Assessment and Detection of Brain Structural Abnormalities in MRI Images

Faculty Development Funded Project Proposal

for Summer 2024

Submitted by

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BUDGET = $7,000

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1. A concise description of the project

There are different conditions which may affect structure of the brain including aneurysm, brain tumor or brain injury, multiple sclerosis, and other. Substantial changes in cognitive abilities and/or functional limitations often lead to diagnostic attempts to evaluate possible factors related to brain structural alterations. There is a continued interest in linked areas. Also, research conducted in developed countries shows that people affected by brain tumor often die due to its inaccurate detection. In particular, the most common malignant primary brain tumor is a type of astrocytoma (a tumor that forms from glial cells) known as glioblastoma multiforme GBM. Therefore, accurate diagnosis of brain tumor is crucial for its successful treatment.

Evaluation of the brain as a soft tissue is very suitable to MRI as these scans provide more details, although CT is also often used as a quick tool for an initial diagnosis. In particular, the tumor tissue mainly appears as brighter shades than the rest of the regions in the brain. Magnetic resonance imaging (MRI) is the most commonly used modality for brain tumor growth imaging and its location detection. The conventional method for CT and MRI brain images classification and tumor detection is human inspection. Typically, radiologists perform visual evaluation of MRI images which is time consuming and prone to human errors affecting accurate determination of stage and size of tumor. Operator assisted classification methods are impractical because of large amounts of data and are also non reproducible.

Segmentation of brain tumors in MRI data sets is of great importance for improved diagnosis, growth rate prediction, and treatment planning. However, quantification of any part of this process is challenging due to the presence of severe partial volume effect and considerable variability in tumor structures, as well as imaging conditions, especially for the gliomas. The most practical way to evaluate brain tumors in detail requires an MRI and/or CT images with and without contrast and also to follow patients after surgery or other treatment procedures.

Many times, there is a difficulty in distinguishing brain tumor tissue from normal tissue because of the similar color density. In particular, brain tumor segmentation is done to separate brain tumor tissue from other tissues such as fat, normal brain tissue, edema and cerebrospinal fluid to overcome this difficulty. Therefore, detection of a brain tumor is a tedious task and its identification often involves segmentation of brain images, extraction of brain features and classification of abnormality in the MRI image.

MRI brain images analysis, classification and tumor detection are mostly based on a direct radiologists' inspection and conventional assessment, although other methods can be found in the literature. The proposed methodology aims to differentiate between normal brain tissue and brain tumor (benign or malignant). The study of some types of brain tumors such as metastatic bronchogenic carcinoma tumors, glioblastoma and sarcoma are performed using brain MRI.

Specifically, my goal is to develop novel method and applicable algorithm for brain tumor detection to assist doctors with accelerated diagnosis and quantification of the degree of abnormality. Developed image processing approach and results generation can be applied to quantitative evaluation of other image documented structural changes. Based on this reflection I intent to propose algorithm for brain structural changes documentation of selected image(s) and a tool assisting doctors in accelerated diagnosis and quantification of the degree of abnormality. I plan to include, at the initial stage, feature enhancement including minimizing gray-scale shade variations which would allow in its final stage color coding of presumptive tumor or other regions of interest (ROI) areas and give an opportunity of comparative evaluation of tumor growth or reduction of its size. This is possible by a graphical and accompanied numerical presentation in terms of the percentage of the area classified as a tumor or other anomaly in reference to the total area of the brain reflected on a selected MRI image. Although the planned technique will focus on brain tumor, it can be applied to images documenting other structural brain anomalies.

2. Measurable goals and objectives for the project

GOAL: Provide documentation of selected image(s) for brain structural changes and a tool assisting doctors in accelerated diagnosis and quantification of the degree of abnormality.

OBJECTIVE: Design mathematical model and intelligent software capable of automatically detecting brain structural anomalies.

3. The timeframe for the project

Phase I:

June 2024 - July 2024 - Research collaboration with Prof. Dr. Pedro Mayorga, Professor at the Instituto Tecnológico de Mexicali, Mexicali B.C., México. I will involve and train in the research two Lincoln students during summer and write a research paper on this topic that I intend to publish.

4. How the project will enhance teaching/learning at Lincoln University

This research will involve two Lincoln students and Engineering Science, Chemistry, Physics and Biology/PreMed major students from the Lincoln University can benefit from this research on whole as they will be exposed to the latest research achievements in this biomedical engineering interdisciplinary field. This will be very advantageous to them as minority students in STEM.

5. The number of people who will benefit, and how

About 5 students pursuing Engineering Science, Chemistry, Physics and Biology/PreMed majors from the Lincoln University will multiply benefit from this project. The students will benefit through educational aspect, being directly involved in the research.

6. How the success of the project will be measured

The success of the project will be measured multiply through:

a) Successful presentation of the research results,
b) Continued collaboration with the Instituto Tecnológico de Mexicali, Mexicali B.C., México.

7. How, when, where, and with whom the project's outcome will be shared

The research results will be presented and discussed in the Center for Excellence in Teaching and Learning, at the Chemistry and Physics Departmental meeting and the workshop will be organized for all the Lincoln University students and faculty members. A summary report of the project will be sent to the Chair of Faculty Development Committee.

Budget

The project budget is as follows:

TWO MONTH STIPEND 2 x $3,500
TOTAL $7,000