Contributed talk

Neurodynamics Inspired Action Timing for Natural Human-Robot Collaboration

Weronika Wojtak[a], Flora Ferreira[b], Estela Bicho[c], Wolfram Erlhagen[b]

[a] CCG/ZGDV, Center Algoritmi and Center for Mathematics, University of Minho
E-mail: w.wojtak@dei.uminho.pt

[b] Center for Mathematics, University of Minho

[c] Centre Algoritmi, University of Minho

Abstract

The ability to perceive and process time is critical for adaptive motor behavior in dynamic environments. Since our brain has no special organ for measuring time, the underlying neuronal mechanisms are still hotly debated. Recent neurophysiological findings suggest that temporal processing in the brain is governed by ramping neural activity, which reaches a threshold to trigger action [1]. This mechanism is thought to support temporal processing in both perceptual and motor domains, enabling humans and other animals to survive in dynamic environments.

We present two timing models, based on the theoretical framework of dynamic neural fields, which we have used to endow autonomous robots with an adaptive timing capacity for natural human-robot interactions. The first encodes time as persistent neural population activity, using ramp-to-threshold dynamics to recall stored temporal information [3]. The second uses a robust neural integrator, where inputs and initial conditions of the dynamical system control timing [2]. The successful testing of the models in a real behaving agent supports the notion that the neurobiology of timing can be understood from a dynamical systems perspective.

References

[1] J. J. Paton and D. V. Buonomano: *The neural basis of timing: distributed mechanisms for diverse functions.* Neuron **98 (4)**, 687–705 (2018)

[2] W. Wojtak, F. Ferreira, E. Bicho, and W. Erlhagen: *Neural field model for measuring and reproducing time intervals.* In ICANN 2019, Munich, Germany, September 17–19, 2019.

[3] W. Wojtak, F. Ferreira, L. Louro, E. Bicho, and W. Erlhagen: *Adaptive timing in a dynamic field architecture for natural human–robot interactions.* Cognitive Systems Research, 82, 101148 (2023)