WWSEF Project Summary

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Aditya Keerthi /

NeuroPET-M: A Novel Diagnostic Multimodal PET Scan Platform

Neuroimaging is a powerful technique to study i) brain function, ii) mechanisms of brain diseases and iii) to diagnose neurodegenerative diseases. In this regard, positron emission tomography (PET) is a powerful imaging technique that enables in vivo examination of brain function and disease diagnosis. PET scans help neurologists to visualize the brain's biochemical levels by injecting a radioactive tracer. Radioactive tracers are essentially molecules that are labelled with a positron-emitting isotope that have an affinity toward neurotransmitter sites, specific proteins, and neurochemicals in certain brain regions. A PET scan can project the brain areas where the radioactive tracers can bind, which results in producing an image that presents the location and concentration of the neurotransmitters or proteins of interest.

Neurodegenerative diseases can be diagnosed by PET scans of a patient's brain region to detect and diagnose diseases. While diagnosing complex brain diseases such as Alzheimerâ€™s disease (AD), there are numerous factors involved in the disease pathology such as brain amyloidosis, tau accumulation, neuroreceptor changes, metabolism abnormalities and neuroinflammation. Analysis of PET scan images provides evidence of abnormal biochemistry in the brain. Physicians and Neurologists can use this evidence to predict and diagnose neurodegenerative diseases such as AD for early detection.
Depending on the disease state, multiple biochemical changes can happen in the brain. PET scans are primarily used to study a single biomarker or neurotransmitter at a time and are one of the most versatile techniques and yet its full potential has not been realized to study and diagnose multiple biomarkers and neurotransmitters in the brain. I am proposing a novel software platform called â€œNeuroPET-Mâ€ which will optimize PET-based neuroimaging by providing a ground-breaking diagnostic tool for neurologists. In theory, the process would require a set of multiple PET scans for different biomarkers and create an interactive three-dimensional space of the patient's brain, mapping multiple biomarkers and neurotransmitters in the brain. There has been little to no work reported on combining PET scans, and my research project will open up a new chapter in medical diagnostic procedures. The engineering problem that â€œNeuroPET-Mâ€ aims to solve is that: current PET-based neuroimaging is limited to a unimodal technique, which prohibits the ability to diagnose complex brain conditions with multiple biomarkers, such as bipolar disorder.

It is anticipated that my research will develop novel software platforms that can be used to study PET images, combine multiple PET images and enable their analysis in disease diagnosis to advance the field of neuroscience. This research will enable the development of open access PET image databases that can be used to study the location of multiple neurotransmitters. The results obtained from this work will be disseminated at conferences (eg: the Annual Symposium on PET/CT organized by the American College of Radiology and Society of Nuclear Medicine and Molecular Imaging, USA).

Rather than mapping and analyzing single PET images as a tool to detect a particular biomarker or neurotransmitter of interest, my research will combine multiple PET images to map the locations of multiple biomarkers and or neurotransmitters for more discrete analysis and disease diagnosis. The main objective of â€œNeuroPET-Mâ€ is to visualize the location of multiple (two or more) biomarkers in the brain through a software application that takes a set of patientâ€™s PET images as input and relays a widget consisting of a 3D interactive brain output. Thus, my project focuses on developing a software platform that combines PET scans to produce a multimodal image that maps numerous biomarkers and or neurotransmitter localizations in the patient brain as a novel diagnostic tool.