The aim of this project is to design and implement a photonics realization of a liquid state machine (LSM), with the potential for versatile and fast signal handling. We target to achieve high computational performance with only a small number of photonics components, using dynamical systems with time delay to realize the required high dimensionality for the LSM. This ambitious aim is motivated by the fact that optical information processing remains to be a major challenge in nowadays and future photonics networks. Huge amounts of data need to be handled/processed in photonics, but also in other fields, like biological or economical systems. Despite of increasing computing power, new approaches are desired and required. Reservoir computing, and in particular the implementation of a LSM, represent such an alternative approach towards computation. It has been shown that reservoir computing serves universal computational properties, such that any potential operation could be realized, outperforming other approaches for certain tasks.

While numerical implementations of this concept exist, technical implementations are lacking. We have identified delay-coupled optical systems as ideal substrates for LSMs. They allow achieving complex dynamics and thus the required mapping with only few elements. Moreover, photonic systems have proven to be robust and well-controllable, offering high processing speed and low power consumption. In order to succeed, we intend to realise two different photonic systems to implement the LSM. The photonic implementation will be supported by modelling and theory, and complemented by studies on versatile electronic systems. With a consortium comprising high expertise from photonics, neuroscience, nonlinear dynamics, complex systems, and electronic systems, we have assembled a well-balanced and determined team to explore and implement this novel and high risk concept, promising major impact on future information processing in case of success.

Project details:

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Links to programme:

7th RTD Framework Programme - Specific Programme Cooperation

Theme 3 "Information and Communication Technologies"