Directional Images applied to axonal arborization identification

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Abstract. This work presents results on axonal arborization identification in cell culture of neurons from *Helix aspersa* with the use of the directional image method. We implemented the algorithm initially proposed for fingerprint recognition and classification, and adapted this idea to axonal classification and measure.

1 Introduction

Directional image is a method usually applied on fingerprint classification. It has been proposed in 1969, by Stock (1969), and nowadays it is used by most commercial systems dealing with fingerprints. A directional image may be defined as a representation of the local orientation of pixels from the original image. Evaluating the individual steps for the obtention of a directional map, one is able to filter, segment and classify fingerprints.

Implementation of such an algorithm presuposes mask definition, analysis of data in the original image, a sufficient signal-to-noise ratio in such a way that the mask may filter noise out as presented by Cappelli (1999). Objectives are defined depending on the application, usually centered on person identification (in the case of a previous existence of a database with fingerprints).

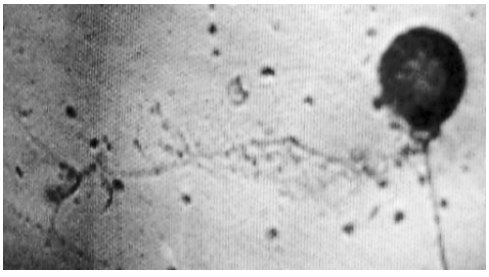

Figure 1 A neuron in culture, soma seen in the upper right, and axonal branches going left

Here we propose the application of this algorithm to the recognition of axonal branches in optical images of neurons in culture. Such images present low contrast due to acquisition method, as one may observe in figure 1. Despite of that, it is possible to see that the directional image of the axonal branch will produce interesting results, as we describe in the next sessions.

2 Materials and Methods

We developed a library in C, which implements bitmap reading and directional image evaluation for up to 512x512 pixels images. The library was initially validated in common databases containing fingerprint images (Web_Page1, Web_Page2).

An example of a directional array obtained in a step of the implemented algorithm is shown in figure 2.

In this case we present a simple example in order to show how a single horizontal line could be interpreted by means of its directional array.

000 000 000 000 000
000 000 000 000 000
012 012 012 012 012
000 000 000 000 000
000 000 000 000 000

Figure 2 Directional array of an horizontal line.

This method has been applied to optical images of neuronal invertebrate cells in culture. Cells are maintained

over glass substrates for fifteen days and photographed in order to monitor their growth.

3 Results

By observing both figures it is easy to conclude that the directional map of neurons in culture produces interesting results in sight of the necessity of definition of the directed growth of axons.

Main step to be analysed in the used algorithm is the directional smoothness, performed by a new definition of the concept of mean. Here we apply the geometrical interpretation of directional mean to each pixel, as discussed by Wilson, Candela and Watson (1994). Smoothness is a relevant point due to the necessity of signal-to-noise ration increasing.

We conjecture that this method may also be useful in several applications in Biology, in particular in the ones which deal with image interpretation as a function of time, as it is the case in this work.

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