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Reserach Article

Convolutional Neural Network Based Classification of Benign and Malignant Tumors from Breast Ultrasound Images

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Abstract

The widely used method for diagnosing the breast cancer is a Breast ultrasound (BUS) imaging, but the interpretation will be vary based upon the experience of radiologist. Now a days CAD systems are available to provide the information regarding BUS image classification. However, most of the CAD systems was based upon handcrafted features. Which are designed for classifying the tumors. Therefore, the capability of these features will decide the CAD system accuracy which is used for classifying the tumors as benign and malignant. With the use of Convolutional Neural Network (CNN) technology, we can improve the classification of BUS images. Because it provides a new approach for classification and generalizable image representations thereby we can get best accuracy as a result. But, the database of BUS image having small size so it might be restricted due to that CNNs cannot trained from scratch. To overwhelmed this drawback, we examine the use transfer learning approach, for enabling the CNN approach to achieve best accuracy regarding BUS image classification. The final results of VGG16_TL methodology beats the AlexNet_TL. And the final results indicate VGG16_TL with accuracy, sensitivity, speci city, precision and F1 values of 88.23%, 88.89%, 88.89, 90% and 88.2% respectively. Therefore, we can say that possibility of pre-trained CNN models achieves good accuracy in BUS image classi cation.

Index Terms— Deep Learning, Breast Lesion classification, Convolutional Neural Networks, VGG16 and AlexNet Transfer Learning models.

Introduction

Female death rates are increasing day by day in the world with one of main disease like Breast cancer. For reducing the death rates early detection was important. Even for common people also can use the mammography technique for screening as well as for detection. It is considered as a standard technique for early detection, but this process involving ionization radiation, namely, X-Rays. However, it is uncomfortable and painful for women [1]. To overcome this type of drawbacks we are using ultrasound imaging technique. Any patient can get good treatment if he / she can be having the awareness regarding disease at early stage itself [2]. In medical image field many techniques are available but it has many advantages compared to other techniques such as it is available with less price, it is very comfortable to the patients compared to mammography, so it is safer because of no radiation process was involved, and it is having more sensitivity than others [3]. But, the understanblitity of an information which was present on the BUS images will be purely depends upon the radiologist experience. CAD systems are available for the radiologist for getting the information regarding diagnosis [4]. CAD systems analyzes mainly 2 components regarding BUS images [4], [5]. Extraction of handcrafted features will be done by the first component [6] and for quantify the tumor from morphological features [7] of the BUS image. Classification of a tumor as a benign & malignant will be done by using a second component with the help of computer classifier. Hence the features of handcrafted will decide the accuracy of CAD system. Now a days deep learning is the advanced technology particularly in that CNN is a widely used approach in classi cation of images [8]. The CNN approach is mainly used for getting better image classification. Because it is having the ability to perform the operations like extraction of the features, producing correct results, and normal representation of an images. Which is learned from the large-scale records, like ImageNet database. This database contains nearly 1.2 squillion annotated natural images [9]. Already in many research areas got best results with CNN

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approach [10], [11]. CNNs have been used for the tumors detection as well as outline purpose from BUS images [12], [13]. In future CNN approach can be explored for classifying the tumor as a benign and malignant [14]-[16]. But, the database of BUS image having small size so it might be restricted due to that CNNs cannot trained from scratch. To overcome this type of limitations we mainly focus on the expansion of CNNs. Which can enable the CNN for getting better analysis of BUS images. Apart from many we mainly concentrating on the classification of tumors as a benign and malignant with CNN approach. For achieving the goal, we mainly concentrated on 2 approaches. One is deep extraction of the features [17] and second one is transfer learning approach [18]. Which can allow this approach in the AlexNet model. This model already trained with database of ImageNet. For obtaining the better classification of BUS images. This paper mainly divided into 4 sections. Section II describing about The AlexNet and VGG16 CNN. Section III explains about the performance evaluation and experimental results. Finally, Section IV we are concluding the proposed concept and future directions.

II. MATERIALS AND METHODS

In our paper we used ultrasound images from linear transducer arrays. We mainly focusing on Classification of Benign and Malignant tumors. We are using CNN approach for classification. Here transfer learning approach was used, it will enable CNN model for achieving good accuracy regarding classification of BUS images. The performance of AlexNet and VGG16 Transfer learning approaches were calculated. The performance of each of model calculated based on accuracy, sensitivity, specificity, precision and F1.

A. The AlexNet CNN model

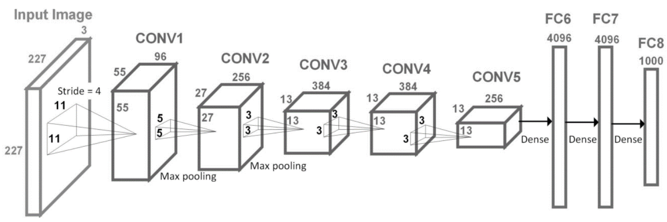

Fig. 1. construction of the pre-trained AlexNet CNN model.

From figure 1, it can be inferred that each layer of AlexNet_TL model consists of stacked convolutional layers filters. In Alex Net's first layer, the convolution window shape is 11×11, whereas the second layer is reduced to 5x5 followed by 3x3. Following the process, extreme pooling layers were added by the network using a window shape of 3x3 and a stride of 2. Moreover, AlexNet consists of 10 times more convolution channels when compared to LeNet. Eventually, the final layer is a two fully connected layers with 4096 outputs.

B. The VGG16 CNN model

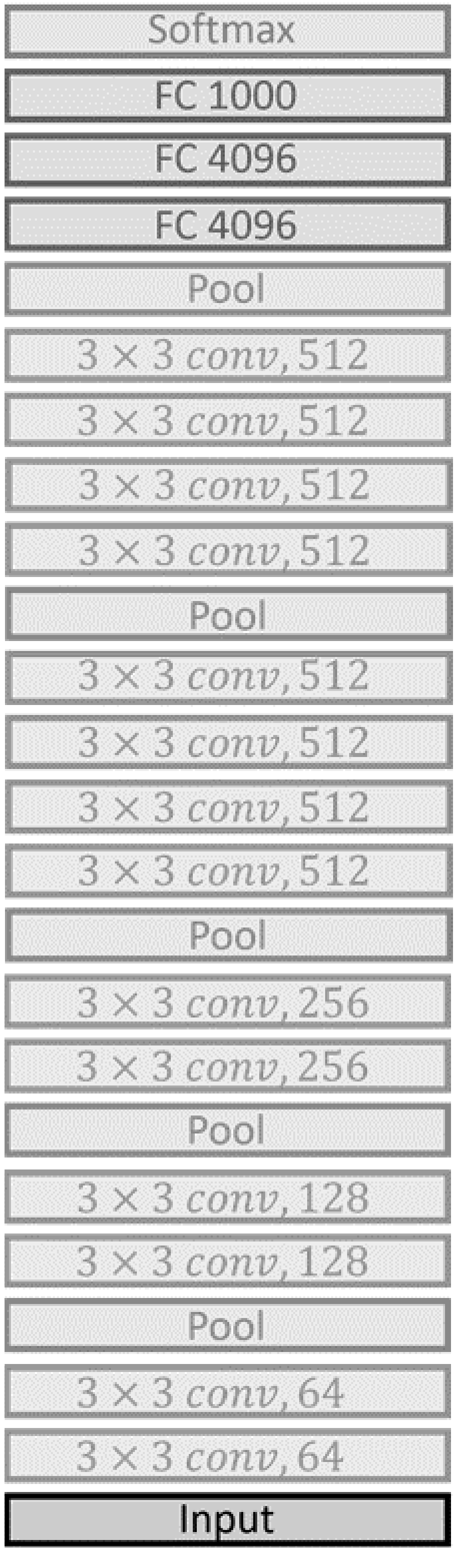

Fig. 2. construction of the pre-trained VGG16 CNN approach.

Table:1

S. No	Transfer learning Model	Accuracy (%)	Sensitivity (%)	Specificity (%)	Precision (%)	F1 (%)
1.	AlexNet	88.24	87.5000	87.50	90.91	87.86
2.	VGG16	88.24	88.9	88.9	90	88.19

Simonyan and Zisserman from Oxford university developed 19 layers having 16 conv and 3 fully-connected CNN layers with Filter having the rang of 3*3, stride and 1 pad. In addition, with this a max-pooling layers having the range 2×2 with stride 2, known as VGG-19 model. As VGG-19 having more layers with deeper CNN which is shown in the Fig.2. number of parameter reduction is necessary in any deeper network. It will be done by using a small 3×3 filters in all CNN layers. Finally, it was achieved with 7.3% error rate. In ILSVRC30 2014 winner was not the VGG-19 model, but, the VGG Net is the best approach since it is protected the notion. A CNN having a deeper network of different layers.

Because of this constructional it is easy to convert data to work. Retain it to deep. Make it was a simple.

The VGG-19 model, contains 138M parameters and it was placed 2nd in classification. At the same time, it was in top position @ localization in ILSVRC 2014. Traning of this approach is done in ImageNet27 database, which is mainly used at Visual Recognition Challenge (ILSVRC) in ImageNet Large-Scale. This approach was trained on nearly greater than million images and it can classify the images into 1000 object categories. And hence we said that this approach learned rich representation of feature which can used for a more number of images.

III. RESULTS

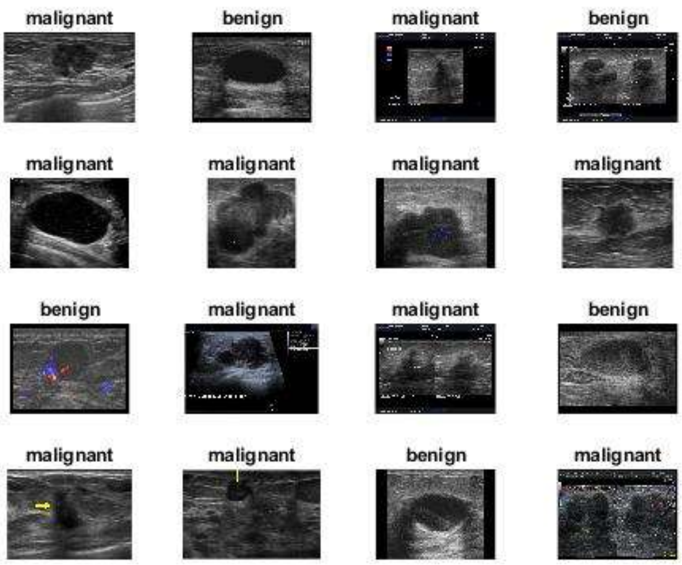

Fig 3. Sample Dataset

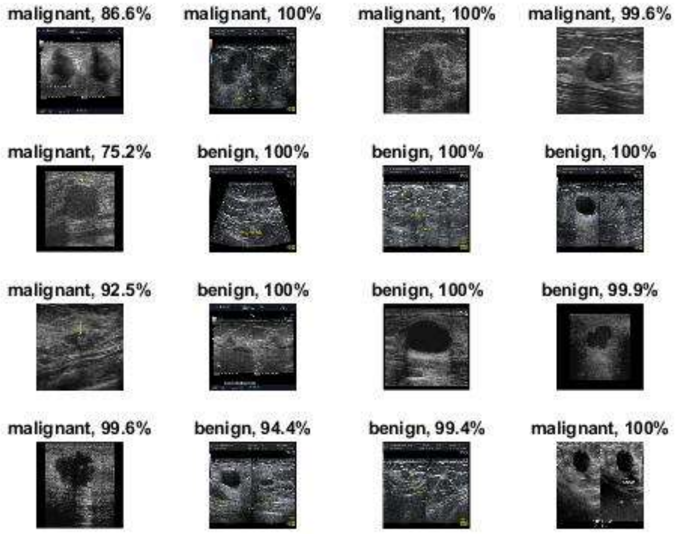

Fig 4. Classification for AlexNet Transfer Learning model

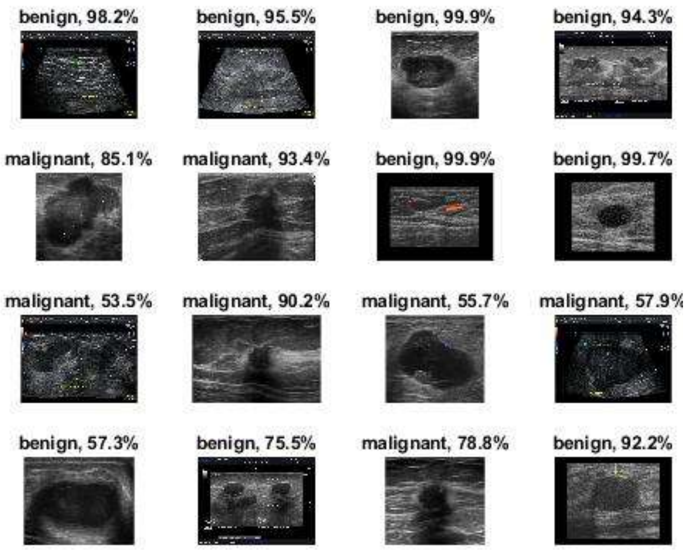

Fig 5. Classification for VGG16 Transfer Learning model

In this paper we used 85 benign and 93 malignant images. The database collected from online. In AlexNet_TL and VGG16 model CNN was used.The images given as input to CNN configured AlexNet and VGG16 Transfer learning (TL) models. In this paper, two classes namely, benign, and malignant were used based on these the architecture softmax value is designed. From figure 3 it is observed that sample data set is trained for AlexNet_TL and VGG16_TL models. The classification results between benign and malignant for AlexNet_TL model is provided in Fig.4. The classification results between benign and malignant for VGG16_TL model is provided in Fig.5. Based on the observation from Table 1, CNN configurated VGG16_TL model outperforms in comparison with AlexNet_TL classifier. From Table 1, it is evident that VGG16_TL model outperforms AlexNet_TL model.

IV. CONCLUSION

CNN Based Classification of Tumors as A Benign & Malignant Breast from Ultrasound Images successfully implemented. we used the transfer learning approach. Which can be used to support AlexNet and VGG16 based CNN models aimed at achieving the accurate classification of BUS images. The Breast Ultrasound Image database given AlexNet and VGG16 CNN models. Final result of VGG16 model beats the AlexNet. Additionally, the final results display the VGG16 with accuracy, sensitivity, speci city, precision and F1 values of 88.23%, 88.89%, 88.89, 90% and 88.2% respectively. With these results it suggests that the possibility of pre-trained CNN models achieve accurate BUS image classi cation. In future work is to use a suitable deep learning algorithm to improve the accuracy and analyse the performance of a variety of CNN models.

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