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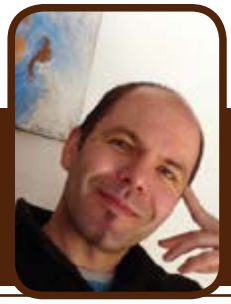

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Optical implementations of neuro-inspired information processing and its applications

Cognitive computing and neuro-inspired information processing have been gaining immense interest in recent years. Increasing demands on computing, problems to maintain Moore's Law much longer and the need for higher energy efficiency have been stimulating novel computational concepts. Their hardware implementation adapted to the concept and to the targeted infrastructure, in which it needs to be embedded, defines a number of challenges. We follow a minimal design approach in optics, allowing for hardware efficiency, high speed, low energy consumption and compatibility with our optical communication infrastructure. Using telecommunication-compatible hardware, we have implemented reservoir computing and extreme learning machine concepts and could demonstrate their attractive features in benchmark tests including classification tasks and nonlinear prediction. The real-word technological challenge we present here is, how to classify ultra-fast signals that are subjected to significant nonlinear distortions. In particular, we process optical fiber communication data. Fiber communication systems are range-limited due to transmission impairments that distort the propagating signals. For extended transmission distances, standard bit recovery techniques fail completely. We overcome this limitation by transforming the bit classification problem into a pattern recognition problem. We experimentally demonstrate a bit error rate improvement of 2 orders of magnitude compared to competing methods. The bit classification performance we achieve is a significant breakthrough, since we can recover data at high speed that otherwise cannot be recovered. Challenges regarding a full hardware and real-time implementation remain, but we show strategies how these challenges can be overcome.

Biography

Ingo Fischer is a research Professor (CSIC) at the Institute for Cross-Disciplinary Physics and Complex Systems, IFISC (UIB-CSIC) in Palma de Mallorca (Spain). Moreover, he is currently a Distinguished Visiting Professor of the International Research Unit of Advanced Future Studies, Yukawa Institute of Theoretical Physics, Kyoto University, Japan. He obtained his PhD degree in physics from Philipps-University Marburg, Germany. After positions at TU Darmstadt, Germany, and Vrije Universiteit Brussel, Belgium, he became a Full Professor (chair) for photonics and integrated systems at Heriot-Watt University, Edinburgh, UK, before taking the position at IFISC. His research concentrates on nonlinear photonics, laser dynamics, complex systems and neuro-inspired information processing. He has published >100 peer-reviewed publications, and has been co-organizer and chair of several international conferences. He received the prize of the Adolf-Messer Foundation and the first Hessian Industry Cooperation Prize of the Technology Transfer Network.

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