 gives accuracy achieved by the model using python program. In this accuracy is calculated by comparing target image and predicted images. The model was able to achieve 99.01% accuracy as given in Figure 5. This model is used for finding various diseases and level of infection in selected part of organ.

```
[ ]  accuracy = np.asarray(accuracy_score(targets, predicted)*100)
     accuracy = accuracy.round(2)
     print("Accuracy of the model is {}%".format(accuracy))

     Accuracy of the model is 99.01%
```

Fig 4. Accuracy achieved by the model

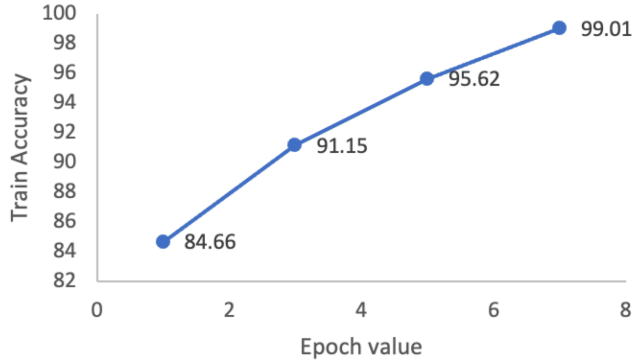

Fig 5. Accuracy achieved by Classifier

5 Conclusion

In this study, classification of various medical images using Convolution neural network approach is proposed. Input is applied to the architecture of CNN based medical image classifier. This input is different medical images like CT, X-ray, and MRI. Images taken for classification are from Kaggle datasets. The architecture of the proposed CNN-based medical image classifier contained three convolutional layers. The result demonstrates that this model can extract different features hence achieving good performance. This model can be used for various applications such as choosing a particular organ and finding out the various diseases and level of infection in that organ. Some of the examples can be finding tumors, heart diseases etc. The main advantage of CNN is its accuracy in image recognition.

References

1) Khatami A, Nazari A, Beheshti A, Nguyen TT, Nahavandi S, Zieba J. Convolutional Neural Network for Medical Image Classification using Wavelet Features. In: 2020 International Joint Conference on Neural Networks (IJCNN). IEEE. 2020;p. 1–8. Available from: https://doi.org/10.1109/IJCNN48605.2020.9206791.
2) Malhotra P, Gupta S, Koundal D, Zaguia A, Enbeyle W. Deep Neural Networks for Medical Image Segmentation. *Journal of Healthcare Engineering*. 2022;2022:1–15. Available from: https://doi.org/10.1155/2022/9580991.
3) Sharma R, Singh A. An Integrated Approach towards Efficient Image Classification Using Deep CNN with Transfer Learning and PCA. *Advances in Technology Innovation*. 2022;7(2):105–117. Available from: https://doi.org/10.46604/aiti.2022.8538.
4) Umer M, Ashraf I, Ullah S, Mehmood A, Choi GS. COVINet: a convolutional neural network approach for predicting COVID-19 from chest X-ray images. *Journal of Ambient Intelligence and Humanized Computing*. 2022;13(1):535–547. Available from: https://doi.org/10.1007/s12652-021-02917-3.
5) Sarvamangala DR, Kulkarni RV. Convolutional neural networks in medical image understanding: a survey. *Evolutionary Intelligence*. 2022;15(1):1–22. Available from: https://doi.org/10.1007/s12065-020-00540-3.

6) Shen X, Wei L, Tang S. Dermoscopic Image Classification Method Using an Ensemble of Fine-Tuned Convolutional Neural Networks. *Sensors*;22(11):4147. Available from: https://doi.org/10.3390/s22114147.
7) RoxanaLuca A, Ursuleanu TF, Gheorghe L, Grigorovici R, Iancu S, Hlusneac M, et al. Impact of quality, type and volume of data used by deep learning models in the analysis of medical images. *Informatics in Medicine Unlocked*. 2022;29(100911). Available from: https://doi.org/10.1016/j.imu.2022.100911.
8) Puttagunta M, Ravi S. Medical image analysis based on deep learning approach. *Multimedia Tools and Applications*. 2021;80:24365–24398. Available from: https://doi.org/10.1007/s11042-021-10707-4.
9) Chiang CHH, Weng CLL, Chiu HWW. Automatic classification of medical image modality and anatomical location using convolutional neural network. *PLOS ONE*. 2021;16(6):e0253205. Available from: https://doi.org/10.1371/journal.pone.0253205.
10) Kim HE, Cosa-Linan A, Santhanam N, Jannesari M, Maros ME, Ganslandt T. Transfer learning for medical image classification: a literature review. *BMC Medical Imaging*. 2022;22(69). Available from: https://doi.org/10.1186/s12880-022-00793-7.
11) Anaya-Isaza A, Mera-Jiménez L, Zequera-Diaz M. An overview of deep learning in medical imaging. *Informatics in Medicine Unlocked*. 2021;26(100723). Available from: https://doi.org/10.1016/j.imu.2021.100723.