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Research Article

MRI analysis using modified Single Shot Multibox Detector for Brain tumor Segmentation

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Abstract

A Neurologist uses many test to locate or diagnose a brain tumor. Several tests may be conducted to identify if tumor has spread to any other part of body from where it started. This is rare in case of brain tumor and known as metastasis otherwise. One of the difficulty arises for a Radiologist or Neurologist while analyzing imaging tests for MRI scans i.e to differentiate healthy tissue from tumorous tissues. The dataset used is BRATS2015 containing both 3D and 2D images but only 2D images are considered. The proposed method is to combine SSD neural network along with GrabCut for proper segmentation of tumor from healthy tissues. Due to unpredictable shape or place of appearance, segmenting brain tumors from imaging data is one of the most challenging tasks in medical image analysis.

Keywords: *Medical Resonance Imaging, Brain Tumor, GrabCut, Single Shot Multibox Detector, Segmentation.*

Introduction

The human visual system is precise and fast when considered for any object detection task. We humans can perform complex task driving a vehicle with less conscious mind. A computer system needs specialized sensors, assisting devices, complex algorithms, huge training data, etc. for real time object detection. Neural networks are capable of performing such complex task and support machine learning. Expeditious development of computer vision and artificial intelligence, along with medical imaging and computer assisted intervention have aided researchers to operate computer assisted diagnostic systems in medicine.

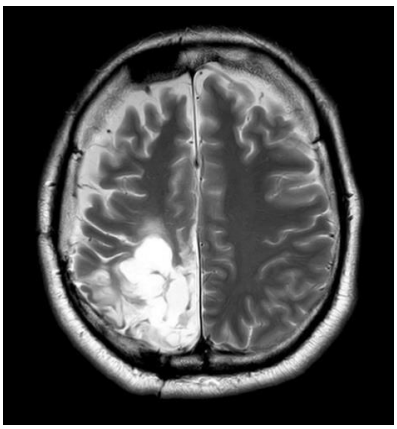

Fig 1. MRI image of brain tumor

Assisting them, burden in diagnosis is largely reduced. Deep learning helps a neuro-radiologist make faster and more accurate diagnosis. It helps doctors visualize, which means that it enhances a doctor's ability to analyze medical image. Therefore medical image detection problems, like brain tumor detection are receiving attention of researchers. The MRI scan is considered safe and painless test that uses magnetic field and radio waves providing more details than a CT scan (Computed Tomography) in a way that 3D images can be generated to pinpoint abnormal tissues. MRI scans typically costs more and take more time to perform than other imaging methods. The quality of images depend on a person's ability to remain as still as possible and follow instructions for holding their breath while the images are being recorded. If patient is anxious, confused or in severe pain, he/she may find it difficult to lie still during imaging.

Literature Survey

A key feature of Single Shot Multibox Detector model is the use of multi-scale convolutional bounding box outputs attached to multiple feature maps at the top of the network. This representation allows to efficiently model the space of possible box shape. Provided an appropriate training strategy, a larger number of carefully chosen default bounding boxes results in improved performance which is experimentally validated. SSD model were built with at least one order

of magnitude more box predictions sampling location, scale, and aspect ratio, than previous methods. [6] Tensorflow object detection API is used which already contains pretrained models for COCO dataset. Additionally, Mobilenet and inception version are provided. The model is trained on local computer. Mobilenet is used only for detection training i.e. single class named – 'Blood cell'. It is observed that reducing learning rate as the training progresses helps coverage slowly and not to pass the optimal. [1] Another study conducted for real-time brain slices detection with microscopic CCD where accuracy is crucial for automatic collection of brain slices. The Cycle-GAN data augmentation method is used to overcome the limitation of training images. The method used had a good performance of rapidly detecting brain slices with only a small training dataset. [2] A novel and effective channel for skin lesion segmentation in dermoscopic images combining a deep convolutional neural network named as You Only Look Once (YOLO) and the GrabCut algorithm is used to perfrom lesion segmentation using a dermoscopic image in four steps-removal of hairs on the lesion, detection of the lesion location, segmentation of the lesion area from the background, and lastly post-processing with morphological operators. [7] Another similar work presented a focal liver lesion detection model leveraged by custom-designed multiphase computed tomography (CT) volumes that reflect real world clinical lesion detection practice using a Single shot Multibox detector (SSD). This study has shown that our optimized version of the SSD can successfully learn an unbiased feature representation from a weakly-labeled multi-phase CT dataset. [4] A similar work in deep learning presented systematic evaluation of the performance of several existing state-ofthe-art object detection methods for breast tumor detection with help of newly created dataset of Ultrasound images collected from Sichuan Provincial People's Hospital due to lack of publicly available dataset. [5]

Proposed System

A. Proposed Approach

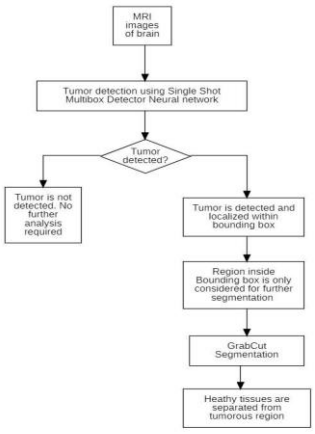

Fig 2. Flow for proposed system

Methods:

1. **SSD**:

The Single Shot Multibox Detector is one of most precise and fast real time object detection neural network. The SSD-500 (the highest resolution of 512 x 512 for input images) achieves best mAP on Pascal VOC2007 dataset at 76.8%, but at cost of trade-off with speed, where its frame rate drops to 22 fps. SSD-300 is thus a much better tradeoff with 74.3 mAP at 59 fps. [6]

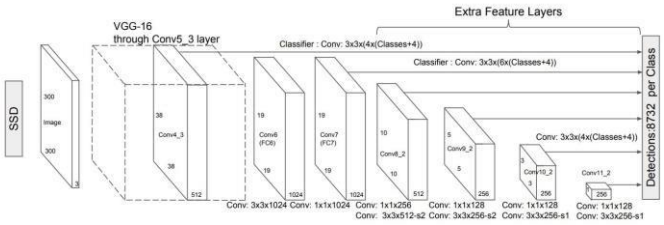

Fig 3. SSD model

2. **GrabCut:**

The result generated after SSD will be an image with bounded box. The bounded box will contain maximum tumor region along with some healthy non-affected tissues. The region outside bounded-box is considered sure background and the within area of bounded-box is considered unknown in GrabCut segmentation. The part where user had to manually draw the rectangle to specify location of object for segmentation is provided by SSD.

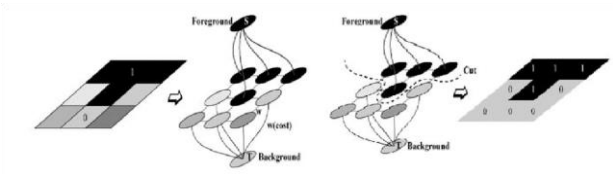

Fig 4. GrabCut for localized image

Dataset: description

The Multimodal Brain Tumor Segmentation (BraTS) is a challenge held annually since 2012 in conjunction with MICCAI conference. BraTS images are available in .mha format which need to be converted into 2D images for deep learning processing. This dataset is benchmarked.

Observation & discussion:

You Only Look Once (YOLO) is another single stage neural network for real time object detection; a competitor for SSD. The method is fast but makes background errors before localization. In case of brain tumor detection, time is of less essence compared to its precision of location. Another point to consider is that even after localization, the bounded-box contains some non-affected part along with tumorous region which

can be further processed and removed with help of a segmentation algorithm GrabCut which is popular for its pixel to graph conversion for separating foreground and background.

Conclusion

The approach does not only locate tumor but with proper segmentation, even greyscale images can provide clear idea of precise tumor shape and location. From the study of different Neural Networks, SSD looks more promising than previously developed state-of-the-art convolutional neural networks.

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