Visual pattern classification by neural fields

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I. Introduction

The recognition of visual motion patterns such as walking, fighting and face gestures among others, is remarkably efficient in humans and many other species. Experiments have already given some clues about the nature of the internal mechanisms of recognition. These experiments are based on point-light stimuli in psychophysics [1], electro-physiological data and functional imaging [3] techniques. In this work, we study some of the identified properties and we propose to model them by means of asymmetric neural fields.

II. Biological data

A. Properties and coding

Visual motion pattern recognition in the human brain seems to be extremely sensitive to temporal correlations [2]. On the contrary, it appears spatially robust: even though the visual input can be severely diminished, stimuli as simple as point-lights [1], where only joints (or random points) are enlighten, can be recognized. Similarly, the observer angle may be perturbed by up to 20 degrees [2].

Experiments [3] indicate that a 2D representation is sufficient to explain brain coding schemes for 3D body actions, indicating a possible template based coding.

B. Biological arguments

The existence of template units in motion information has not yet been proved. Nevertheless, there is a direct analogy with "snapshot" units found in the ventral pathway. Moreover, these templates could be the input for decision units that may be similar to some single neurons observed in areas EBA and OFA that are sensitive to human actions such as walking [2].

III. Modeling

Taking into account the tolerance to diminished stimuli, we consider motion information that could be available from areas V1/MT as relevant to model. To extract *discriminative* information, we build local flow pattern detectors as observed in area STS (motion as: spirals, expansions, translations, etc.). These two operations approximate a "joints-like" detector.

From the *discriminative* points' information $B(\vec{x},t)$ (see Fig. 1) we generate a population of units to simultaneously track the different trajectories. We use one of these populations $m(\vec{x},t)$ for each motion pattern. To achieve temporal selectivity with high sensitivity, we use 2D asymmetric neural fields (extending the 1D model of [4]):

$$\tau\frac{\partial m(\vec{x},t)}{\partial t}+m(\vec{x},t)=\left[\int_0^{x_f} w(\vec{x},\vec{x}')m(\vec{x},t)d\vec{x}'+B(\vec{x},t)\right]^+$$

where the asymmetric kernel $w(\vec{x},\vec{x}')$ gives the direction selectivity in time. Our model implicitly has all "snapshots" in the same population, eliminating global comparators as in [2].

IV. Results & Conclusion

Simulations show that our model is able to classify synthetic patterns and we are currently working with real videos, from noisy environments to test our model further.

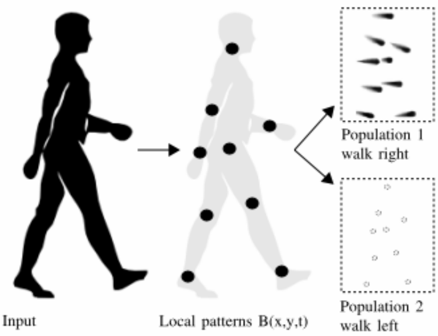

Fig. 1. Schematic view of our model for the left/right discrimination task.

In this work we show that several key features of the human recognition of visual motion patterns may be modeled using 2D asymmetric neural fields. Additionally, we conclude that the key evidence to support template-based recognition from the dorsal pathway is the existence of units or populations acting as snapshots.

V. Bibliographie

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