A faster and accurate treatment method to cure Brain Tumor using AI and IoT techniques

1st Muhammad Umar Zeshan
ISUS group
FCT/UFP
Porto, Portugal
umarzeshan@ufp.edu.pt

2nd Rui S. Moreira
ISUS group
FCT/UFP, INESC TEC and LIACC
Porto, Portugal
rmoreira@ufp.edu.pt (0000-0002-4123-0983)

***Resumo*—Clinical diagnosis and effective therapy depend on the identification, segmentation, and classification of brain tumors. Recently, there has been an increased interest among researchers in combining machine learning and the Internet of Things (IoT) to accurately classify brain tumors. Due to vast amounts of data and hazy borders, tumor classification and segmentation in magnetic resonance imaging are rigid. Therefore, an IoT-based Automatic Brain Tumor Detection Framework with Deep Learning support has been suggested in this study. A deep learning model is proposed with a lightweight backbone ResNet model, with a segmentation head including attention modules to predict the tumor. IoT services are implemented to communicate the results directly with health experts to make the treatment faster and more effective. The system showed excellent accuracy in terms of detection results and overall working.**

***Index Terms*—Deep Learning, Artificial Intelligence, Medical Imaging, MRI, Mobile and Ubiquitous Computing, IoT**

I. Introduction

The development of next-generation systems based on pervasive, wireless remote sensing has a tremendous amount of promise as a result of the recent expansion of the Internet of Things (IoT) and 5G technology. The demand for pervasive, wireless technology is real. With this rapid development of UbiComp systems and artificial intelligence technologies represented by deep learning, smart medical care has become one of the most important application areas of artificial intelligence. In recent years, AI-based technologies are being used in medical images specially for the detection of cancer cells in the body to assist in the cure of cancer patients. In this study, a detection system is presented which is a combination of IoT and AI technologies to detect the brain tumor in the body. To predict the brain tumor, a standard medical images dataset of MRI images is being used to get the output images with the predicted tumor. After that, An IoT-based system is applied to help the specialists of brain tumors to apply further curing procedures. The major goal is to not just predict the tumor, but also help the patients with immediate treatment afterward.

II. State of the Art - Background and Related Work

The main State of the Art applied in this paper is in two sections. First is image detection which includes the backbone model of ResNet for feature extraction from input image and segmentation head involving attention modules for final prediction [1], and the other one is applying IoT with cloud services [2]. Recent human efforts to improve computer-aided medical diagnosis yield better results. For instance, the identification of BTs used an ANN in conjunction with canny detection [3]. In order to eliminate the quality of BT's photos, they used a smart edge detection technique to change the sizes of previously altered images that had been converted from RGB to grey. Eventually, BTs identification was implemented using an ANN. A DL network was suggested by Mehrotra et al. [4] for the classification of datasets into two classifications, malignant and benign.

They made use of the AlexNet, GoogLeNet, ResNet101, ResNet50, and SqueezeNet deep learning models, among others. By altering a deep learning model, Cinar et al. [5] presented a hybrid CNN architecture for BT detection. Eight extra layers were added after the final five ResnNet50 layers were deleted. In comparison to the single ResNet50 model, their proposed hybrid ResNet50 model had an accuracy of 97.2. The fuzzy c-means clustering method is used to segment the MR images into normal and abnormal by BT detection and classification [6]. DWT is used to extract the features from segmented pictures. Different CNN architectures were applied by Waghmare et al. [7] for the detection and categorization of BTs. The classification accuracy of the supplemented data set was improved by fine-tuning VGG-16, which ultimately achieved the most acceptable accuracy of 95.71.

And finally, The IoT method is being applied to communicate with the health experts to carry out the treatment [2].

III. Methododlogy

The methodology is explained in two steps. A. Image detection to predict Brain Tumor B. Applying IoT system to connect with Medical Aids

A. Brain Tumor Detection

To detect the brain tumor in the body, a standard MRI dataset is used to collect the input images for training and testing. As medical images are generally quite complex and arbitrary in shape, pixel aggregation can present the solution

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to this problem. The detection model used for image prediction in this research is basically divided into two parts, one is feature extraction and the other one is to retune these extracted features with the attention mechanism. It starts with applying using the basic ResNet network with efficient use of a lightweight head to improve the refinement of feature maps by implementing attention modules-based segmentation head, because it permits us to detect the complex and arbitrary structure of MRI images. The proposed method comes up with a lightweight backbone feature extraction model in the form of ResNet to acquire an effective outcome. Although this lightweight backbone is the best to improve efficiency, it has consequences in terms of weak representation of extracted features. To fine-tune the extracted features, our method allows us to employ a segmentation head containing two pivotal attention modules with the basic idea of self-attention, namely the Self Attention-Channel attention module (SA-CAM) and the Self Attention-Spatial attention module (SA-SAM). Both attention modules are used along with the self-attention mechanisms in a convolutional block in a sequential manner to improve the working of the lightweight backbone model by refining the feature maps in a way to implement attention concepts that involve where to put focus in the model. The output from the attention block is the production of the final feature for the segmentation process and then the Pixel Aggregation methodology is implemented to predict the similarity vector between the region of interest i.e. pipe defect in our case, and nearby pixels to give the output predicted image.

The result could be an effective detection of arbitrary-shaped medical images with accuracy and less complexity because of using the attention mechanism which allows the model to process only the necessary and important feature maps. This result could be so effective in the detection of MRI images, cancer cell images, and other states of the art medical image datasets or custom-made dataset, unlike other state-of-the-art methods which could compromise the accuracy in trying of making the system less complex. Figure 1 explains the detection system.

B. IoT based system to connect with Medical Aids

After the detection of the tumor, the next step is to help the patients connect with the specialists to treat them according to the tumor situation. Fig. 2 displays the segmentation and classification of IoT-based brain tumors. Cloud management has suggested IoT-based brain tumor segmentation and classification. The cloud is the best option for a medical system since it makes it simple for professionals to access data. Using an IoT-based healthcare system to upload an MRI and instantaneously obtain segmentation and classification results, radiologists may identify malignancies promptly. A copy of the report is given to the patient's doctor, who will use it to choose the best course of action. To use this application locally, neither an internet connection nor a slow response time is required.

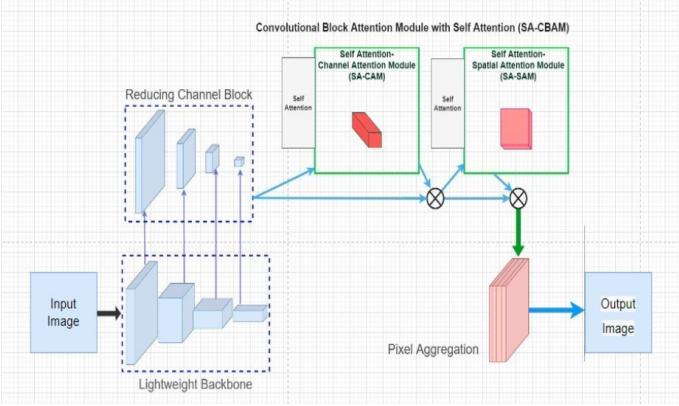

Figura 1. Deep learning based Detection System for brain tumor

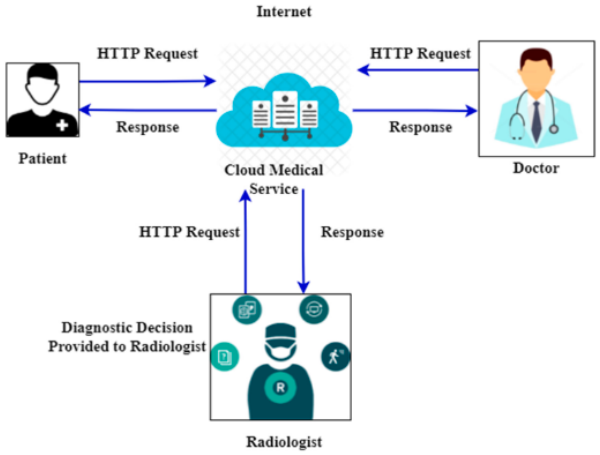

Figura 2. IoT based cloud system

IV. System Evaluation

The efficiency and effectiveness of the system depend on two key factors. Firstly, how the detection model is performing in terms of accuracy in predicting and classifying the tumor, and secondly how effectively the IoT system is performing to provide the medical aid of the specialists to the patient. After training the model with 7000 MRI images, another 650 images are selected for testing. The results show that system showed 81 percent accuracy which is quite good. The Precision and Recall curve is shown in Fig 3 depicting the Average Precision of the system. After that IoT based system is implemented as shown in the figure to help the patients with prioritized care and cure.

V. Conclusion

In this study, a combination of IoT systems and deep learning methodologies is presented to develop a system to predict and detect the brain tumor in the body and classify it. For this purpose, an attention algorithm-based system is developed with a lightweight ResNet backbone that returns an output image with a predicted tumor. Afterward, The results

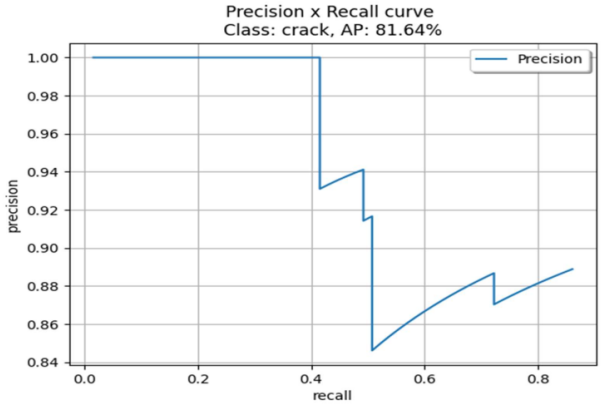

Figura 3. Precision Recall curve showing AP value

are communicated directly with the doctors and experts in the field to help the patients with immediate cures.

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