CELL DETECTION FROM BRAIN HISTOLOGY USING ARTIFICIAL NEURAL NETWORK

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ABSTRACT

Investigation of cell populations through biomarkers helps to understand the mechanisms driving brain diseases, particularly at the early steps in the drug discovery process. A major challenge is to target key cells and quantify their concentration among batches of specimens. This paper describes preliminary steps in automating cell counts from virtual dissectors of brain tissue using an efficient artificial neural network.

Index Terms— brain cells, detection, neural nets

1. INTRODUCTION

Validating biomarkers in cell populations provide critical insights into mechanisms driving disease, particularly at the early steps in the drug discovery process. Immunohistochemistry and immunofluorescence (IHC/IF) apply antibodies to unlock information from cells into molecular cascades while preserving tissue integrity. IHC/IF often occurs in large batches resulting in high amounts of data, making manual analysis very time-consuming and prone to error. Despite several proposals to automate cell counting, most of the methods for IHC/IF samples focus on images from cell cultures or experimental animals, in which several parameters can be controlled to render IHC/IF images with a smooth, clean background and high contrast [1]. Contrary, IHC/IF images from postmortem human brain present lower signal-to-noise ratio, inherent to human brain tissue because lipofuscin accumulates with aging and uncontrollable periagonal factors affect tissue quality. Also, state-of-the-art quantification requires stereological methods [2] and the use of thicker tissue slides, increasing the amount of image artifacts. Here, we propose an automated segmentation algorithms based on neural networks (NN) for segmenting cells from 3D stacks of IHC/IF microscopy images of thick postmortem human brain sections, aiming to reduce counting time and inter and intra-observer variability.

2. METHODS

Confocal microscopy often improves spatial resolution, but even regional analysis can be time consuming as the human brain cells are highly diverse; histological sections usually have a much larger surface than thickness, therefore artifacts such as folds and tears are common. Nonetheless, well-trained cytologists have been able to detect and count cells by analyzing staining nuances, texture variations and cell morphology. By exploring these specific features, we design a cell detection algorithm based on a NN applied to 66 images, forming 6 stereological stacks from human brain histology, each with 11 sections. The backpropagation parameters of our NN MLP are: learning rate=0.3, momentum rate=0.2 and 50 epochs to train and transfer learning from 1 to 5 other images.

3. RESULTS & CONCLUSIONS

Figure 1 shows preliminary results applied to IHC/IF stained microscopy image stacks. We tested both Extended Depth Focus (EDF) and Maximum Intensity Projections (MIP) for considering 3D information as well as improving image quality. Proposed algorithm detects IHC/IF cells, including neurons with accuracy higher than 90%. Future results will soon be available at https://github.com/dani-lbnl/dipcell.

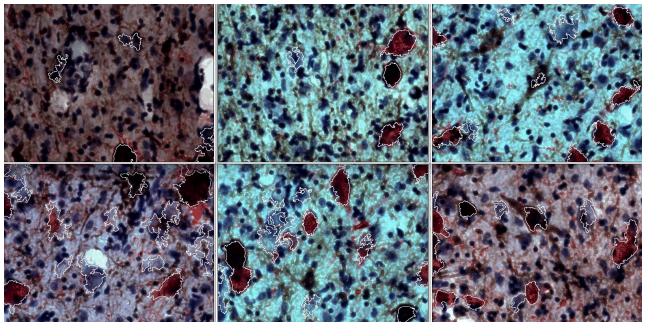

Fig. 1. Neuron detection from IHC/IF tissue using NN.

4. REFERENCES

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