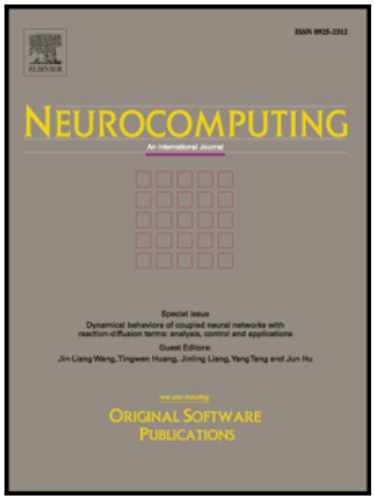
Communicated by Prof. R. Capobianco Guido

Accepted Manuscript



Spiking Signal Processing - Principle and applications in control system

L.M. Grzesiak, V. Meganck

PII: S0925-2312(18)30443-0
DOI: 10.1016/j.neucom.2018.03.054
Reference: NEUCOM 19476

To appear in: *Neurocomputing*

Received date: 31 August 2017
Revised date: 5 February 2018
Accepted date: 19 March 2018

Please cite this article as: L.M. Grzesiak, V. Meganck, Spiking Signal Processing - Principle and applications in control system, *Neurocomputing* (2018), doi: 10.1016/j.neucom.2018.03.054

Spiking Signal Processing - Principle and applications in control system

L.M. Grzesiak[a], V. Meganck[a]

[a] *Institute of Control and Industrial Electronics, Warsaw University of Technology, Warsaw, Poland*

Abstract

This paper introduces an innovative interpretation of spiking signal processing (SSP) and proposes applications in control system. Taking the firing rate as the coding principle employed by biological neurons, we have transformed continuous signals in geometric spiking series evolving over time. New fundamental SSP equations are presented and compared to classical digital signal processing (DSP). Application to the linear system analysis and control drive using spiking transformation is finally presented. This paper launches the theoretical SSP basis to investigate more deeply the geometric neural networks with learning ability.

Keywords: Spiking Neuron, Firing Rate, Geometric Series, Spiking Signal Processing, Digital Signal Processing, Linear Control System, Golden Ratio.

1. Introduction

A boundary still exists between conventional control or system theory and the emerging artificial intelligence (AI). Conventional control and system theory study the decomposition of a linear system in the amplitude and frequency domain using different transformations such as the Fourier transform, the Laplace transform or the Z-transform (cf.[1]-[5]). AI gets inspiration from nature in order to assign learning, adaptiveness or optimization to different processes by using algorithms such as the Artificial Neural Networks (ANN, cf.[6]-[7]), the Genetic Algorithms (GA, cf.[8] and [9]) or the Particle Swarm Optimization. In this paper, we will see that learning spiking neurons give a great and unique opportunity to get the conventional theory and AI closer together.

The $I_{Na,p}+I_K$ neuron model (cf.[16]) is used in the first chapter to interpret what spiking signal processing (SSP) could be regarding classical digital signal processing (DSP) theory. Then, we use the SSP theory in the next chapters to create specific recursive spiking series and to apply it for control and system applications.