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Optimization of Variational Model Using Deep Learning: An Application to Brain Tumor Segmentation

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ABSTRACT: The proposed replacement of variational model for saliency detection in images and its application to brain tumour segmentation. By incorporating a saliency term to a classical Total Variation based restoration functional, the new model is in a position to discriminate what's relevant (salient) from the background. The resulting nonconvex and non-smooth problem features a special Difference of Convex structure and it's numerically solved employing a proximal point algorithm that involves employing a primal-dual method to unravel an indoor nonsmooth sub- problem. I introduce a Deep Learning framework for using available knowledge from a selected application to optimize the parameters of the energy functional. The proposed framework is successfully tested on a database of resonance Images of the brain of patients affected by a glioblastoma reaching a Dice Similarity Coefficient of 85,7%.

KEYWORDS: Image segmentation, Tumor, Brain modeling, TV, Adaptation Models, Machine Learning, Saliency detection

I. INTRODUCTION

Brain tumor segmentation is one of the most important and difficult tasks in medical imaging. A proper segmentation provides quantitative and qualitative information of the cancer that helps clinicians to find the most effective treatments for each patient or in case of need to better plan a surgical intervention. Nevertheless, this work is usually done manually by experts resulting in a slow, difficult and tedious task that is subject to errors and differences between expert's criteria. In order to overcome these problems many methods have been proposed to automatically perform this task especially when using Magnetic Resonance Images (MRI) of the brain. The current state of the art for this task involves using cutting edge techniques such as Convolutional Neural Networks (CNN) and Deep Neural Networks.

II. DISEASE SYMPTOMS

Glioblastoma symptoms:

Glioblastoma causes symptoms when it presses on parts of your brain. If the tumor isn't very large, you might not have any symptoms. Which symptoms you have depends on where in your brain the tumor is located.

Symptoms can include:

- headaches
- nausea and vomiting
- sleepiness
- weakness on one side of your body
- memory loss
- problems with speech and language
- personality and mood changes
- muscle weakness
- double vision or blurred vision
- loss of appetite
- seizures

Benign tumor symptoms:



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Not all tumors, cancerous or benign, have symptoms. Depending on the tumor’s location, numerous symptoms could affect the function of important organs or the senses. For example, if you have a benign brain tumor, you may experience headaches, vision trouble, and fuzzymemory. If the tumor is close to the skin or in an area of soft tissue such as the abdomen, the mass may be felt by touch.

Depending on the location, possible symptoms of a benign tumor include:

- chills
- discomfort or pain
- fatigue
- fever
- loss of appetite
- night sweats
- weight loss

Benign tumors may be large enough to detect, particularly if they’re close to the skin. However, most aren’t large enough to cause discomfort or pain. They can be removed if they are. Lipomas,for example, may be large enough to detect, but are generally soft, movable, and painless. Some skin discoloration may be evident in the case of benign tumors that appear on the skin, such as nevi.

Malignant tumor symptoms:

A malignant brain tumour is a fast-growing cancer that spreads to other areas of the brain and spine. Most malignant tumours are secondary cancers, which means they started in another partof the body and spread to the brain. Primary brain tumours are those that started in the brain.

The symptoms of a malignant brain tumour depend on how big it is and where it is in the brain. Common symptoms include:

- severe, persistent headaches
- seizures (fits)
- persistent nausea, vomiting and drowsiness
- mental or behavioural changes, such as memory problems or changes in personality
- progressive weakness or paralysis on one side of the body, vision problems, or speechproblems

III. PROPOSED METHODOLOGY

In this work, we tend to aim at overcoming the quality parameter tuning drawback by coaching a Convolutional Neural Network (CNN) with the conferred model end-to-end. The goal is to coach CNN to produce the optimum parameters for our model once given a new input file. To beready to train the model we'd like to mend the amount of iterations of our model (resulting in precisely a pair of for the outer loop and ten for the inner). Then, every step is unrolled as one more layer to the whole network because it has completed.

We use a CNN with sixty-four options in every layer and kernel size 3 × 3 for the filters. This CNN provides a spatially adaptation $\delta(x)$ function thus providing our model with a spatially optimized stringiness term (2). Moreover, we tend to add a Multilayer Perceptron (MLP) to estimate the remaining parameters λ and α . Finally, of these parameters are fed to the variational model during a prime layer of the worldwide Deep Variational Framework.

IV. THE EXPERIMENTAL RESULTS



Fig.1 Uploading Image

Fig.2 Total variation saliency & Type of Brain Cancer

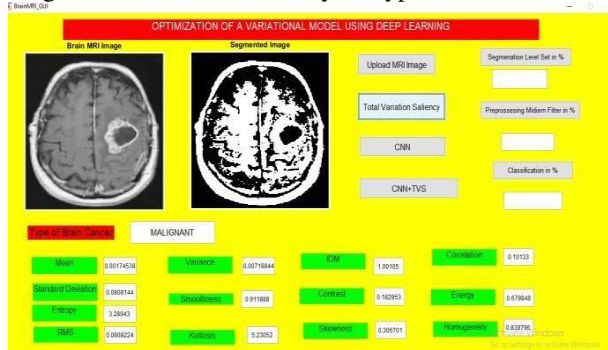


Fig.3 CNN(Convolution Neural network)

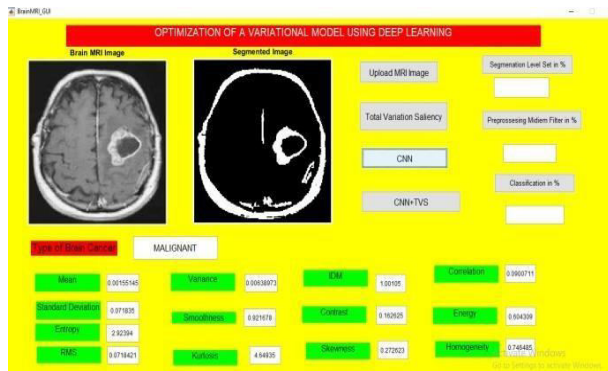


Fig.4 Segmentation level



Fig.5 CNN+TVS





Fig.6 Preprocessing Median Filter

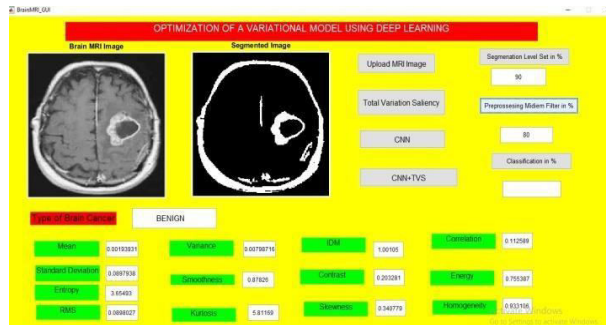
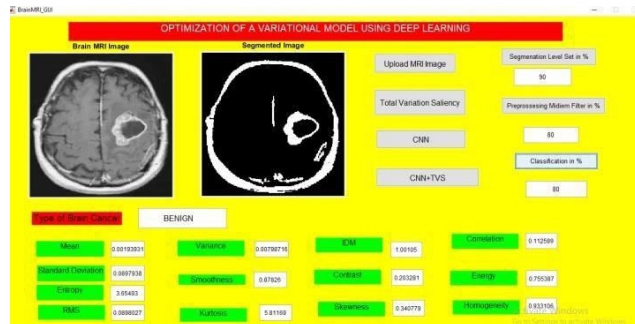


Fig.7 Classification %



V. RESULT

The developed image segmentation tumor detection techniques are found to have an accuracy of 90%, segmentation of 90% and classification of 80%.The comparison of the proposed technique with existing methods, proves that the technique developed in this paper has the highest accuracy. The accuracy can be further improved using large datasets. All the Datasets in a BRATS Datasets were trained with all the models and have analyzed and designed and concluded that the CNN provides the best result. The results indicate the brain tumor segmentation is difficult even for human raters, CNN algorithm reaches Dice scores of over 80%for whole tumor segmentation.

VI. CONCLUSION AND FUTURE SCOPE

In conclusion, we have presented a new variational model for brain tumor segmentation and a Deep Variational Framework that allows us to optimize the parameters of our model using previous knowledge from the application. The preliminary tests confirm the potential of the proposed approach. Future work includes testing with different architectures and more complex CNNs and comparing embedded variational CNN models with pure Deep Learning architectures in terms of over-fitting and reduced training datasets. We shall also consider the extension of the proposed variational model for 3D images as well as the possibility of using more than one image modalities.

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