A bio-inspired bi-operation mode vision sensor

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***Abstract*— A bio-inspired vision sensor that can compute spatial contrast magnitude or generate intensity images will be described.**

I. INTRODUCTION

The development of Wireless Sensor Networks has increased the demand of smart autonomous sensors. Such sensors send a reduced processed output data flow to a central node that makes decisions. In that sense, frame-free vision sensors have became popular during the last decade. Such devices process visual information in a similar way the human retina does. Typically we can find bio-inspired vision sensors that compute the spatial or the temporal contrast. These devices have inherent advantages and can outperform conventional frame-based cameras in terms of power consumption, data compression, and speed.

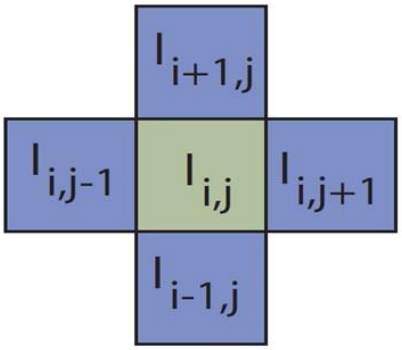
However, traditionally they have been limited to one operation mode: spatial or temporal contrast extraction. It would be desirable to have bio-inspired devices that can compute either spatial or temporal contrast and display traditional intensity images. In the presentation, we will describe a novel camera that can compute the spatial contrast magnitude and also display intensity images. Switching one digital input signal, the two operation modes are toggled.

II. SYSTEM DESCRIPTION

A. Principle of operation

Each pixel has a photodiode that senses the local photocurrent. This photocurrent is compared to the average photocurrent in a 4-pixel neighborhood. If the local photocurrent is higher, the pixel will send output spikes with a frequency proportional to the difference between the local photocurrent and the average photocurrent in the neighborhood (See Fig. 1).

$$P_{i,j} = \max\left(0, I_{i,j} - (I_{i+1,j} + I_{i-1,j} + I_{i,j+1} + I_{i,j-1})/k\right)$$



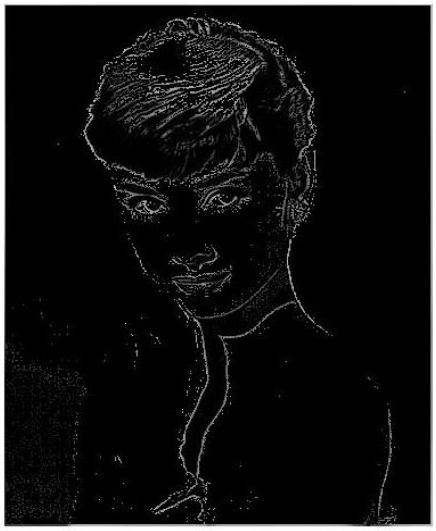


Fig. 1: Left: Proposed algorithm to compute the spatial contrast. Right: Example of algorithm execution with an intensity image.

B. Pixel operation

Each pixel is made up of one integrate and fire neuron, one capacitor, and one comparator. The integrate and fire neuron spikes with a frequency proportional to the local photocurrent. Its output pulses enable a transistor that injects a packet of charge in a capacitor, increasing its voltage. Neighbors provoke the contrary effect. Their output pulses enable a transistor that removes charge from the capacitor. If the capacitor voltage exceeds a threshold voltage, the comparator will send an output pulse, indicating spatial contrast. The frequency of these output pulses will be proportional to the spatial contrast magnitude.

To operate in intensity mode, the influence of the neighborhood is disabled. Pixels will spike with a frequency proportional to the photocurrent. Both operation modes can be toggled just switching a digital input.