RESEARCH PROPOSAL

According to world health organization's statistics, cancer is considered as the second leading cause of human fatalities across the world, being responsible for an estimated 9.6 million deaths in this year. Among different type of cancers, brain tumor is widely seen as one of the deadliest cancers due to its aggressive nature, heterogeneous characteristics (types), and low relative survival rate (e.g., in US relative survival rate following a diagnosis of a primary malignant brain tumor is around 35%).

Brain tumor is referred to the aggregation of abnormal cells in some tissues of the brain or central spine canal. The term "tumor," which literally means swelling, can be applied to any pathological process that produces a lump or mass in the body. Primary brain tumors and metastatic brain tumors form the two basic kinds of tumors. Primary brain tumors start and stay in the brain itself whereas metastatic brain tumors begin as cancer in different parts of the body and then spread to the brain. Tumors can be cancerous (or malignant) or noncancerous (or benign). Malignant brain tumors grow fast and spread to other areas of the brain and spine and compared to benign tumors, they are more life-threatening.

The World Health Organization (WHO) classifies brain tumors by cell origin and behavior, from least to most aggressive. Many non-malignant brain tumors are classified as Grade I or II, also known as low grade (LG) tumors, and malignant tumors as Grade III or IV, as high grade (HG). While HG tumors are threatening with a maximum life expectancy of two years, LG tumors may allow the sufferer to have many years of life expectancy. A tumor which occurs in the brain or spinal cord is called as glioma and the tumor that arises from the meninges is called as meningioma. The abnormal cell growth in the pituitary gland is observed as pituitary tumor.

The American Cancer Society's estimates for brain and spinal cord tumors in the United States for 2020 include both adults and children.

- About 23,890 malignant tumors of the brain or spinal cord (13,590 in males and 10,300 in females) will be diagnosed. These numbers would be much higher if benign (non-cancer) tumors were also included.
- About 18,020 people (10,190 males and 7,830 females) will die from brain and spinal cord tumors.

This cancer can drastically influence the quality of life, for both patients and their families. The key factor in treating brain cancer and increasing its survivability rate is early diagnosis and correctly determining its type.

Since manual segmentation of brain tumors is a highly time-consuming, expensive and subjective task, Brain tumor segmentation is a critical step towards improving disease diagnosis, treatment planning, monitoring and clinical trials. Reliable brain tumor segmentation is required to detect the location and also the extent of the tumor. However, brain tumors have properties that make their accurate segmentation challenging. These tumors are highly heterogeneous in terms of location, shape, texture and size. In addition, they are usually poorly contrasted and the intensity value of a tumor may overlap with the intensity value of healthy brain tissue. Therefore, it is not easy to distinguish healthy tissue from the tumor.

The early brain tumor detection plays a major role in treatment and recovery of the patient. For medical image diagnosis, the images can be obtained from various imaging modalities namely Positron Emission Tomography (PET), Magnetic Resonance Imaging (MRI) and Computed Tomography (CT). Among different screening technologies, Magnetic Resonance Imaging (MRI) is, typically, selected as the utilized technique for brain tumor classification, due to the high resolution images it can provide on brain tissue and MRI is harmless because it is based on magnetic field and radio waves and do not pose any radiation hazard to human body. However, cancer type recognition based on MRI images is a challenging, error-prone, and time-consuming procedure, as it highly depends on the experience of the radiologist, and more importantly, there may not be enough visible landmarks in the image to contribute to an accurate decision. Segmentation methods includes a range of approaches based on

classification using extracted features, level set methods, Markov random field (MRF) methods, fuzzy c-means (FCM), k-nearest neighbor (KNN) and region growing.

Conventional MRI detects and localizes the proton signals from fat and water molecules to produce images. Proton MR Spectroscopy (MRS) measures the chemical spectrum of the tissue, where individual resonance peaks represent metabolite concentrations from a specific region. Hence, MR Spectroscopy can complement the anatomical information from conventional MRI to allow better tissue characterization. The most important and common MRS metabolites include N-acetyl aspartate (NAA), total choline compounds (Cho), total Creatine compounds (Cr), lipids, lactate, myoinositol, glutamate, and glutamine. Increased levels of Cho and decreased levels of NAA have been detected in malignant tumors. MR Spectroscopy is a promising non-invasive technique that provides both tumor metabolic information and insight into the physiology of malignant transformation in brain tumors. MRS spectra can be analyzed both qualitatively and quantitatively to distinguish between tissue conditions, i.e. normal, benign, malignant, necrotic or hypoxic.

The aim of the proposal is to extend the concept of deep learning networks to MR Spectroscopy to obtain super-resolution MR Spectroscopy Imaging (MRSI). Deep learning techniques can be used to remove artifacts so that the accuracy of the MRSI can be improved. Different deep learning models and architecture can be used to improve the accuracy, classification and prediction rate of the brain tumor. Deep learning techniques might provide super resolution MRSI images similar to MRI and using both MRI and MRS may help tailor treatment planning.

Rajeev S K
Associate Professor
YCET, Kollam