THESIS TOPICS: 2024-2025

Title: Photonic Ising machines containing millions of spins based on spatial light modulators

Description:

Ising machines (IMs) are a newly emerging approach to efficiently perform difficult computational tasks such as solving optimization problems and machine learning. These tasks can otherwise be hard to solve on conventional digital computers. Similar to quantum annealing devices such as the D-WAVE system, IMs allow to efficiently solve hard optimization problems by performing a ground state search of Ising models. However, many currently existing implementations of IMs require large and complex optical setups and are thus difficult and expensive to build and operate.

The objective of this project is to develop a new kind of optical IM, which is as performant as current IM designs while being significantly more practical to build and operate. The system you will be working on is illustrated in the figure you can find in the supporting document. It is based on opto-electronic oscillators that have been shown to be excellent building blocks of low-cost IMs. The novelty in your project will be to investigate and test if such opto-electronic IMs can be build using at its core a high-resolution spatial light modulator, which is a photonic component typically used in projectors. The number of artificial spins in the IM – which determines the size of the computational problems that can be solved - will then be proportional to the number of pixels. This way we aim to achieve millions of parallel spins in a single, compact system. During this project, you will develop, model, build, and test the system in the lab, and perform benchmarks to compare its performance with other approaches.

The work will be both experimental and numerical.

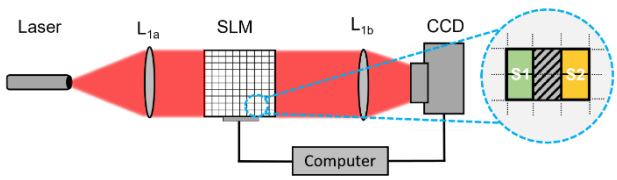
Link to current research project: aphy.research.vub.be/eos-project

Location: VUB - Etterbeek

Promotor 1
Name: Guy Verschaffelt
e-mail: Guy.Verschaffelt@vub.be

Promotor 2
Name: Guy Van der Sande
e-mail: Guy.Van.der.Sande@vub.be

Supervisor
Name: Toon Sevenants
e-mail: toon.jan.b.sevenants@vub.be



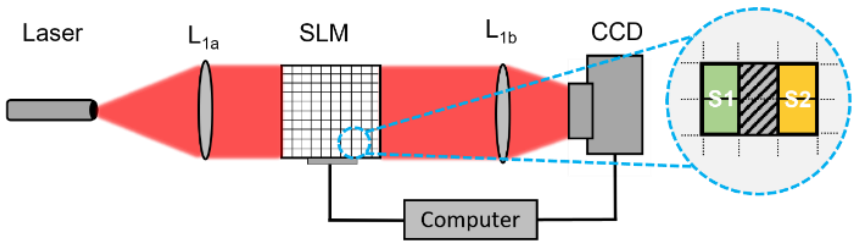


Illustration of an Ising machine based on a spatial light modulator (SLM). The spins are encoded in the phase of the SLM's pixels. A laser beam is first collimated, subsequently passed through the SLM, and finally projected onto the CCD camera. From there, the feedback signal is processed digitally, and the spins encoded on the SLM are updated. The zoom-in illustrates how two spins (S1 and S2) are encoded in a vertical pixel pair. The shaded area represents unused pixels to prevent signal overlap between S1 and S2.