Chapter 10
Application of AI for Computer-Aided Diagnosis System to Detect Brain Tumors

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ABSTRACT

Early detection and proper treatment of brain tumors are imperative to prevent permanent damage to the brain even patient death. The present study proposed an AI-based computer-aided diagnosis (CAD) system that refers to the process of automated contrast enhancement followed by identifying the region of interest (ROI) and then classify ROI into benign/malignant classes using significant morphological feature selection. This tool automates the detection procedure and also reduces the manual efforts required in widespread screening of brain MRI. Simple power law transformation technique based on different performance metrics is used to automate the contrast enhancement procedure. Finally, benignancy/malignancy of brain tumor is examined by neural network classifier and its performance is assessed by well-known receiver operating characteristic method. The result of the proposed method is enterprising with very low computational time and accuracy of 87.8%. Hence, the proposed method of CAD procedure may encourage the medical practitioners to get alternative opinion.

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INTRODUCTION

The main objective of a new AI based CAD system is to analyze the brain MRI to detect the lesion characteristics in early stage. In most of the cases, existence of different brain tumors including gliomas, meningiomas, medulloblastomas, pituitary tumors in a patient is diagnosed after long suffering from the symptoms of unexplained nausea, headaches, vision problems, speech difficulties, personality changes, Seizures etc (Ricard et al., 2012). However, in most of the cases these symptoms are very common to other diseases and hence neglected to encounter the early detection procedure. During last few decades, death rates due to brain tumor are increasing rapidly as compared to any other diseases among the men, women and children. The 5-year survival rate is also very poor for people with a cancerous brain or CNS tumor. It is approximately 34% for men and 36% for women. However, survival rates vary widely and depend on several factors, including the type of brain or spinal cord tumor.

The primary tumors start in the brain and are inclined to stay in the brain, the metastatic or malignant tumors may also be developed and spread out in the brain from other parts of the body (Davies & Clarke, 2004). Brain tumors are classified from grade I to IV. Generally, grade I and grade II are benign (non-cancerous) brain tumors which are also called as low-grade. Grade III and grade IV are malignant (cancerous) brain tumors which are called as high-grade.

Patients having stage II (cancerous) tumors in brain need continuous monitoring and observations by magnetic resonance imaging (MRI) or computed tomography (CT) scan by every 6 months (Herholz et al., 2012). However, from the previous studies we have found that the composition of gray matter/white matter density of brain substantially varies from relative smooth to complex patterns of brightness (Rogowska, 2000)-(Simmons et al., 1994). Regarding this, appearance of tumors may also be obscured by the surrounding soft tissues, presence of cerebral cortex, ventricles etc. As we know that the composition of MRI depends on the differing relaxation times of water contents within various tissues, noises during MRI mainly caused due to field strength variations with time, presence of RF pulses, and receiver bandwidth variation pattern (McVeigh et al., 1986). All these factors may provide serious inaccuracies regarding the location and exact boundaries of tumors. Sometimes recent technology undergoes MRI with contrast for obtaining better contrast which in turn occasionally introduces many side effects including allergic reactions. Few researchers also found that this toxic contrast agent is deposited and retained in the brain (Rogosnitzky & Branch, 2016). Hence there is a biggest concern in radiology about the safety of these agents. Nevertheless, cost of so-called safe contrast agents in MRI is also expensive.

All these factors arise because of visual inspection and interpretation of MRI is performed to find out the presence of abnormalities. Decision made by this examination is going to be much difficult for radiologists to provide accurate and uniform interpretation due to the enormous number of images generated in a widespread screening. Yearly routine check-up of MRI also demands automated computer assisted interpretation system to find out the risk factors. So, the radiologists turn to automated and accurate detection approach prescribed by the specialized computer algorithms which in turn safe, non-invasive and fast. Obscured nature of normal brain MRI also alternatively bypasses the requirement of invasive contrast agent technique. Therefore, enhancement of brain MRI followed by proper segmentation approach is very important and emerging demand for visual interpretation and therapeutic planning of tumors by the radiologists.

In a successful CAD based detection procedure, inhomogeneous nature of brain MRI requires an appropriate contrast enhancement technique followed by a segmentation approach and then significant features to be extracted to distinguish the benignancy/malignancy of the tumors. This proposal will pro-