PCICF: A Pedestrian Crossing Identification and Classification Framework

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Domain and Goal

Domain:

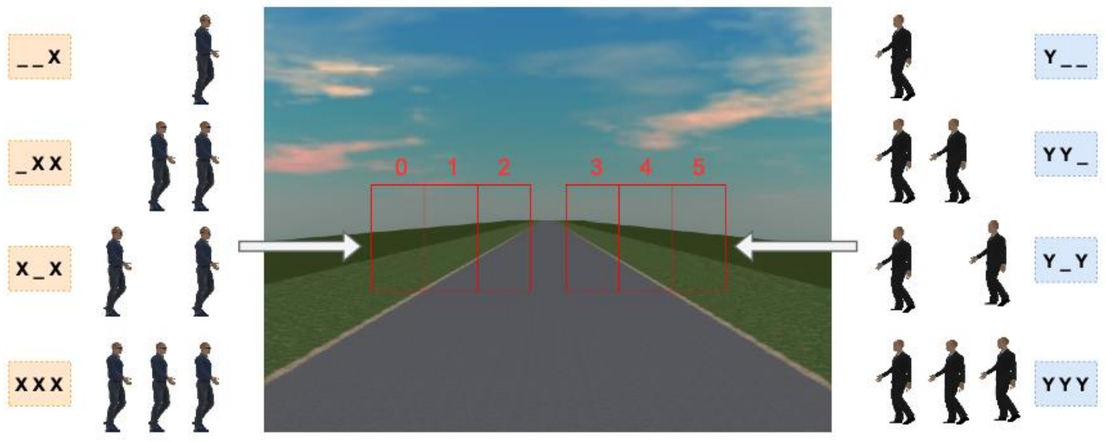
- The detection of vulnerable road users when they interact with vehicles.
- Qualification assessment of datasets for safety-related traffic research.

Goal:

- A systematic dictionary (**MoreSMIRK**) to describe the pedestrian crossing events.
- A framework (**PCICF**) to detect the pedestrian crossings and classify them with dictionary.

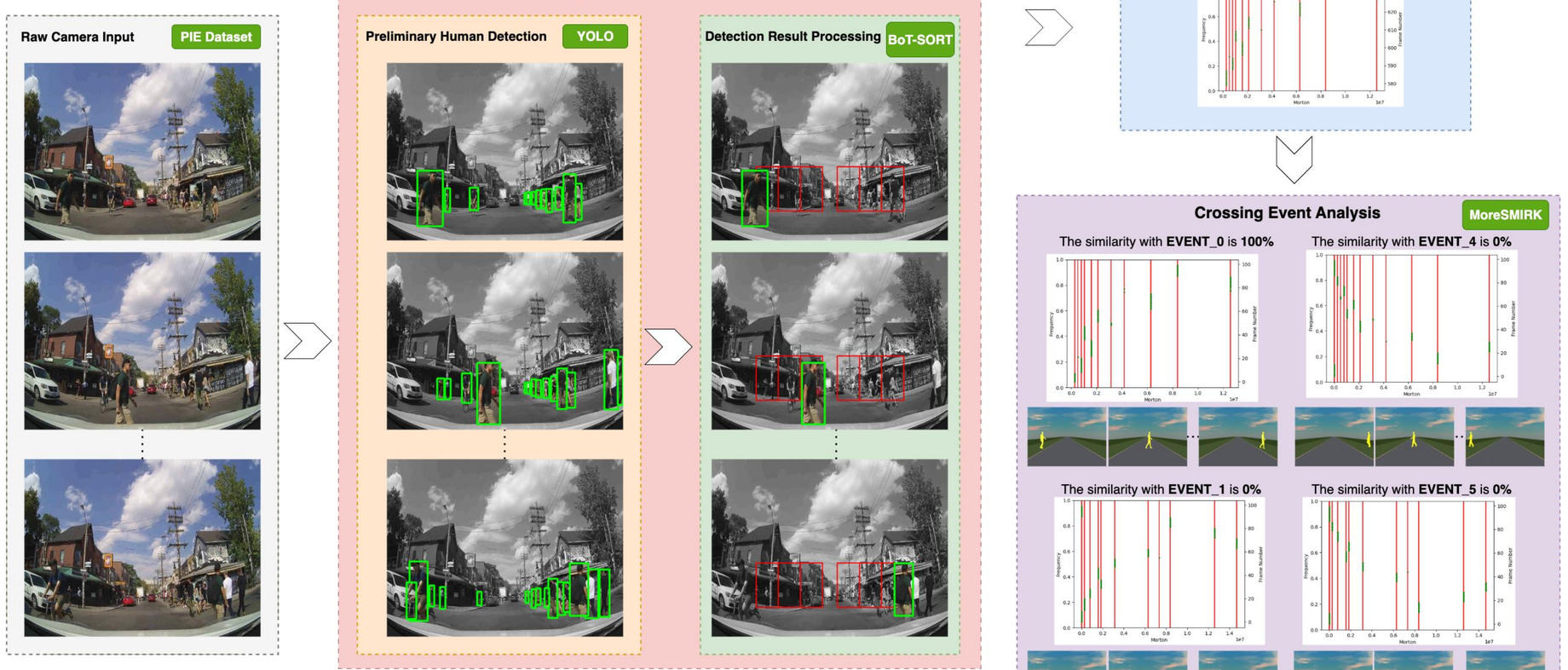
MoreSMIRK

- A synthetic dataset based on the SMIRK [1].
- A total of 104 sequences, each represents a unique crossing event.
- Each sequence is 100 frames with ground truth annotation.



Events (E)	Left Pedestrians (L)	Offset (Φ)	Right Pedestrians (R)
0	_ _ X	N/A	_ _ _
1	_ X X	N/A	_ _ _
2	X _ X	N/A	_ _ _
3	X X X	N/A	_ _ _
...	...	...	...
8	_ _ X	0	Y _ _
9	_ X X	0	Y _ _
10	X _ X	0	Y _ _
11	X X X	0	Y _ _
...	...	...	...
100	_ _ X	5	Y Y Y
101	_ X X	5	Y Y Y
102	X _ X	5	Y Y Y
103	X X X	5	Y Y Y

PCICF



Evaluation Result

- Evaluation based on real-world PIE dataset [2].
- A total of 21,327 frames that span 158 sequences.
- 85% and 80% accurate mapping for 'Single Ped L to R' and "Single Ped R to L' to MoreSMIRK dictionary.

Subset	Number of frames	Number of sequences
Single Ped L to R	6649	55
Single Ped R to L	6769	56
Two follow-up Ped L to R	1211	9
Two follow-up Ped R to L	1404	11
Multiple no-follow-up Ped L to R	1859	10
Multiple no-follow-up Ped R to L	1520	9
Multiple Ped both directions	1915	8

Table 3: Follow-up pedestrians (peds) crossing from left to right. PCICF results show the similarity of the event.

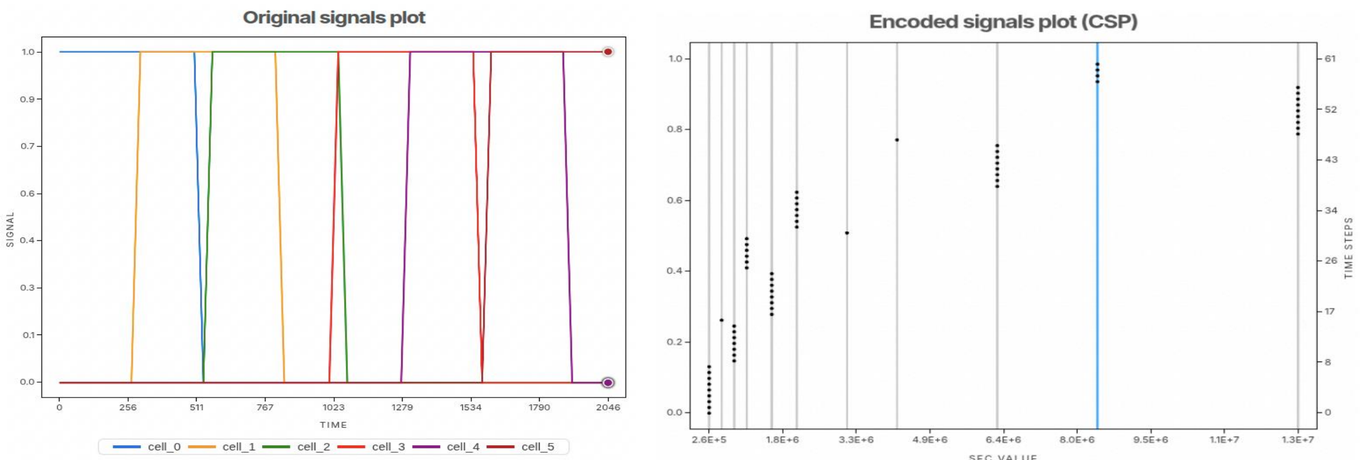
Seq. ID	Start-End Frame	PCICF Results	Manual Annotation
003	598-690	E1: 70% E3: 54%	two peds
012	160-230	E1: 80% E3: 63%	two peds merge to one
021	139-200	E0: 54% E1: 70%	two peds
034	463-602	N/A	far away, challenging
036	232-479	E0: 63% E1: 50%	two peds
037	434-637	E0: 54 %	two peds merge to one
276	22-87	E0: 63% E1: 70%	two peds
292	281-400	E0: 72% E1: 80%	two peds merge to one
430	192-538	E0: 90% E1: 80%	two peds merge to one then split to two

Table 4: Follow-up pedestrians (peds) crossing from right to left. PCICF results show the similarity of the event.

Seq. ID	Start-End Frame	PCICF Results	Manual Annotation
008	571-697	E4: 81% E5: 70%	one ped splits to two
009	50-210	E4: 81% E5: 70%	one ped splits to two
011	621-731	E5: 100%	two peds merge to one
045	343-410	E5: 50% E7: 81%	four peds
128	101-232	E4: 54% E5: 50%	four peds, far to close
280	280-419	N/A	far away, challenging
282	1-166	E4: 72% E5: 80%	two peds merge to one
391	73-175	E5: 100%	two peds
391	176-271	E5: 100%	two peds
546	440-590	E4: 72% E5: 70%	two peds

Dimensionality Reduction with SFC

- SFC: Space Filling Curve
- SFC is for mapping multi-dimensional values to single-dimensional representations.
- Check AutoSFC [3] for interactive demonstration.



Visualization

Figure 4: Misclassifications of single-directional crossing for single pedestrian: The ground truth for (a) and (b) are '_ _ X; N/A; _ _ _' and '_ _ _; N/A; Y _ _', respectively.

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References

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[2] Amir Rasouli, Iuliia Kotseruba, Toni Kunic, and John K Tsotsos. 2019. Pie: A large-scale dataset and models for pedestrian intention estimation and trajectory prediction. In Proceedings of the IEEE/CVF international conference on computer vision. 6262–6271.

[3] AUTOSFC. AutoSFC. (n.d.). https://www.autosfc.org/

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