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A Novel Fully Automated – Hybrid Convolutional Neural Network For Breast Infrared Thermographic Screening

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In

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Abstract

Breast cancer is a disease causing the major mortality among women worldwide. Early diagnosis of cancer is a key to greater chances of cure and recovery of patients. If breast cancer is getting detected earlier, it will be a highly treatable disease with 97% chances of survival. Nowadays, breast thermography screening has already proven the potential to detect tumors early, especially in young women. Also, it has proved to be a promising technique because of no harmful radiation, low cost, non-invasive and it provides sufficient information for detecting abnormalities in breast.

Recent advances in deep learning (DL), especially Convolutional Neural Networks (CNNs), are making them a versatile method for computer-aided detection and diagnosis systems assisting physicians. This thesis aims to explore the superiority of deep convolution neural networks (DCNNs) with the new and promising thermography technology screening. Eventually, building a model capable of performing the activity of Computer-Aided Diagnosis (CAD) effectively based on DL is the objective. The proposed model is a bi-task CAD system to accomplish two tasks: segmentation of region of interest (ROI) and classification of breast thermographic images as healthy or non-healthy.

For the first task of the proposed bi-task CAD system: there are two proposed segmentation techniques, based on the deep fully convolutional neural networks (FCN). The first one introduces an adaptive fine-tuning of the FCN-AlexNet which has already pre-trained on hug non-medical data, and the objective is to search for the best tier of fine-tuning that gives the best segmentation performance.

The second model of segmentation endeavored to enhance the performance of the first proposed segmentation model by incorporating a preprocessing step using Nonsubsampled Contourlet Transform (NSCT). The learning is divided into two parallel paths of FCN to learn the different feature bands. Hence the name of this model arose as a multi-band multi-path fully convolutional neural network (MBMP-FCN). Also, the pre-processing step presented the novel data augmentation approach by enriching the training samples. The performance of the proposed MBMP-FCN outperformed the single path FCN.

For the second task the proposed bi-task CAD system: a strong classifier is built that can accurately distinguish between different classes (healthy or non-healthy). The proposed classification model is based on a support vector machine (SVM) by following the "off-the-shelf" technique for the learned features of the pre-trained MBMP-CNN.

All the proposed models have employed the fine-tuning technique (FT) that varied from fully FT and adaptive FT, the transfer learning technique (TL) for the pre-trained parameters by deep networks from other data, and the conventional data augmentation approach.

Finally, the performance evaluation of the proposed models is introduced depending on quantities assessment (accuracy, sensitivity, specificity, etc.), and also by comparing the obtained results with the ground truth (GT) which was introduced by the specialists. The results confirm that the interpretation of thermography by the suitable adjustment of deep neural networks (DNNs) can help to detect breast cancer efficiently.