Received: 6 July 2017 | Revised: 25 July 2017 | Accepted: 16 August 2017

DOI: 10.1002/ima.22238

RESEARCH ARTICLE

WILEY

# Segmentation of glioma tumors using convolutional neural networks

**R. Anitha**[1] | **D. Siva Sundhara Raja**[2]

[1] Faculty of Electronics and Communication Engineering, Adhi College of Engineering and Technology, Chennai, Tamilnadu, India

[2] Faculty of Electronics and Communication Engineering, SACS MAVMM Engineering College, Madurai, Tamilnadu, India

**Correspondence**
R. Anitha, Faculty of Electronics and Communication Engineering, Adhi College of Engineering and Technology, Chennai, Tamilnadu, India.
Email: anithagodavarthy@gmail.com

**Abstract**

The abnormal development of cells in brain leads to the formation of tumors in brain. In this article, image fusion based brain tumor detection and segmentation methodology is proposed using convolutional neural networks (CNN). This proposed methodology consists of image fusion, feature extraction, classification, and segmentation. Discrete wavelet transform (DWT) is used for image fusion and enhanced brain image is obtained by fusing the coefficients of the DWT transform. Further, Grey Level Co-occurrence Matrix features are extracted and fed to the CNN classifier for glioma image classifications. Then, morphological operations with closing and opening functions are used to segment the tumor region in classified glioma brain image.

**KEYWORDS**

brain tumors, classifier, features, glioma, image fusion

## 1 | INTRODUCTION

As per the report 2016 of American Brain Tumor Association (ABTA), 61 200 persons in United States of America (USA) are affected by brain tumor. WHO (2016) reported that the persons affected by brain tumor is 6.2 million worldwide. The tumor is formed in brain due to the abrupt development of the cells in brain region. The initial stage of the tumor formation in brain region is primary brain tumors (PBT) and they are further treated as benign. The tumors in this category are having homogeneous structures. The severe stage of the tumor in brain region is secondary brain tumors (SBT) which is also called as malignant. The brain tumors are differentiated with their shape, size, intensity, and density. The benign tumors can be controlled and cured by medication. The untreatable benign tumors become malignant tumors. The malignant tumors are the uncontrollable tumors which can be cured only by surgery. The brain tissues in brain are gray matter, white matter, and cerebro spinal fluid. These brain tissues play an important role in the process of brain tumor classification. The tumors are having different shape, size, and located in different areas in brain region which makes the tumor detection and segmentation process more complex. The brain tumor segmentation by physician is time consuming and error probe process. The manual detection of brain tumor is not suitable for large population countries. Hence, there is a need for automatic detection and segmentation of brain tumors. The malignant tumors in brain image are classified as glioma and meningioma. Figure 1A shows the glioma tumor brain magnetic resonance imaging (MRI) and Figure 1B shows the meningioma tumor affected brain image.

## 2 | LITERATURE SURVEY

Bahadure et al.[1] used wavelet transform method to detect abnormal lesions in brain region. The authors used Berkeley type wavelet kernels which were symmetric with its decomposition level. This multi level decomposition sub-bands were trained properly with support vector machine (SVM) classifier. The sensitivity rate about 97.72%, specificity rate about 94.2%, and accuracy rate about 96.51% were achieved by authors on BRATS 2015 dataset. Sreedhanya and Pawar[2] applied hybrid classification technique on preprocessed brain MRI image. Gaussian mixture model was developed by authors to represent the texture features of the brain image for improving the segmentation accuracy. Fast Fourier transform was used by Alfonse and Salem[3] to transform the spatial domain features into frequency domain features. Maximal-relevance classifier was used to train the extracted