Multi-Person Tracking Using Generic Person Detector and Particle Filter

Kokul, T.[†], Ramanan, A.[§] and Pinidiyaarachchi, U.A.J.[†] [†]University of Peradeniya [§]University of Jaffna

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Introduction

Automatically detecting and tracking multiple persons in videos is one of the main research interest in computer vision based applications. The aim of person tracking is to find the location of a specific person in a video sequence, while the initial location information of the person is given.

Contribution

We improve the tracking performance by proposing a tracking-by-detection approach for tracking people in dynamic backgrounds by combining:

- Pre-trained generic person detector,
- Online trained person-specific detector, and
- Particle filter based motion tracker.

Generic Person Detector

We create the generic person detector using the most popular ACF detector [1] and AdaBoost classifier. This training process of generic person detector is performed offline.

Person-Specific Detector

Person specific detector is able to detect a specific person in a video frame. We follow the IDBoost approach [2] to learn the person-specific detector. We further improve the IDBoost by including additional positive samples to the training process.

Particle Filter Motion Tracker

Particle filter based motion tracker is used for the following two purposes:

- To find a narrow search region of a target person that will reduce the computational needs.
- To estimate the state of a target person that ensures the right tracking of the person.

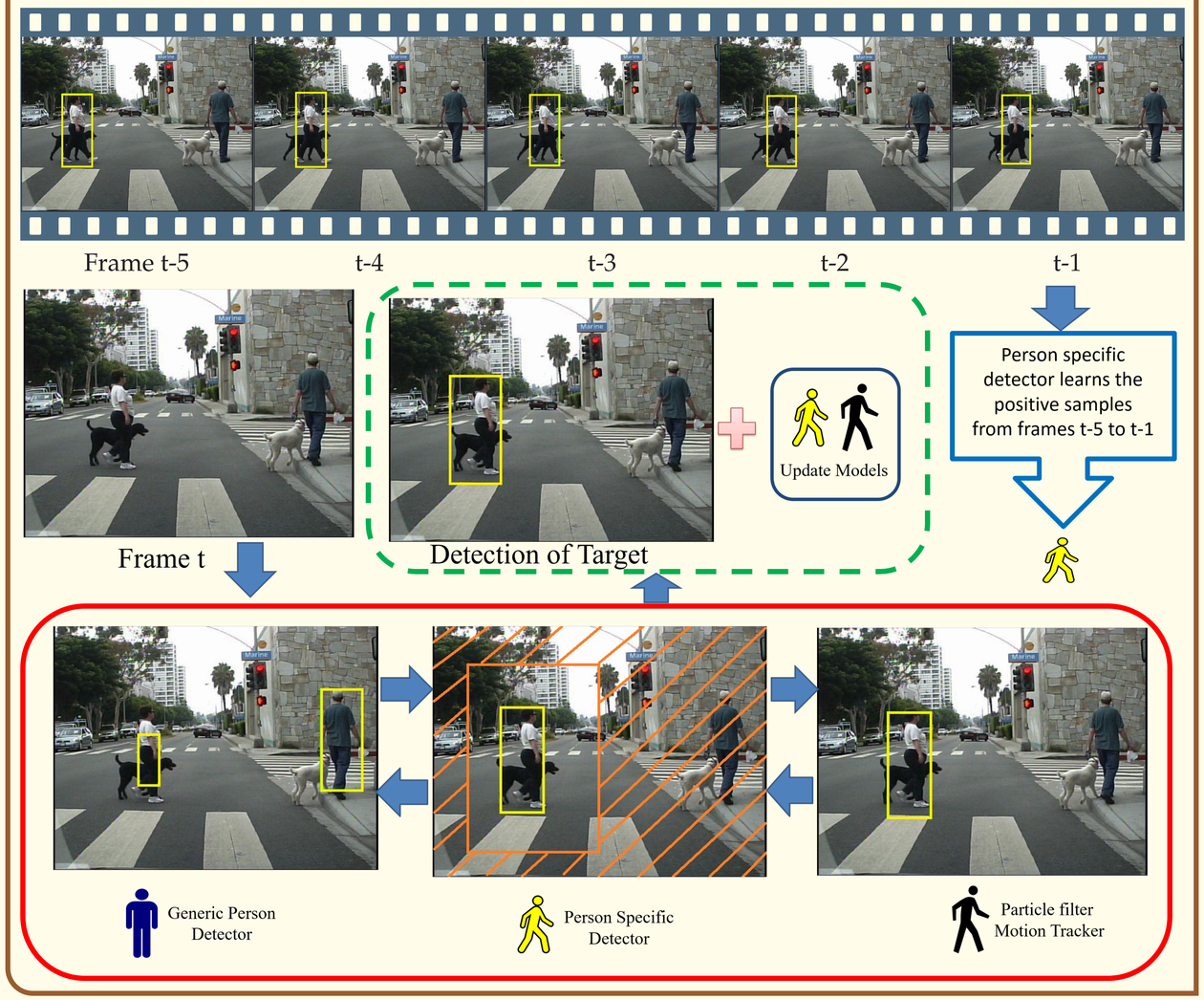
We use the following motion model in this work:

$(x_t, y_t) = (x_{t-1}, y_{t-1}) + (u_s, v_s)\Delta t + \varepsilon_{(x,y)}$

$(u_t, v_t) = (u_s, v_s) + \varepsilon_{(u,v)}$

where (x_t, y_t) are location information, (u_t, v_t) are the corresponding velocity components, (u_s, v_s) are the instantaneous target velocity, $\varepsilon_{(x,y)}$ and $\varepsilon_{(u,v)}$ are the noise values. Δt - frame-rate.

Methodology



Methodology ...

- Generic person detector is used to initialise the tracking process.
- Person-specific learning uses a weighted scoring technique to assign high probability learning to recent frames in the time space.
- Combined coincident detections of both detectors and tracker are used to locate the target person in a Frame t.
- The tracking process is stopped when the person-specific detector fails to coincide with generic person detector or person-specific detector fails to detect a person from a fixed number of consecutive frames.

Dataset

- We evaluate the proposed method on Caltech Pedestrians benchmark dataset [3].
- 250,000 frames of video with a total of 2300 unique pedestrians.
- Divided into 11 sets: six for training and five for testing.
- Pedestrians over 50 pixels tall with no or partial occlusion are considered in this work.
- Pedestrians visible for at least five or more frames are considered in this evaluation.

Testing Results

We report the performance of the proposed method in Table 1 as precision *(P)*, recall *(R)*, continuity *(C)*, and average tracking speed (S).

Since CIT [4] approach is benchmarked against seven well-known trackers in Caltech dataset, we compare CIT with our approach.

Method	R	P	C	Average	S (fps)
CIT [4]	0.12	0.65	0.49	**0.42**	25.3
Ours	0.10	0.68	0.58	**0.45**	22.7

Table 1: Tracking performance and speed

The results indicate that our approach improves the average performance by 3% and considerably faster while comparing to the state-of-the-art tracker.

Discussion and Conclusion

- The proposed method shows better performance against the state-of-the-art person tracker while maintaining the tracking speed in real-time.
- Even though our proposed method includes additional positive samples in training process, it achieves tracking speed of 22.7fps by performing the operation on a reduced search space for each target person.
- Our method improves the detection of person-specific detector by including additional positive samples to the training process which captures the appearance of the target person more accurately.
- The performance of motion tracker is improved by initialising particles with target specific information and using instantaneous target velocity to update the motion tracker.

References

[1] P.Dollar, R.Appel, S.Belongie and P.Perona, "Fast Feature Pyramids for Object Detection" In *PAMI, 2014.*

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[4] H.Hall and P.Perona "Online,Real-Time Tracking Using a Category-to- Individual Detector" In *ECCV, 2014.*