ICIG 2025

Paper ID 119

SNN-PAR: Energy Efficient Pedestrian Attribute Recognition via Spiking Neural Networks

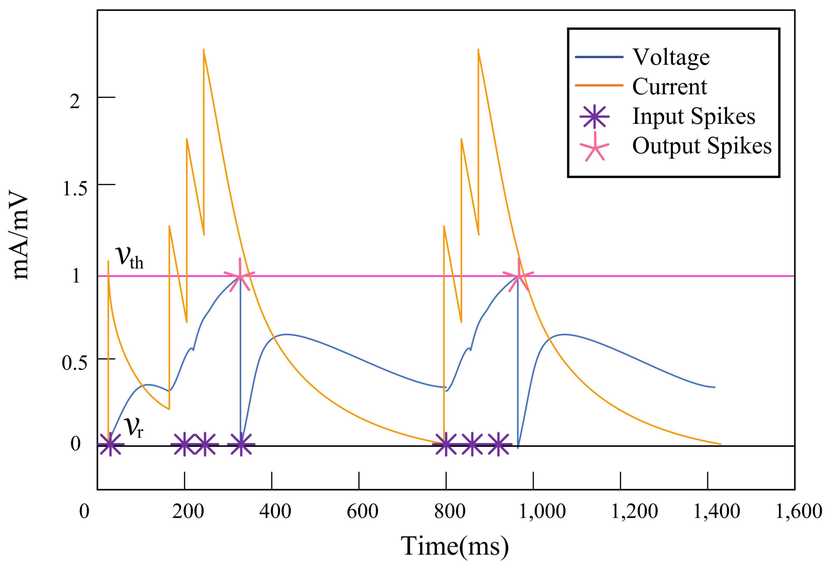
Haiyang Wang, Qian Zhu, Mowen She, Yabo Li, Haoyu Song, Minghe Xu, Jin Tang, Xiao Wang

GitHub: *https://github.com/Event-AHU/OpenPAR*

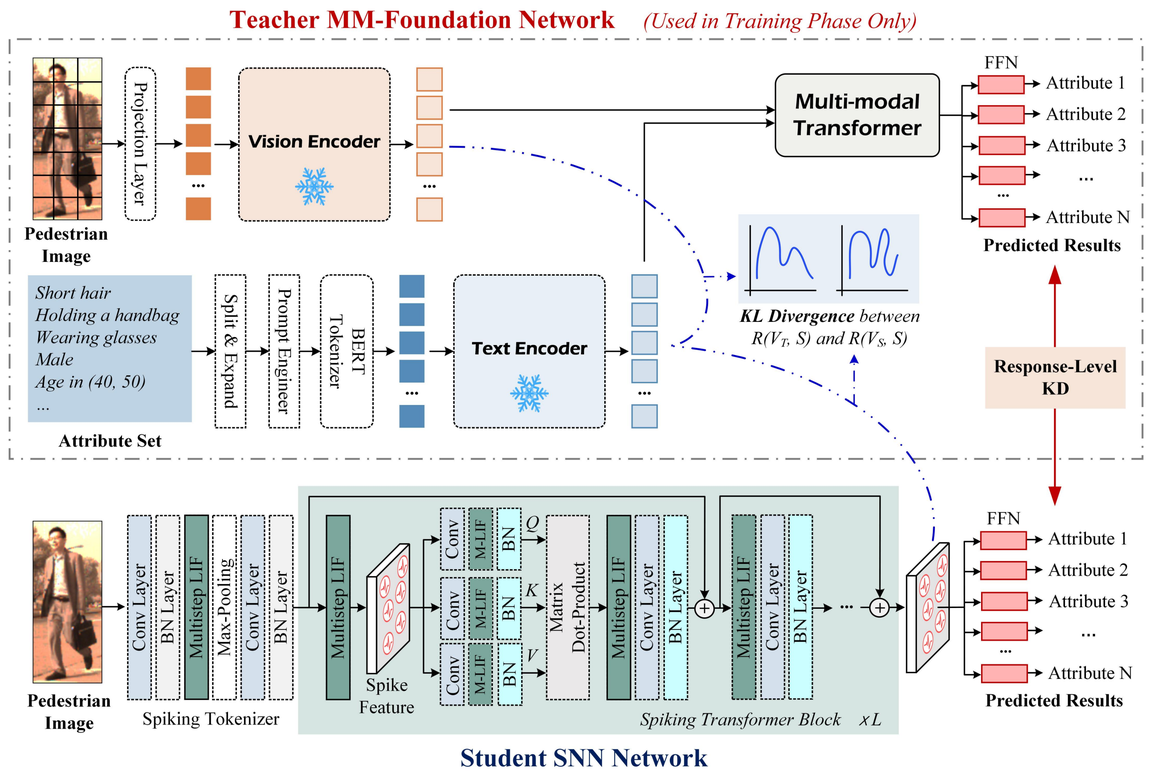
Background

1. Current CNN and Transformer-based PAR models are computationally intensive with low energy efficiency, limiting their deployment.

2. SNNs achieve high energy efficiency through event-driven operation, core to which is the LIF neuron that processes information via bio-inspired spiking dynamics.



Methodology



$$X' = SN(X),$$
$$Q = SN_Q(ConvBN_Q(X')),$$
$$K = SN_K(ConvBN_K(X')),$$
$$V = SN_V(ConvBN_V(X')),$$
$$SSA(Q,K,V) = ConvBN(SB(QK^TV * s)),$$

$$\mathcal{L}_{respKD}(S,T) = D_{KL}(T||S) = \sum T_i(\log(T_i) - \log(S_i))$$

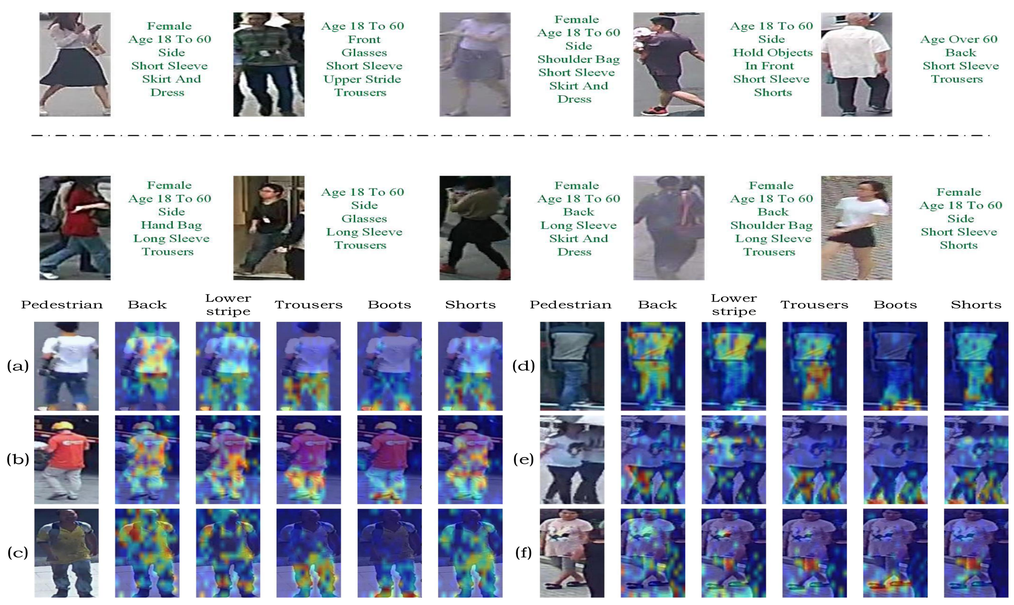
$$\mathcal{L}_{featKD} = \sum_i P(\mathrm{sim}(F_t, F_v))_i \log\left(\frac{P(sim(F_t, F_v'))_i}{P(\mathrm{sim}(F_t, F_v))_i}\right)$$

$$\mathcal{L} = \mathcal{L}_{CE} + \alpha\mathcal{L}_{respKD} + \beta\mathcal{L}_{featKD}$$

Experiments

Table 1. Comparison with SOTA methods on PETA, PA100K and RAPv1 datasets.

Methods	PETA					PA100K					RAPv1				
	mA	Acc	Prec	Recall	F1	mA	Acc	Prec	Recall	F1	mA	Acc	Prec	Recall	F1
SSCsoft [19]	86.52	78.95	86.02	87.12	86.99	81.87	78.89	85.98	89.10	86.87	82.77	68.37	75.05	87.49	80.43
IAA [37]	85.27	78.04	86.08	85.80	85.64	81.94	80.31	88.36	88.01	87.80	81.72	68.47	79.56	82.06	80.37
MCFL [28]	86.83	78.89	84.57	88.84	86.65	81.53	77.80	85.11	88.20	86.62	84.04	67.28	73.44	87.75	79.96
DRFormer [30]	89.96	81.30	85.68	91.08	88.30	82.47	80.27	87.60	88.49	88.04	81.81	70.60	80.12	82.77	81.42
VAC [13]	-	-	-	-	-	82.19	80.66	88.72	88.10	88.41	81.30	70.12	81.56	81.51	81.54
DAFL [20]	87.07	78.88	85.78	87.03	86.40	83.54	80.13	87.01	89.19	88.09	83.72	68.18	77.41	83.39	80.29
CGCN [10]	87.08	79.30	83.97	89.38	86.59	-	-	-	-	-	84.70	54.40	60.03	83.68	70.49
CAS [38]	86.40	79.93	87.03	87.33	87.18	82.86	79.64	86.81	87.79	85.18	84.18	68.59	77.56	83.81	80.56
VTB [4]	85.31	79.60	86.76	87.17	86.71	83.72	80.89	87.88	89.30	88.21	82.67	69.44	78.28	84.39	80.84
SNN-PAR (Ours)	80.58	73.55	81.76	82.79	81.96	73.86	71.70	83.03	81.30	81.67	75.43	63.06	74.67	78.28	75.94



Contributions

1. We propose an energy-efficient spiking transformer network for pedestrian attribute recognition, termed SNN-PAR.

2. To enhance the performance of SNN-PAR further, we adopt knowledge distillation from the artificial neural networks to guide the learning of spiking transformer networks.

3. Comprehensive experiments carried out on three publicly available datasets show that our proposed SNN-PAR model is effective for the PAR task.

References

[1] Cheng et al., **A simple visual-textual baseline forpedestrian attribute recognition**. IEEE Transactions on Circuits and Systems forVideo Technology 32(10), 6994–7004

[2] Zhou et al., **Spikingformer:Spike-driven residual learning for transformer-based spiking neural network**. arXivpreprint arXiv:2304.11954

[3] Wang et al., **Pedestrian attribute recognition: A survey**[J]. Pattern Recognition, 2022, 121: 108220.