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Convolutional Neural Network Based Medical Image Classifier

Ranjeeth Kumar Sundararajan, Sivagurunathan S, Venkatesh S, Jeya Pandian M

Abstract— Deep learning had provided good outcome in analyzing images of tumours, however, the deficiency of large annotated datasets reduces its importance. The proposed medical image processing system is based on image segmentation and image classification. It is to be used by medical field experts. In order to classify the Brain tumour images the semantic level classification and segmentation network techniques are applied. This includes prior knowledge of testing samples and training samples, using Convolutional Neural Networks (CNN). The CNN based classifier improves the detection accuracy compared to the existing segmentation based classifier. In this project, the automated system would help the medical image analyst to identify the Brain Tumour in patient by making use of deep convolutional neural network (CNN).The image is obtained from MRI scan of a brain. The tumourless patient's image dataset is used as the training and testing data for the classification network. Patient image is compared with dataset of a tumour affected images for differentiating an image as Non-timorous sample, low grade glioma and glioblastoma after segmenting and classifying the image. The Watershed segmentation algorithm is used for segmenting images and CNN is used for classifying the images. Finally the system will detect the tumour is affected or not in the given image of a patient's brain, then the system will identify the tumour affected region and differentiate the low grade glioma and glioblastoma in the image.

Keywords— convolutional neural network, Image segmentation, image classification, deep learning,

I. INTRODUCTION

1.1 Research Background

Deep learning provides challenging outcome in the field of medical analysis. The proposed medical image processing system is based on image segmentation and image classification and achieved the accuracy of 89%. It is to be used by medical field experts. In order to classify the Brain tumour images the semantic level classification and segmentation network techniques are applied. This includes prior knowledge of testing samples and training samples, using Convolutional Neural Networks (CNN) for realizing images. In this project, the automated system would help the medical image analyst to identify the Brain Tumour in patient by making use of deep convolutional neural networks (CNN). Medical analyst will upload the image of an MRI human brain into the system, the system will provide an output that the given image is affected with tumour or not. And the tumour is classified into low grade glioma and glioblastoma.

Deep Learning

Deep learning is a sub-domain of machine learning technique that applies the learning data representations. There are three types of Learning like supervised, semi-supervised or unsupervised. Deep neural networks which is a part of deep learning technique is advantageous for medical image analysis that produces results better than the human experts.

Deep learning models have the roots from the biological nervous systems.

Neural Network

An artificial neural network is a network of neurons or nodes for solving artificial intelligence (AI) related problems.

The neuron connection are modeled as weights of two types, excitatory connection for positive weights and inhibitory connections for negative weights.

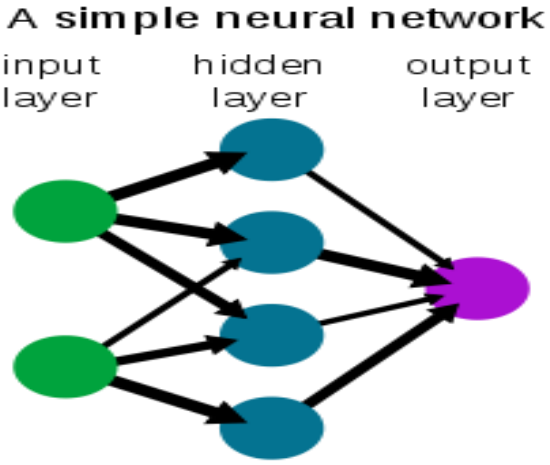

Figure 1.1 Simple Neural Network

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* Correspondence Author
Ranjeeth Kumar Sundararajan*, Deparment of Computer Science & Engineering, Srinivasa Ramanujan Centre, SASTRA Deemed University, Kumbakonam, Tamil Nadu, India.
(Email: : ranjeethkumar@src.sastra.edu)
Sivagurunathan S, Deparment of Computer Science & Engineering, Srinivasa Ramanujan Centre, SASTRA Deemed University, Kumbakonam, Tamil Nadu, India.
(Email: : sivagurunathan@src.sastra.edu)
Venkatesh S, Deparment of Mathematics, Srinivasa Ramanujan Centre, SASTRA Deemed University, Kumbakonam, Tamil Nadu, India.
(Email: : mailvenkat1973@gmail.com)
Jeya Pandian M Deparment of Computer Science & Engineering, Srinivasa Ramanujan Centre, SASTRA Deemed University, Kumbakonam, Tamil Nadu, India.
(Email: : jeyapandian@src.sastra.edu)

Convolutional Neural Network

The Convolutional neural network (CNN) is a kind of deep neural network that is mostly used in analyzing images. CNNs requires minimal preprocessing. Based on their shared weights architecture and translation invariance characteristics, CNNs are also called as space invariant artificial neural network (SIANN).

In the connectivity pattern the CNNs resembles the organization of the animal visual cortex. In the receptive field, Individual cortical neurons respond to stimuli. The receptive fields of different neurons partially overlap, so they can cover the complete visual field.

Since, CNNs need little preprocessing, the human effort with no prior knowledge is a major advantage.

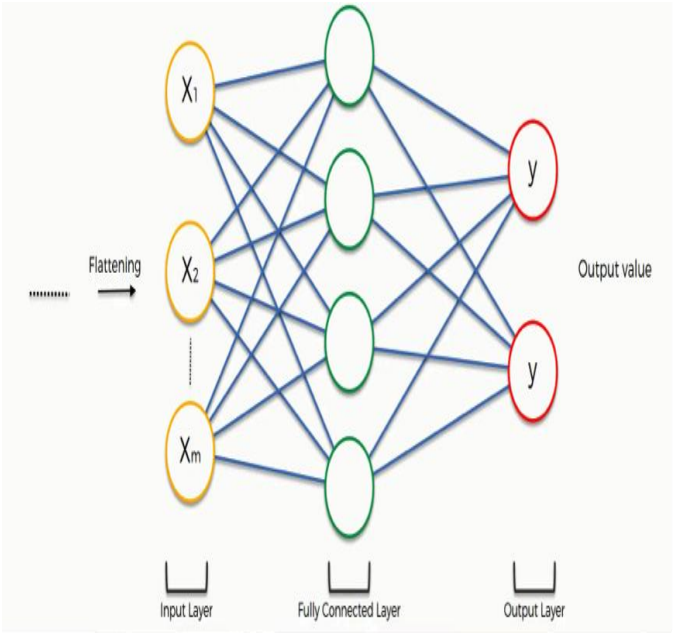

Figure 1.2 Convolutional Neural Network

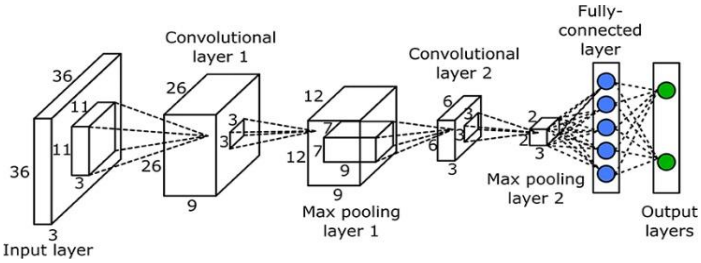

Figure 1.3 Convolutional Layer Representation

1.2 Literature Review

A medical image classifier using segmentation networks for brain tumour classification is proposed [5]. The maximum accuracy marked by their approach was 82% accuracy on 91 training samples. A semi-supervised learning Generative adversarial nets based semi-supervised learning was proposed in chest X-rays cardiac abnormalities [6]. This method supports both labelled and unlabeled data. In [7], the CNN based models like AlexNet, GoogleNet, and VGGNet is adopted for lymph node detection and lung disease classification.

Various CNNs trained models are studied with different imaging applications [2]. The AlexNet architecture is applied that proved CNNs performed better because of less number training samples.

II. SYSTEM ANALYSIS AND DESIGN

A. Existing System

The framework of an existing system is based on segmenting the image, training the data and classification of data. The data will be segmented manually by experts and the data is used for training and testing the MRI brain image. The given image will be compared with the given dataset using Convolutional Neural Network (CNN). Then the data will be classified into the different type of brain tumour.

Limitation of Existing System

New data could not be added by a user to the training set, which will not increase the accuracy of a framework. Segmentation has done manually. Tumour affected region in the given MRI brain image is not found.

B. Proposed System

To overcome the limitations in previous works, here we propose to use an original MRI brain image for training a classification network. CNN classify the image as a tumorous and non-tumorous sample. Watershed algorithm is used for segmentation. It will help us to identify the tumour affected region of a human brain and also help us to differentiate low-grade glioma and glioblastoma.

Advantages of Proposed system

Accuracy will be improved. User can upload a data to the dataset easily which allows to increase the system accuracy by applying the deep learning. Tumour affected region will be identified and differentiated as low grade glioma and glioblastoma.

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C. System Architecture

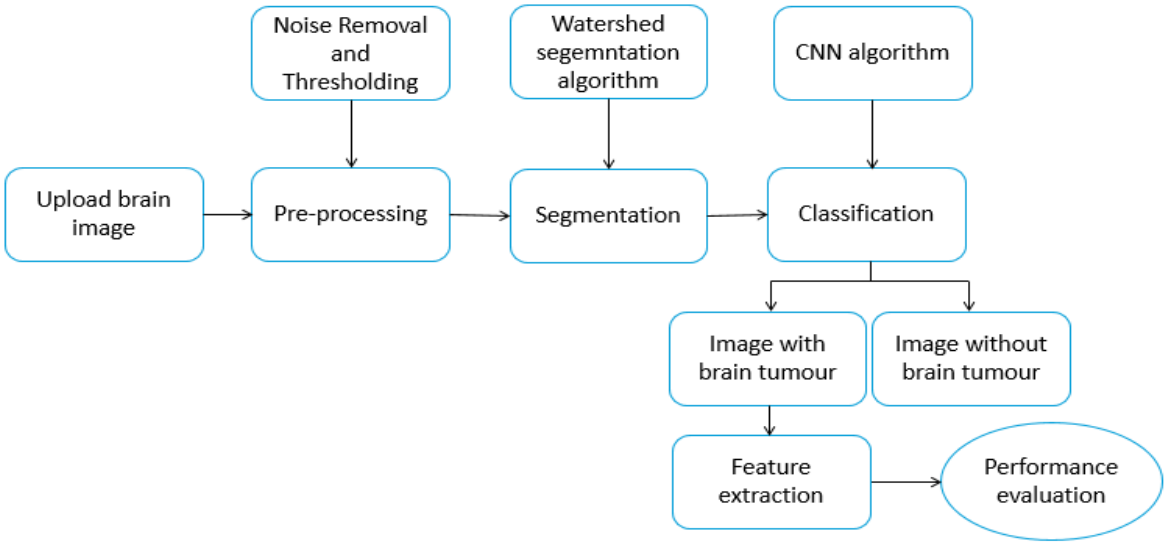


Figure 2.1 Architecture of Medical Image Classifier

As shown in the Fig 2.1, the proposed application will work on the neural network, where user will upload the image, then the system will pre-process the image and watershed segmentation algorithm for segmentation and the CNN algorithm is used for classification. If the tumour is identified, Later the feature will be extracted.

Use Case Diagram

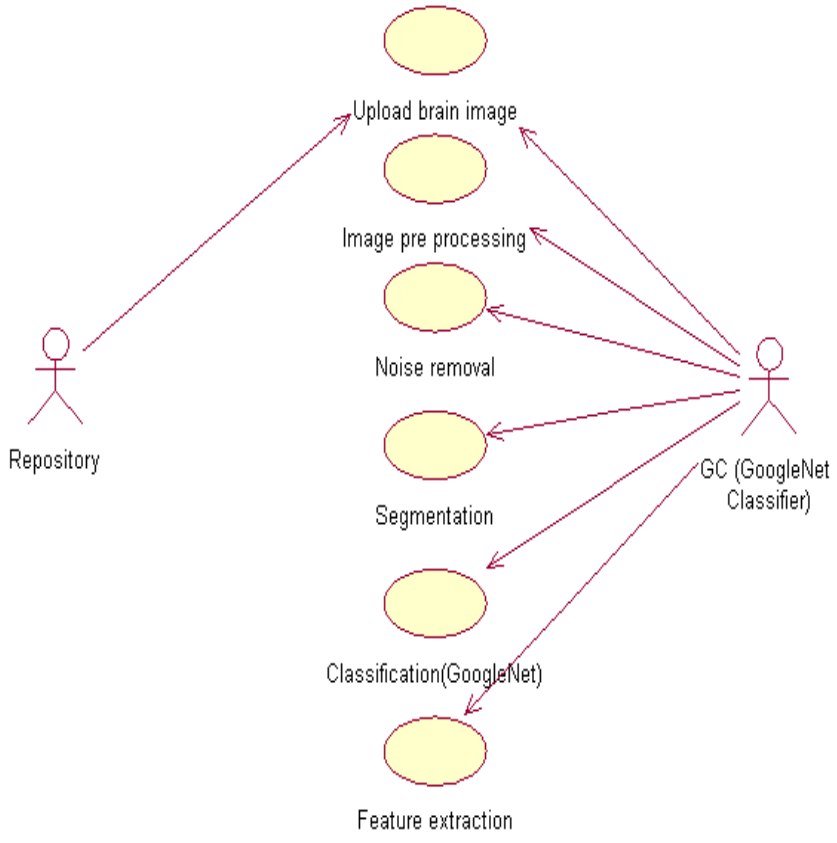


Figure 2.2 Use case of Medical Image Classifier

As shown in Fig 2.2, The only actor involved in the system is user. The user will upload the MRI brain image from the repository, the system will process the uploaded image, by using the Convolutional Neural Network the given image is classified as a tumorous or non-tumorous. If the tumour is identified system will identify the tumour affected region and produce an output.

III. IMPLEMENTATION & RESULTS

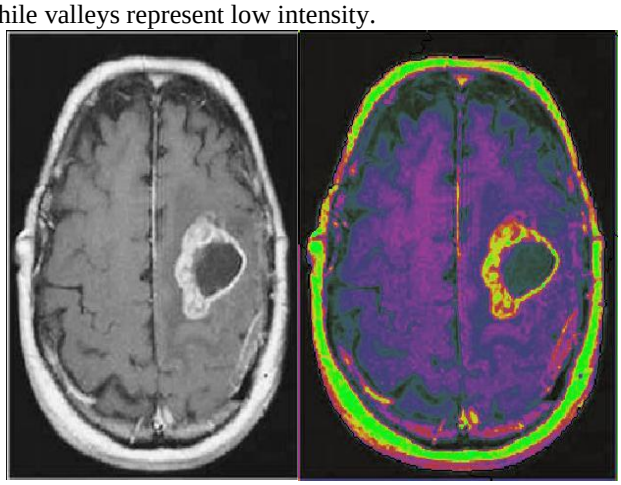
A. Methodology

The proposed work follows image segmentation and image classification.

Image segmentation

The image segmentation is done with the help of Watershed algorithm. The grayscale image based transformation is watershed and it considers the image like a topographic map. The height is represented by the brightness of every point and top of the ridges represents the lines.

The grayscale image can be correlated as the topographic surface. The peaks are represented by high intensity and hills while valleys represent low intensity.



3.1 (a) Grayscale Image (b) Segmented image

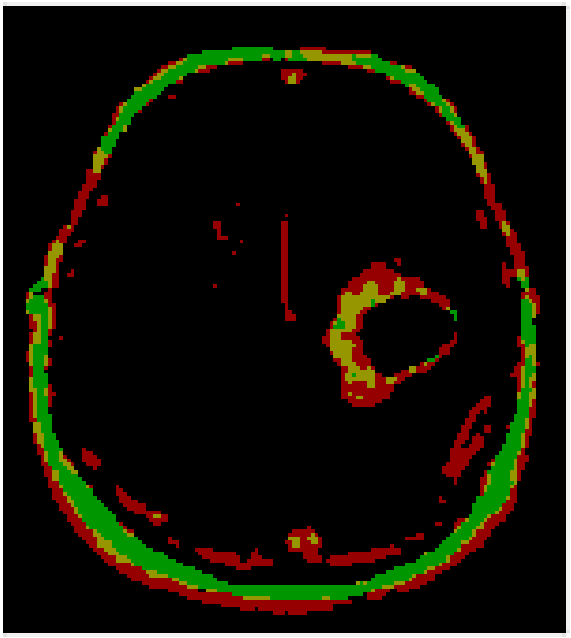
Figure 1: Image segmentation. (a) A normal MRI brain image. (b) Image after implementing watershed segmentation algorithm.

Image thresholding

An image segmentation method namely thresholding that is done on grayscale image is used to create binary images.

The algorithm considers that the image contains two classes of pixels that follows bi-modal histogram which is foreground pixels and background pixels.

Thresholding will replace each pixel in an image with a black pixel if the image intensity $I_{i,j}$ is less than some fixed constant T (that is, $I_{i,j}$< T), or a white pixel if the image intensity is greater that the constant.

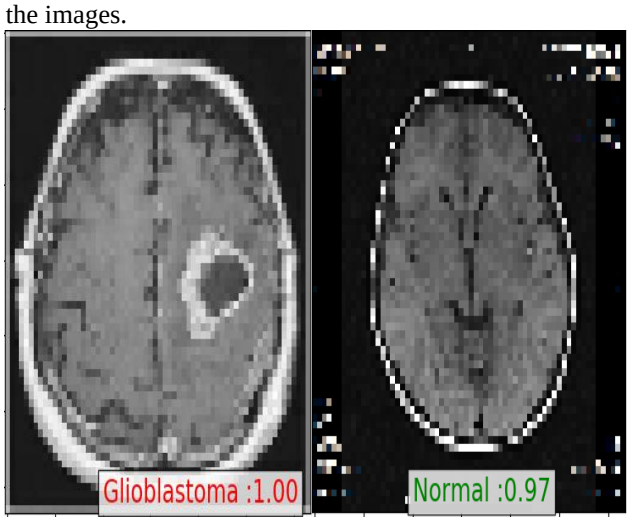


3.2 Threshold image

Image Thresholding. (a) Image after using global thresholding algorithm.

The proposed method uses a Convolutional Neural Network Algorithm for classification. We found that using a segmented image for training may produce an effective result but training the new samples will be complicated process. Our classification network will train the image without any segmentation.

The algorithm take input image and perform classification of the images.



(a) Tumorous sample (b) Non-tumorous sample

Figure 3.3 Image classification. (a) Sample with tumour. (b) Sample without tumour

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B Results and Discussion

The following section shows stage-wise of the resultant images.

Input Design

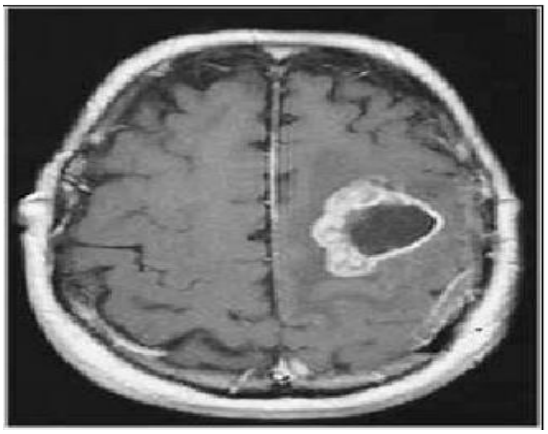

Figure 3.1 Upload Image

Figure 3.2Threshold Image

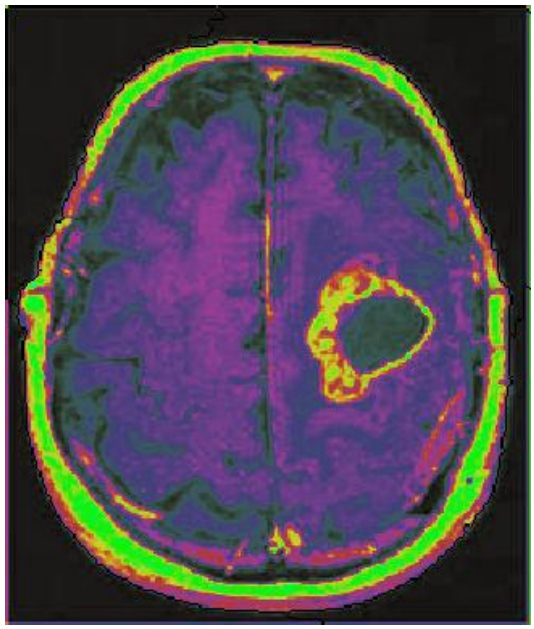

Figure 3.3 Watershed Segmentated Image

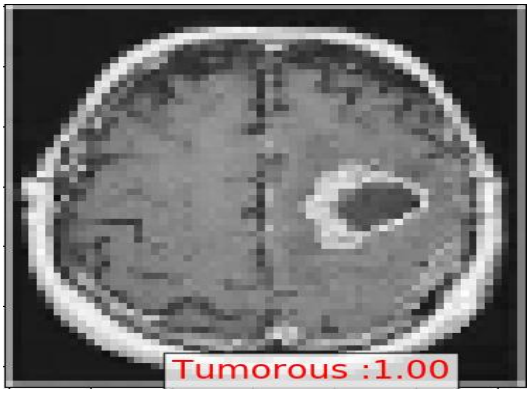

Figure 3.4 Classification

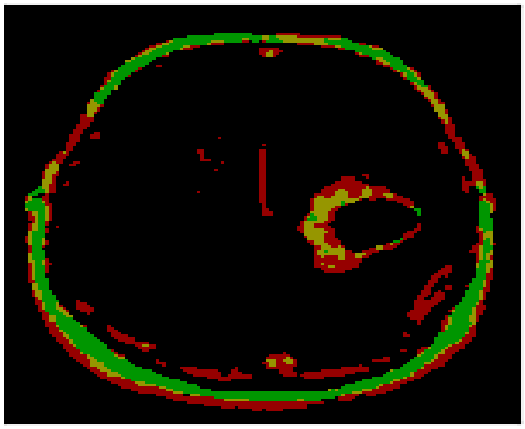

Figure 3.5 Tumour affected region

Detection Accuracy

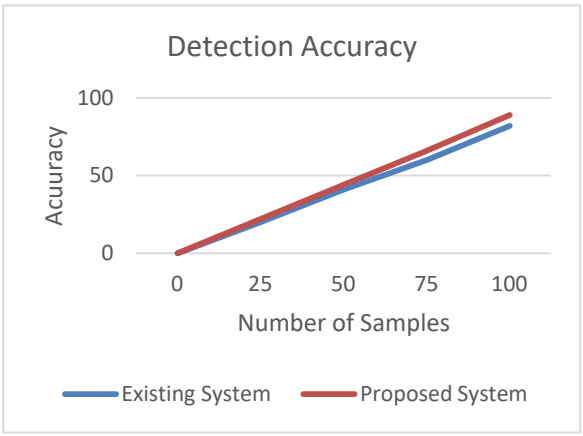

Figure 3.6 Detection accuracy

IV. CONCLUSION AND FUTURE ENHANCEMENTS

Conclusion

In this paper, a strategy for building medical image classifiers from pre-trained images for classification of tumour image is proposed. Using segmentation, we can differentiate glioma and glioblastoma. The proposed framework achieved the accuracy of 89% on 2D brain tumour classification from MRI images, and outperformed the framework with 82% on pre-trained segmentation networks on 3D brain tumour classification from MR images. This

framework is applicable to 2D medical image analysis and gives the practical solution. The proposed system is fully computerized. In future, we can extend the framework to improve the accuracy in various kinds of datasets.

Future Enhancements

(i) Accuracy of a framework can be increased.

(ii) The framework is extended for different kind of cancers.

(iii) Execution time can be decreased.

V. ACKNOWLEDGMENT

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