TRACING, EXTRACTING FEATURES, AND CLASSIFYING MICROGLIA FROM VOLUMETRIC IMAGES OF BRAIN TISSUE

By

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ABSTRACT

Macrophages are an important component of our immune system. These are cells that hunt down and consume pathogens, foreign materials, and damaged cells in our bodies. By doing so, macrophages protect us from infection and help us recover from injury. Throughout most of the body, this role is played by a subset of the white blood cells.

White blood cells cannot be found within the central nervous system (CNS). This is due to the existence of the blood-brain barrier, which prevents many materials from entering the environment of the CNS. The blood-brain barrier protects us from substances found in the rest of the body that may be injurious to the brain. It also provides a consistent environment for the CNS.

Instead of white blood cells, the CNS has its own specialized type of macrophage known as the *microglia*. Microglia are intimately involved in a number of conditions affecting the CNS including Alzheimer's disease, multiple sclerosis, and spinal cord injury. In this thesis, we present an open-source system to automatically segment microglia from 3D images of brain tissue. This produces a model of each microglial cell in the original image.

In addition to segmentation, we also demonstrate how to use the L-Measure software package to generate an extensive set of features from these cellular models. These features allow us to perform Kernel Partial Least Squares regression. This technique produces a classifier that can predict whether or not a microglial cell was found in injured tissue with an accuracy of 86.4%.

This thesis is motivated by a desire to promote progress on open areas of biological research. It is our hope that the tools presented in this study will allow researchers to gain greater understanding from biological images. In turn, perhaps they will be able to develop more effective treatments for neuro-degenerative conditions.