Tutor name: Bernabé Linares-Barranco (www.imse-cnm.csic.es/~bernabe)

Name of AI-HUB associated Research group: Neuromorphs – The group of Neuromorphic Systems at the Seville Microelectronics Institute (www.imse-cnm.csic.es/neuromorphs)

Center Location: Instituto de Microelectrónica de Sevilla (www.imse-cnm.csic.es) is a mixed-center belonging to the University of Seville (www.us.es) and the Spanish Research Council (www.csic.es), located at the Cartuja Science and Technology Park (www.pctcartuja.es) in the city of Sevilla (www.visitasevilla.es).

Project Title: Low-Energy AI for Always-On Edge Devices

Project Description: AI has a severe problem: it consumes an enormous amount of energy. Present day AI systems need to run on power-hungry GPU-driven data centers interconnected with the users through fast internet. This trend is unsustainable and today we know that with the present trend, by 2030 internet and data centers will consume 20% of the world's electricity. On the other hand, the human brain consumes just 20W of power while being capable of cognitive tasks not yet mastered by man-made machines, and while continuously interacting with all body sensors and actuators. The brain uses a different technology than standard computers, which uses neurons that are over one million times slower, become defective and compute with poor precision. However, information encoding is done through population based nervous spikes that exploit spatial sparsity and time-driven computing principles. Spiking Neural Networks (SNNs) are the third generation of Neural Networks that try to imitate such computing principles. World-wide top computer industries are presently investing strongly in the potential of SNNs, with the hope to deploy low-energy AI on portable edge devices (phones, tablets, appliances, toys, security and surveillance). Examples are IBM with their TrueNorth chip and systems, Intel with their Loihi chip and related systems, or on the academic side the EU Flagship Project "The Human Brain Project" which has provided, among many other outputs, the SpiNNaker computer, an SNN machine capable of simulating in real time 1-billion neurons (1% of the human brain). At IMSE, the neuromorphic group has over 25 years of experience with SNN hardware, vision sensors, and computing algorithms. We have SpiNNaker and Loihi hardware devices, as well as vision sensors that directly provide spiking output information, similar to biological retinas, ready to be processed by SNN hardware. The neuromorphic group at IMSE has participated as co-founder of spin-off companies Prophesee (www.prophesee.ai) which produces spiking retina chips (called Dynamic Vision Sensors – DVS), and GrAI-Matter-Labs (www.graimatterlabs.ai) producing SNN processing hardware.

The project for the successful candidate will consist in getting familiar with SNN software for training such neural networks and apply it to camera recordings obtained from DVS cameras available at IMSE, to recognize familiar objects. Once a specific computing architecture is performing correctly using the software, it would be deployed on the SpiNNaker or Loihi computing platforms available at IMSE, running the SNN algorithm with live DVS data. Our group has experience in both: (a) computational aspects of SNNs using and creating SNN databases for machine learning training, down to (b) fully hardware aspects for SNN implementations ranging from programming FPGAs or to designing specific chips. Therefore, the project can be adapted to the candidate's preferences and prior training, emphasizing more the computational and algorithmic aspects or setting the strength onto more hardware specific aspects. Schedule and duration of the scholarship is negotiable with the successful candidate in order to adjust them to the candidate's restrictions and preferences during the training at IMSE.