Real-time Motion Detection in a Spiking Neural Network with the Integer Quadratic Integrate-and-fire (iqif) Model

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Performing simulations of a spiking neural network evolves solving a large number of differential equations. This becomes a real challenge for the modern computer systems when one simulates a visual system that processes optical flow signals in real time. To address the problem, we design a novel neuron model, the Integer Quadratic Integrate-and-Fire (IQIF) neuron. IQIF reproduces spiking behavior similar to the classical Quadratic Integrate-and-Fire (QIF) neuron but reduces all variables from commonly used floating points to integers, providing a simulation solution that requires significantly less memory and gates at the cost of limited dynamical ranges of membrane potential and synaptic current. To demonstrate the capability of the IQIF neurons, we construct a spiking neural network (SNN) to perform optical-flow based camera motion detection. The design of the network is inspired by the visually directional-selective lobula plate tangential cells in Drosophila. The result shows that the IQIF neurons are capable of performing real time motion estimation on Raspberry Pi 4, providing a solution to low-powered motion detection in small unmanned aerial vehicles (UAVs).

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