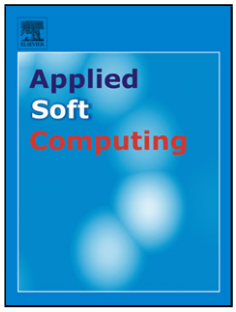

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A Dual Fast and Slow Feature Interaction in Biologically Inspired Visual Recognition of Human Action

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Abstract

Computational neuroscience studies have examined the human visual system through functional magnetic resonance imaging (fMRI) and identified a model where the mammalian brain pursues two independent pathways for recognizing biological movement tasks. On the one hand, the dorsal stream analyzes the motion information by applying optical flow, which considers the fast features. On the other hand, the ventral stream analyzes the form information with slow features. The proposed approach suggests that the motion perception of the human visual system comprises fast and slow feature interactions to identify biological movements. The form features in the visual system follow the application of the active basis model (ABM) with incremental slow feature analysis (IncSFA). Episodic observation is required to extract the slowest features, whereas the fast features update the processing of motion information in every frame. Applying IncSFA provides an opportunity to abstract human actions and use action prototypes. However, the fast features are obtained from the optical flow division, which gives an opportunity to interact with the system as the final recognition is performed through a combination of the optical flow and ABM-IncSFA information and through the application of kernel extreme learning machine. Applying IncSFA into the ventral stream and involving slow and fast features in the recognition mechanism are the major contributions of this research. The two human action datasets for benchmarking (KTH and Weizmann) and the results highlight the promising performance of this approach in model modification.

Keywords:
Biologically inspired model, interaction between ventral and dorsal stream, human action recognition, incremental slow feature analysis, extreme learning machine, dual processing pathways.

1. Introduction

A biologically inspired mechanism for human action recognition provides a new horizon in the fields of computer vision and video processing. Neurophysiological, physiological, and psychophysical evidence suggests two independent pathways in the system configuration where motion and form information are provided. The slowness principle provides a more stable form information than the current approaches [1, 2, 3, 4, 5, 6] because of the independent behavior of temporal variations. In the motion pathway (dorsal stream), the motion information (dynamic pattern) is analyzed locally or globally [7, 8, 9, 10, 11, 12] and is extracted by an optical flow that creates fast features. In the form pathway (ventral stream), the active basis model (ABM) [13] based incremental slow feature analysis (IncSFA) [14] generates slow features corresponding to the form of movements. The interaction between these two pathways defines the combination of information for making a recognition decision. Biologically inspired models have been analyzed in many research fields, such as artificial intelligence (e.g., early detection of the action [15] or fusion of homogeneous convolutional neural network classifiers [16]), soft computing (e.g., fuzzy shortest path problems [17]), computer vision (e.g., human action recognition system with projection-based metacognitive learning classifier [18]), and computational neuroscience, all of which follow the biological evidence. This research also follows the same