eeeID: Energy Efficient Event-Based Person Identification via Gait Recognition using Spiking Neural Networks

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Gait recognition is a promising biometric for person identification that preserves privacy, as it requires no subject cooperation and works at a distance [1] [2]. However, traditional systems that attempt to capture gait using conventional RGB cameras and deep neural networks are slow, computationally intensive, and prone to interaction lags. Dynamic Vision Sensors (DVSs) offer a more streamlined, privacy-preserving alternative, capturing sparse event-streams. However, processing these asynchronous data through dense convolutional neural networks (CNNs) significantly reduces its temporal resolution and efficiency.

To address this, we propose an event-based gait recognition spiking neural network (SNN) that directly processes DVS event-streams, leveraging the inherent compatibility between spike-driven computation and asynchronous event data. Specifically, we utilize a convolutional SNN architecture comprising Parametric Leaky Integrate-and-Fire (PLIF) neurons [3]. While the convolutional topology extracts robust spatial features from the sparse events, the PLIF neurons utilize learnable membrane time constants to dynamically optimize their temporal receptive fields. This mechanism allows the network to natively capture the multi-scale spatio-temporal dynamics of human gait without heavy data accumulation [4].

Benchmarked and deployed on the Intel Loihi 2 neuromorphic research chip [5] [6], our PLIF SNN demonstrates breakthrough efficiency and performance on DVS128-Gait dataset [7]. For short 1-second event-stream windows, our model achieves an identification accuracy of 98.90%. Furthermore, it requires only 11.25 ms of inference time per sample, consumes a mere 1.292 mJ of energy, and utilizes just 8.5 MB of memory. We compare these results against the state-of-the-art graph-based approach, EV-Gait-3DGraph [7], which requires 3-to-4 seconds of event-stream data to achieve 94.90% accuracy. This baseline requires 436.23 ms of inference time, 0.876 J of energy, and 410.87 MB of memory when running on standard edge hardware. In contrast, our convolution PLIF SNN is approximately 39x faster, 678x more energy-efficient, and requires a 48x smaller memory footprint.

By successfully coupling neuromorphic sensing with biologically inspired computation, this work validates a highly efficient approach to event-based gait recognition. These results highlight the broader potential of fully neuromorphic systems to enable scalable and privacy-preserving identification across diverse applications, ranging from seamless office access and automated sports training logs, to personalized smart home control and real-time human-robot interactions.

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