

AI Techniques to Identify Nerve Cell Alterations in Digital Images

Ilias ARGYROS^{a,1}, Emmanouil ZOULIAS^a, Joseph LIASKOS^a,
Antonis STAMATAKIS^b and John MANTAS^a

^a*Health Informatics Laboratory, Faculty of Nursing, National and Kapodistrian
University of Athens, Athens, Greece*

^b*Biology-Biochemistry Laboratory, Faculty of Nursing, National and Kapodistrian
University of Athens, Athens, Greece*

Abstract. Artificial intelligence (AI), utilising computing power, has managed to influence the health sector with many applications based on algorithms, tools, and automated processes. In this work, neuronbiological images acquired by an electronic microscope are assessed under appropriate image processing to identify areas of interest. The algorithmic steps identified the alterations of nerve cells that appeared as areas in the red channel of each digital image.

Keywords. Digital image processing, artificial intelligence, neurons

1. Introduction

Digital image processing is the science of modifying digital images using a digital computer. Image analysis in Biology seeks to fully exploit the information provided by images and create an essential connecting link between experimental and theoretical examination of biological processes [1].

This work aimed to find areas of alterations in images of nerve cells and locate their position to the nearest nerve cells by analysing the available digital images, using algorithms implemented with additional software packages, which ImageJ offers.

The proposed methodology can be used by the scientific community of biologists, microbiologists and doctors, as a decision support system locating the relative position of the lesions in nerve tissue cells, regardless the physicians eye quality and experience.

2. Methods

This work analysed five images sets of brain nerve cells' using Fiji (Fiji Is Just ImageJ). Fiji is a distribution of ImageJ, an open source, cross-platform software for image analysis. The aim of applied algorithms is the accurate detection of areas of interest, which usually are alterations. Nerve cells and nerve alterations in the images are shown as shades of green and red [2],[3].

¹Corresponding Author, Ilias Argyros, Health Informatics Laboratory, Faculty of Nursing, National and Kapodistrian University of Athens, Athens, Greece; E-mail: iliasargyros7@hotmail.com.

The algorithmic steps applied to separate the two-colour channels were a) Separating and displaying the different layers of the image, and b) Splitting the two-colour channel image into two separate images, one for red and one for green. c) Maintaining maximum colour intensity in every image. The following algorithmic steps were applied to on the red areas i) 8-bit and then binary image conversion, ii) Particles' analysis to light the selection areas, measuring them and taking the individual measurements. On the green areas, the additional algorithmic steps were applied: i) Background adjustment for noise and pixel isolation, ii) Gaussian Blur to normalise the globules in the images, in the localisation cell areas, iii) Image threshold adjustment, iv) Watershed separation of binary image, e) Particles' analysis.

3. Results

Areas that appeared in the green channel illustrate normal nerve cells, and areas in the red channel demonstrate alterations of nerve cells. Green channel areas of interest were identified and counted as multi-coloured areas of particles using the Watershed method (figure 1B) and red channel areas as red-coloured areas of particles (figure 1C). Furthermore, the proximity of each centre of the green area (normal nerve cell) to each centre of the red area (alterations of a nerve cell) is estimated by calculating the Euclidean distance. Figure 1A illustrates the initial image before processing.

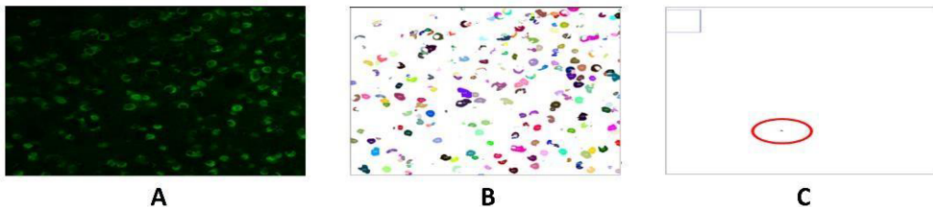


Figure 1. Initial Image (A), Illustration and Enumeration of Green (B) and Red (C) channels.

4. Discussion and Conclusions

In this work, the identification of nerve cells and their alterations are achieved by analysing the available digital images. Despite the user-friendliness of ImageJ, a fundamental limitation of implementing procedures was its unstable operation and the need to repeat all steps.

References

- [1] Ramesh AN, Kambhampati C, Monson J, Drew PJ. Artificial intelligence in medicine. *Ann R Coll Surg Engl.* 2004;86:334–8, doi: 10.1308/147870804290.
- [2] Schindelin J, Rueden CT, Hiner MC, Eliceiri KW. The ImageJ ecosystem: an open platform for biomedical image analysis. *Mol Reprod Dev.* 2015;82(7–8):518–29, doi: <https://doi.org/10.1002/mrd.22489>.
- [3] Schindelin J, Arganda-Carreras I, Frise E, Kaynig V, Longair M, Pietzsch T. et al. Fiji: an open-source platform for biological image-analysis. *Nat Methods.* 2012;9(7):676–82, doi: <https://doi.org/10.1038/nmeth.2019>.