Improvement of machine learning movement detection

October 14, 2020

- Domain: Deep learning.
- Place: I3S lab
- Environment: I3S lab of Université Côte d’Azur is situated at the Sophia Antipolis technology park (Europe’s leading technology park). In computer science, Université Côte d’Azur is a leading place with one the four French Interdisciplinary Institute for AI (3IA). Also, considering the internship topic, interactions are expected with the new interdisciplinary NeuroMod institute.
- Competences: Good object-oriented programming skills, computational modeling and experience with deep learning libraries (e.g. PyTorch or TensorFlow) is desirable.
- Duration: 5-6 months.
- Starting date: early 2021.
- Stipend: 560 €/month.
- Context: this position is funded by the ANR PRCE project “Deep Spiking networks for Embedded and Efficient intelligence”, involving the academic labs LEAT [I3S] and CERCO, as well as the companies Renault Software Lab and Prophesee. Following this internship a PhD is also funded.
- Contact: Send a CV and a motivation letter to Alexandre Muzy (alexandre.muzy@cnrs.fr), CNRS researcher and co-deputy of NeuroMod institute.

In artificial intelligence, deep learning method (LeCun, Bengio, and Hinton, 2015) is at the origin of current “AI revolution”. In 2018, the Turing Award (Computer Science Nobel Prize) was given to the “godfathers” of deep learning; french Yann LeCun, canadian Yoshua Bengio and british-canadian Geoffrey Hinton. The method is based on artificial neural networks. The depth refers to the number of layers of such networks. These networks aim at mimicking both structure and learning mechanisms of the brain. Particularly, the networks are high-performance in computer vision domain to recognize objects in pictures. However, they are far from the brain energetic efficiency and problem solving capabilities. Using this method usually requires super-computers to be able to recognize penguins in pictures. This lack of efficiency prevents deep learning programs to be embedded in cars for scene understanding. This is currently a major technical and economical drawback of deep learning.

A new method, spiking neural networks (Tavanne et al., 2018), closer to the biological neural networks, has been designed to improve the efficiency of artificial neural networks but they face current performance limitations. These networks aim at exploiting the interaction sparsity of neurons. Interactions between neurons consist of electrical action potentials: the spikes. These potentials occur only at discrete points in time. It is why they can efficiently encode information based on the time occurrences of the spikes. Although the discreteness is a computational advantage, it does not ensure the continuous variations of electrical potentials that make artificial neural networks able to encode any real values.
Taking advantage of the temporal aspects of spiking neural networks, a new class of spiking neural networks, more efficient, can be developed. Despite a focus on spikes, these networks do not really account for spike time information. Spikes are generated by neurons based on a clipping of the electrical potential received from other neurons. Spike times are thus the result of this step-by-step computation rather than predicted. This is a major limitation to fully exploit time information. Reconsidering the temporal aspects of the electrical potential computations will lead to a new class of models of spiking neural networks. This class can be closer to the discrete changing information between frames in a movie. This is especially interesting for detecting moving objects in a scene. The validation of the approach will be achieved using the event gesture dataset. The latter has been generated based on new event cameras (Mueggler et al., 2016). These cameras detect only changing pixels (events). The whole chain of events, from camera detection to the spikes (events) occurring in the neural network, can be modeled and simulated efficiently using a discrete event abstraction approach (Zeigler, Muzy, and Kofman, 2018), developed at I3S lab.

This new class of models of spiking neural networks obtained should be much more efficient than usual artificial networks. They should provide faster and more reliable classifications of movements, consuming less energy. Reaching this goal would have major scientific, technical and economical impacts. It should make it possible to embed such algorithms on cars for detecting moving objects from cameras. This is why this project is done in collaboration with Renault Software Lab.

References