Appearance & Motion based Deep Architecture for Moving Object Detection in Moving Camera

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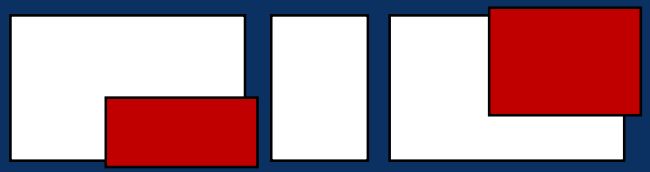
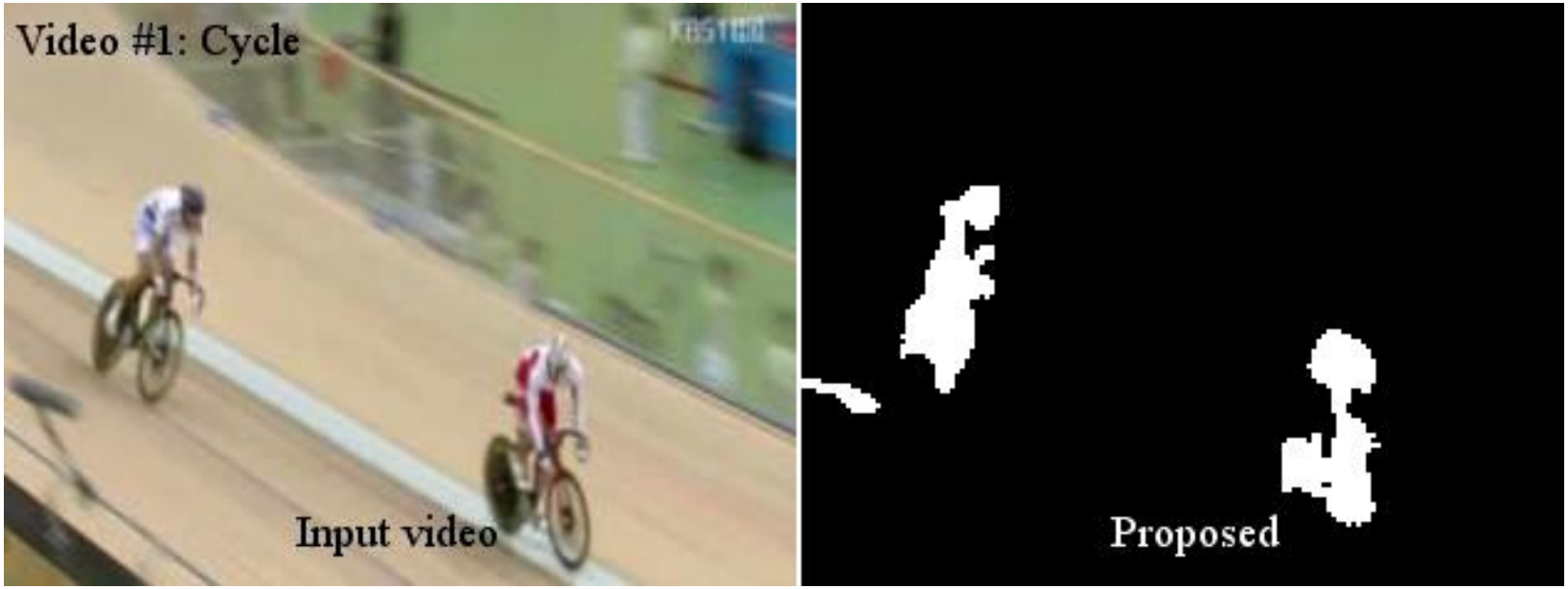


Perception and Intelligence Laboratory

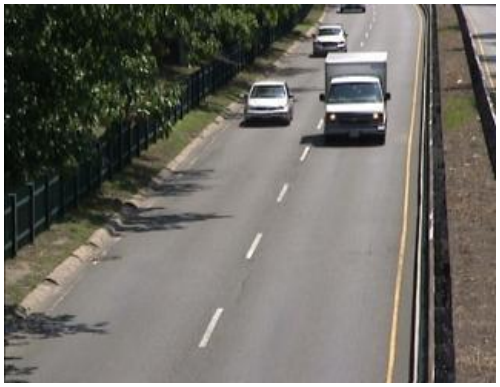
Introduction

- Moving object detection



Introduction

- Fixed camera



- Moving camera



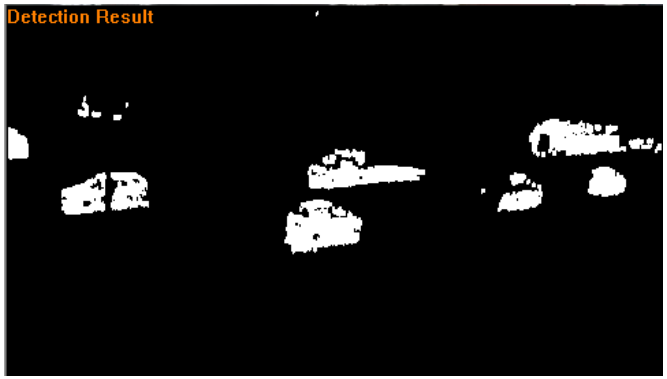
Introduction

- Background-centric method

Input video

Compare

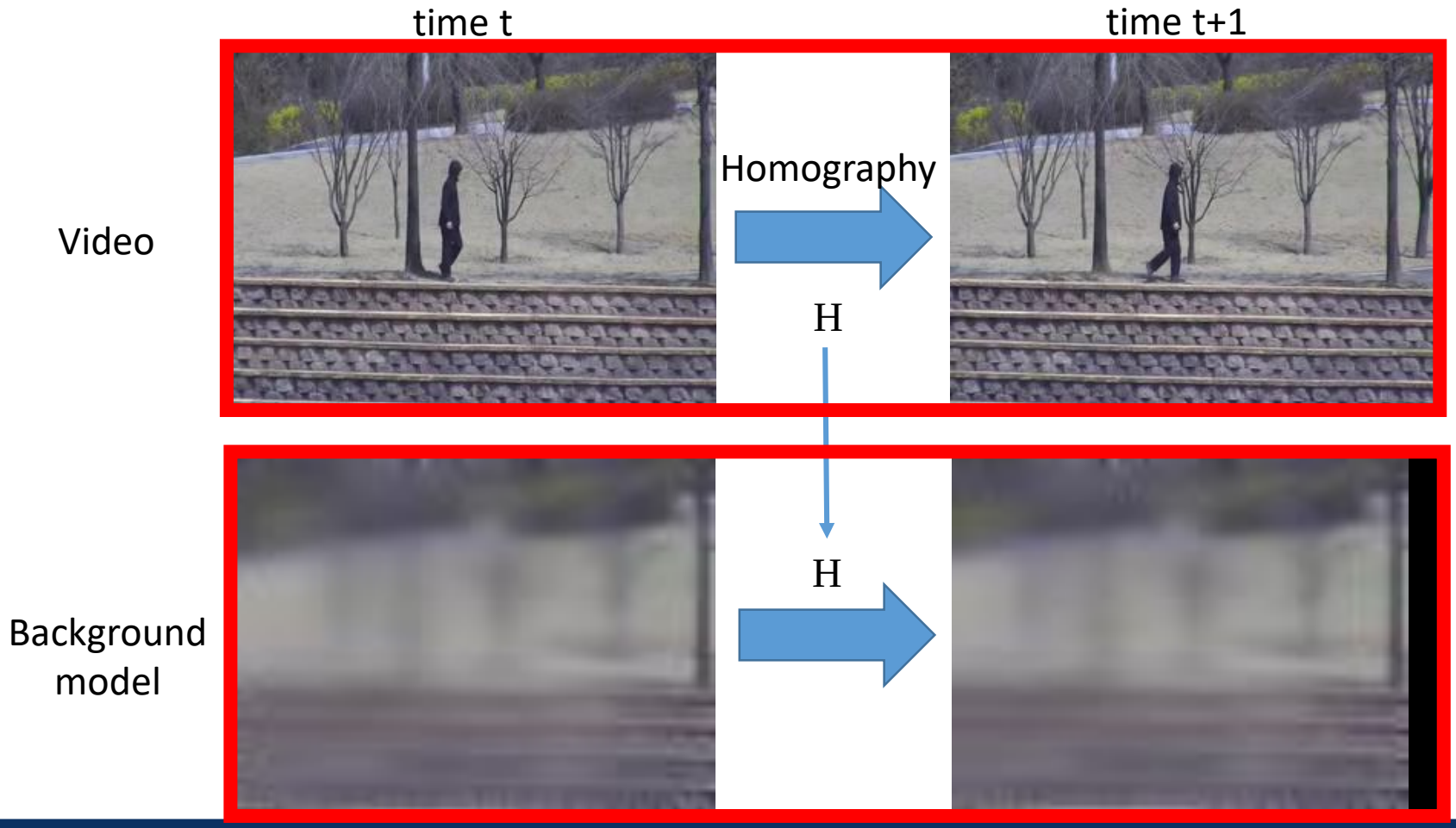
Background model



Moving object detection

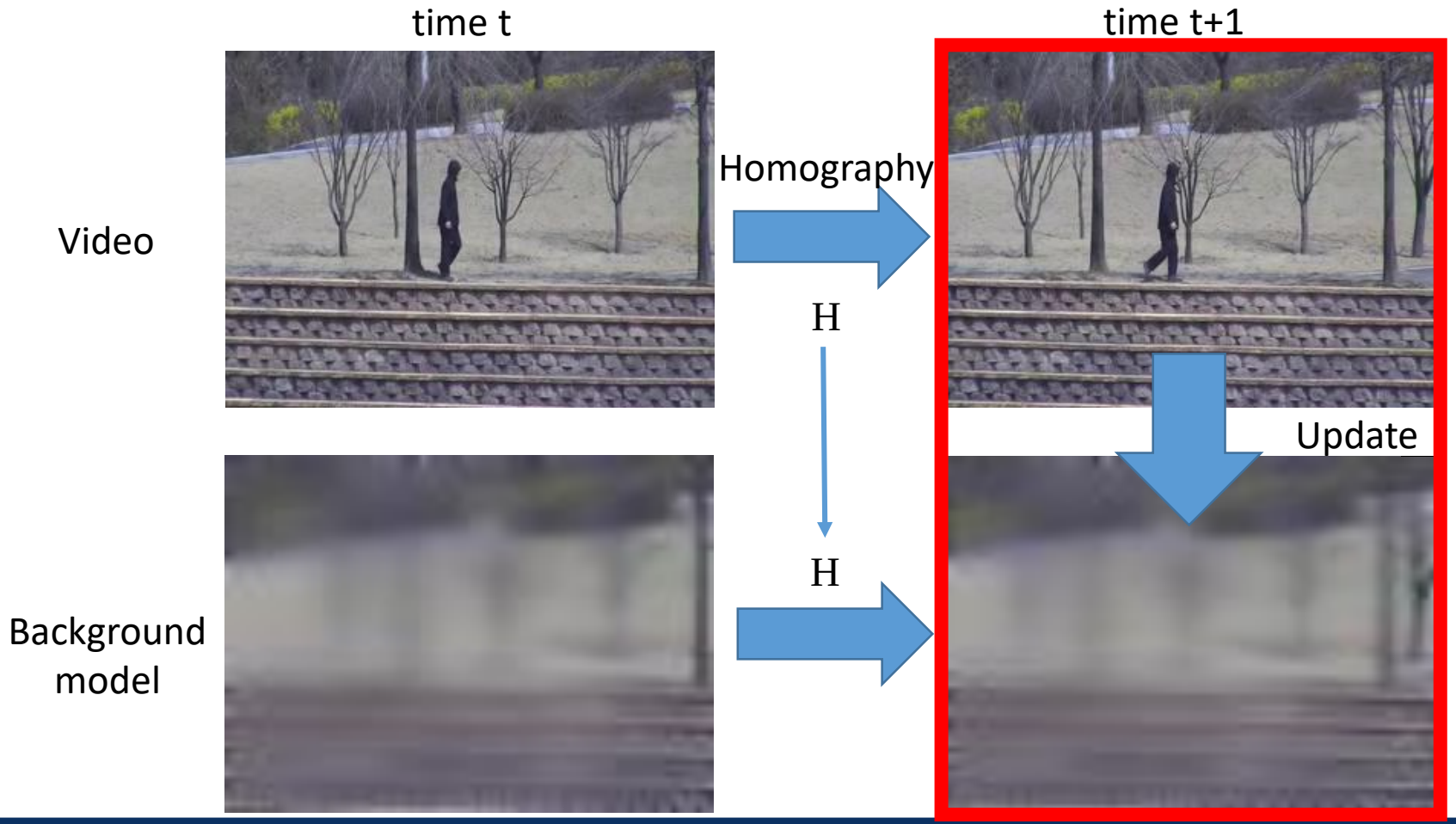
Introduction

- Background for moving camera
  - Transform background model with homography H



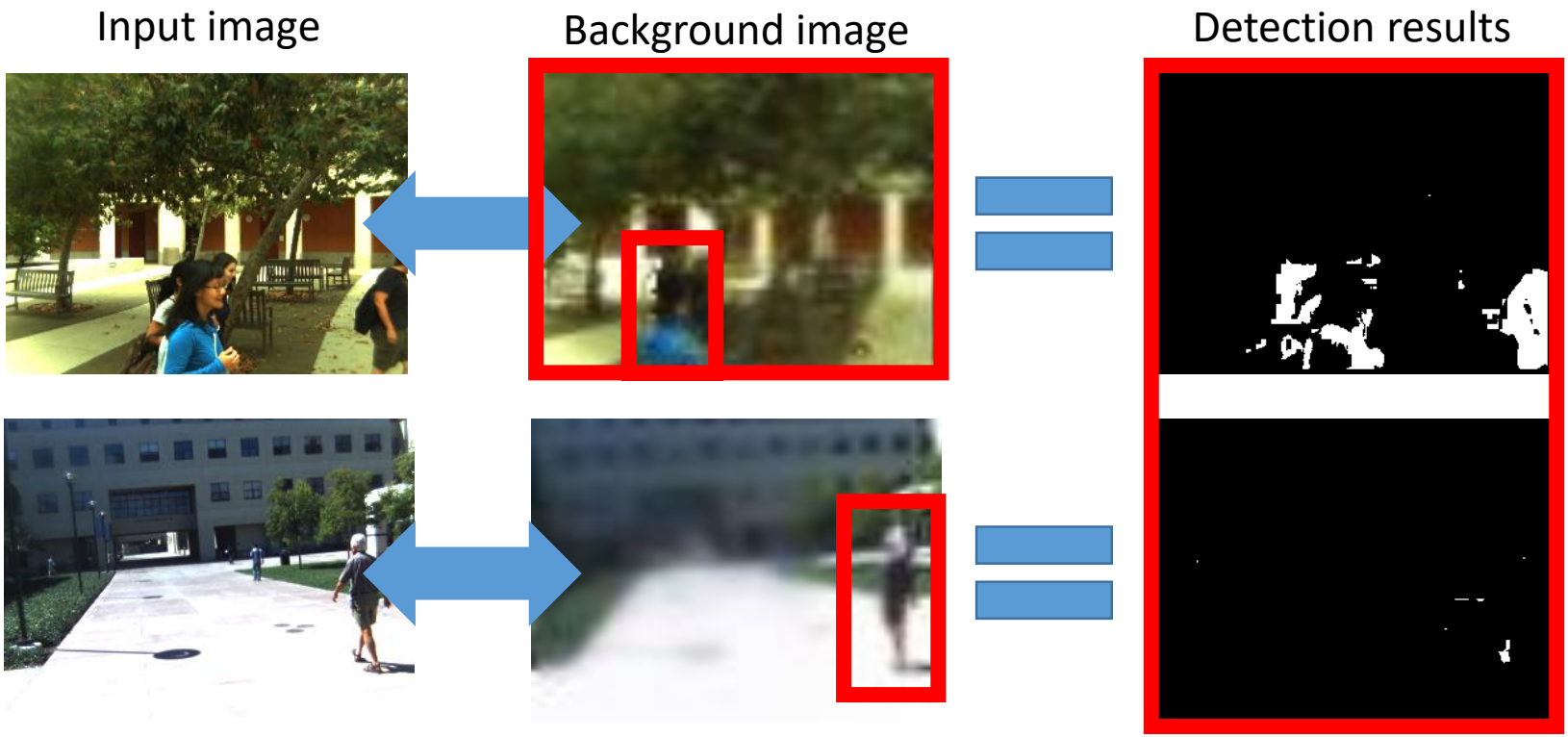
Introduction

- Background for moving camera
  - Update background by the image of t+1 frame



Introduction

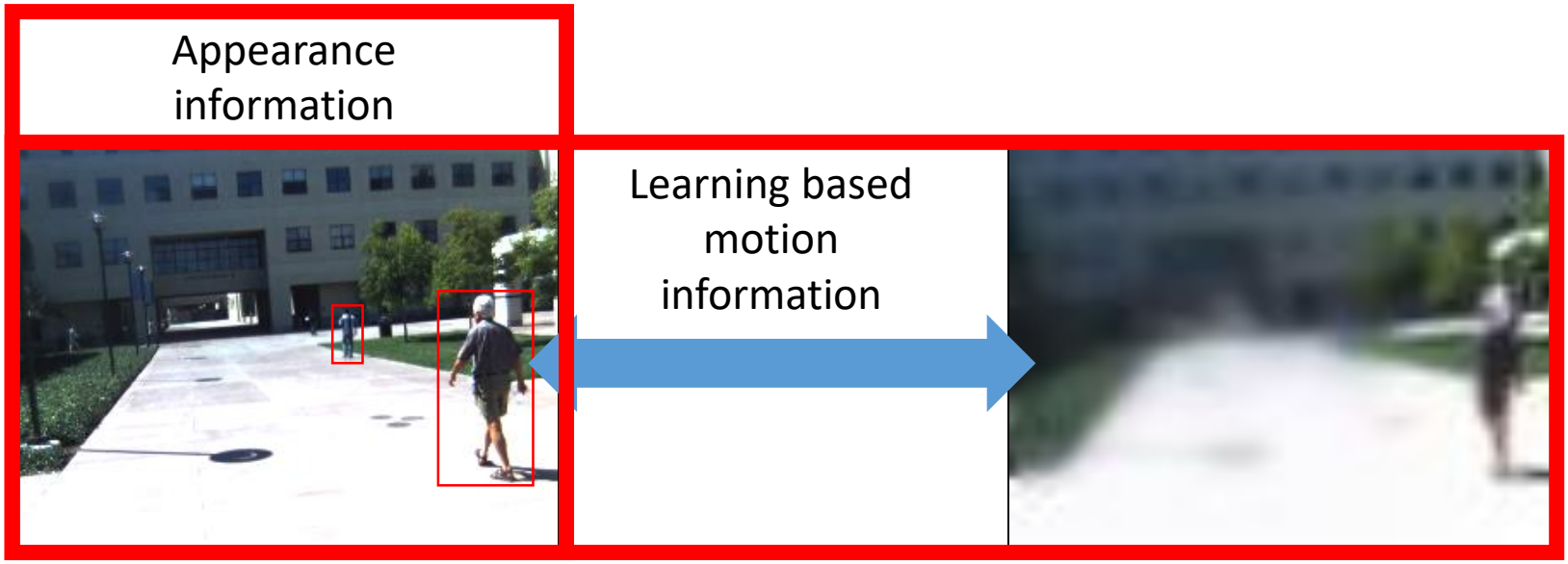
- Background contamination
  - Background model in moving camera is not perfect
  - Motion compensation is not suitable for complex camera movements
  - Background based method is weak to background problem



Deep architecture

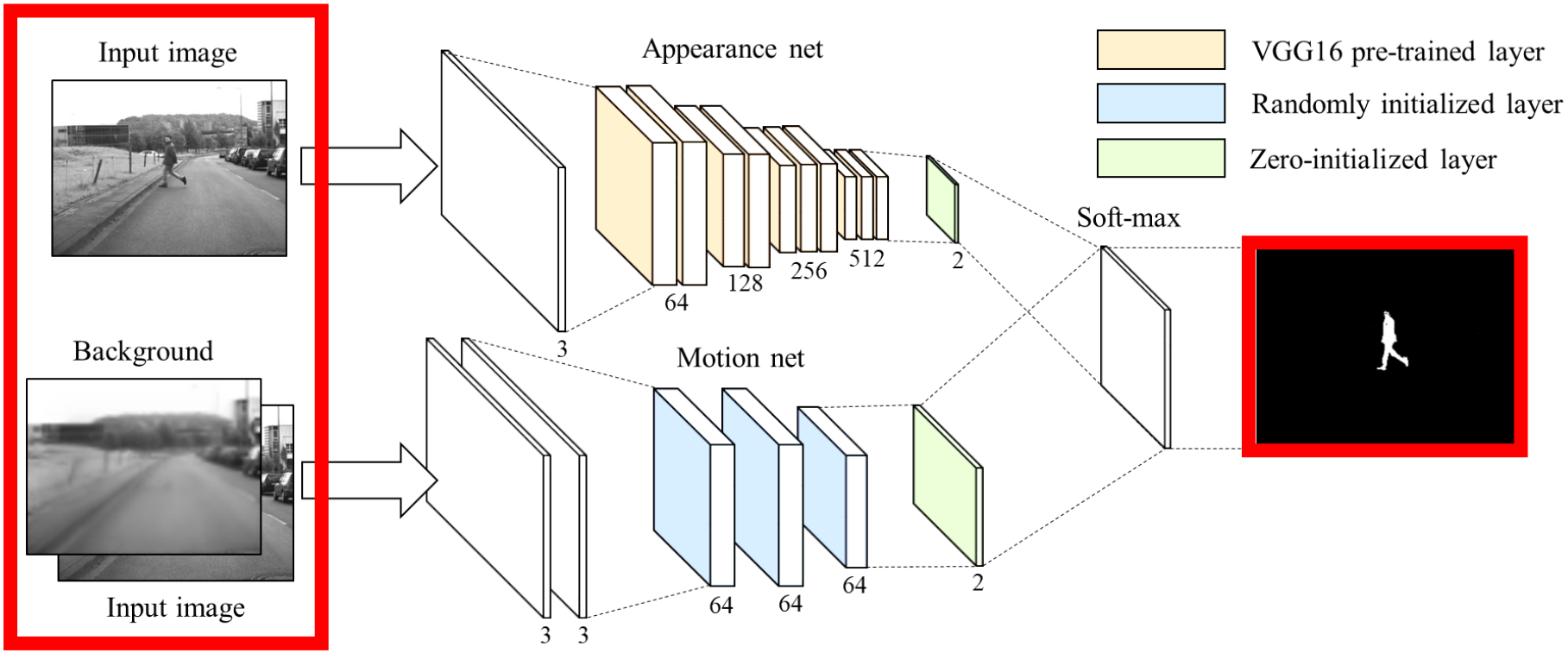
- Proposed method
  - Uses background model for motion information
  - Two components to cope with background contamination

1. Appearance information of moving objects
2. Learning based motion information



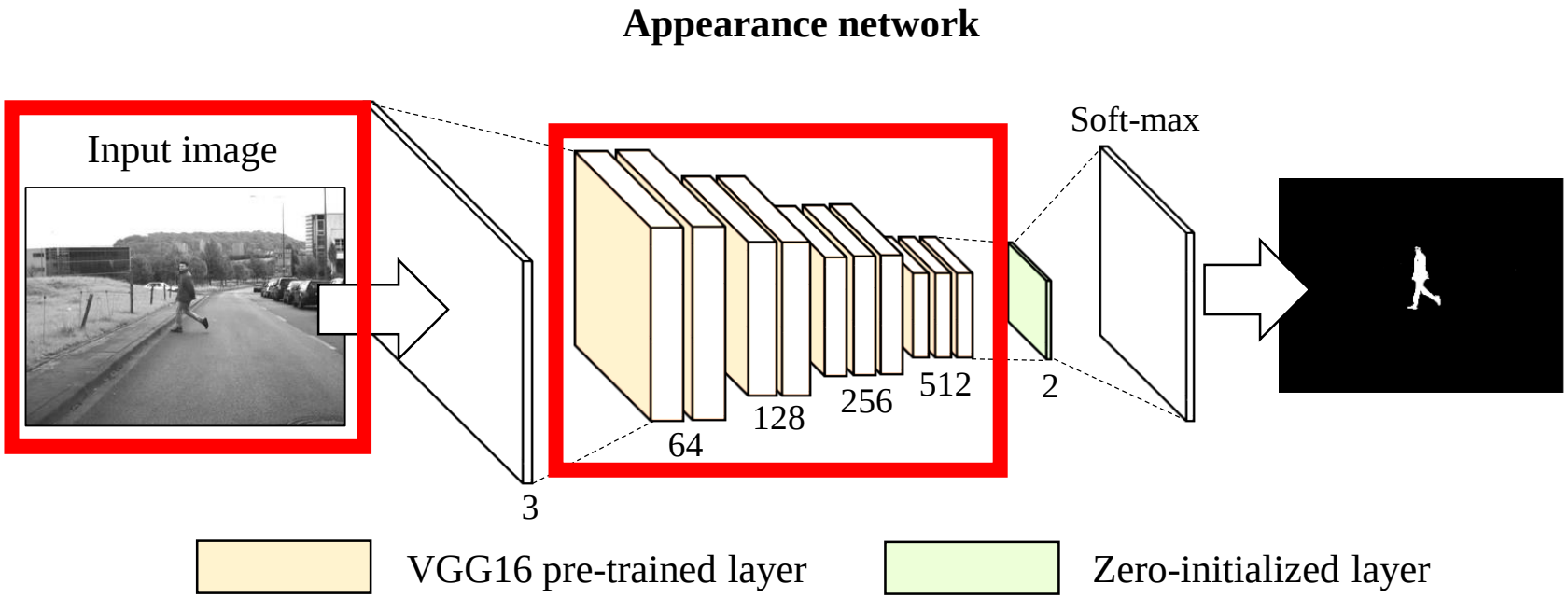
Deep architecture

- Structure of the proposed method
  - Input : image and background
  - Two sub-network : Appearance Net and Motion Net
  - Fully Convolutional Neural Network



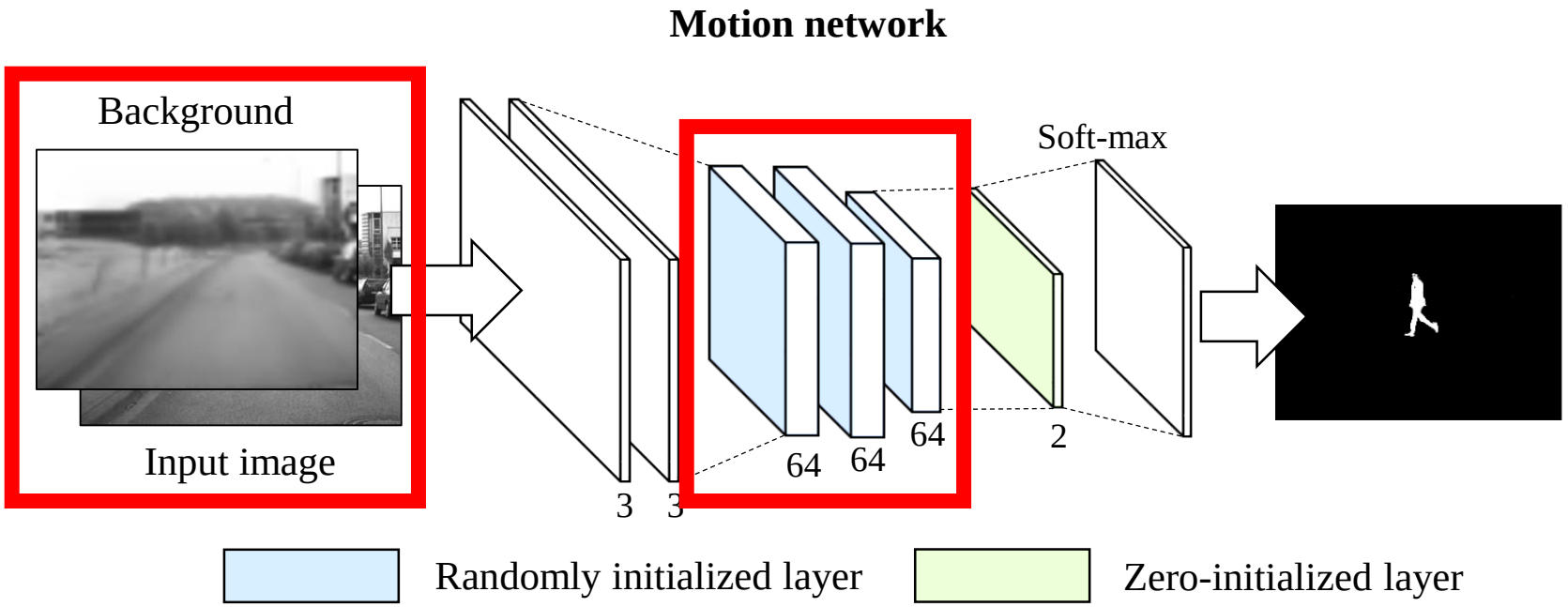
Deep architecture

- Appearance network
  - A network without background
  - Detects appearance of movable objects
  - VGG-16 pre-trained network (objectness information)



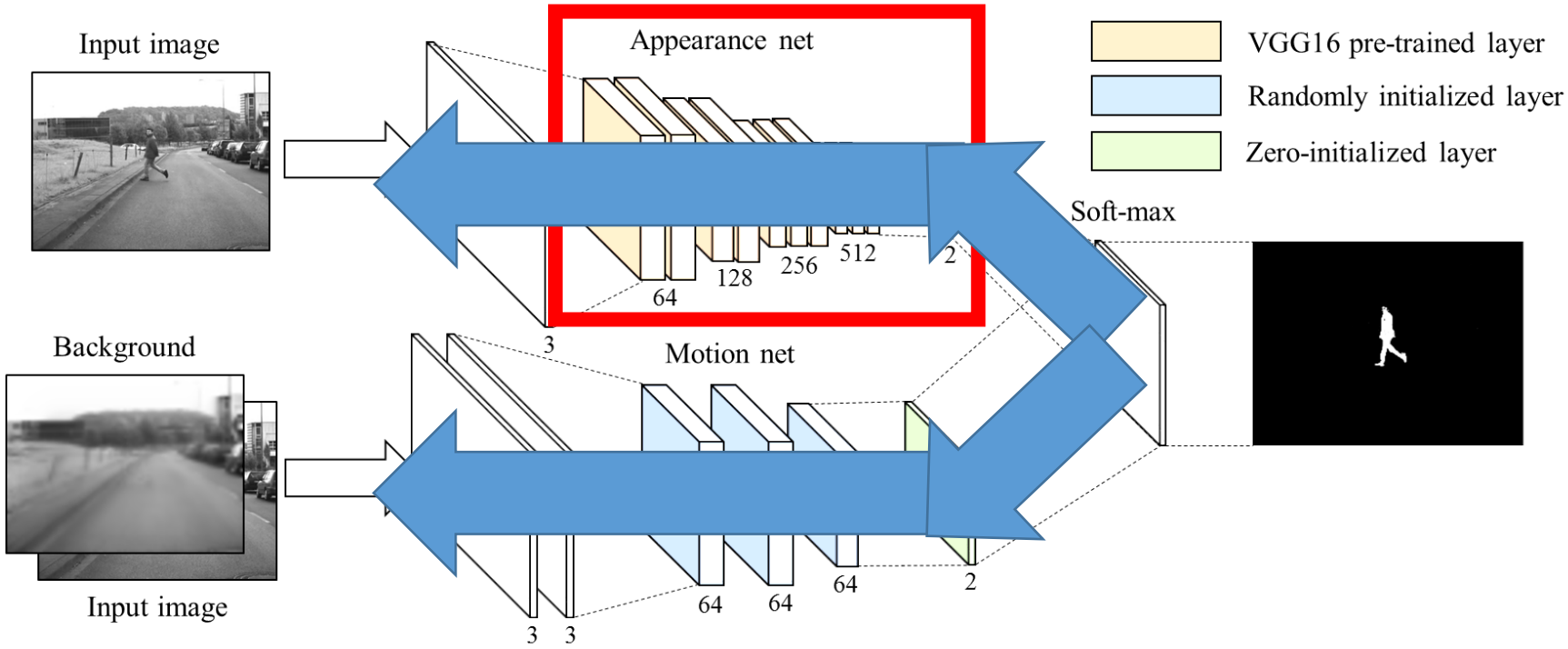
Deep architecture

- Motion network
  - Detects motion based on background image
  - Training dataset includes contaminated background
  - Randomly initialized shallow network (low-level information)



Deep architecture

- Merging appearance and motion
  - Unbalance between pre-trained and randomly initialized network
  - Two networks are separately trained for the balance
  - After that, two networks are merged and fine-tuned



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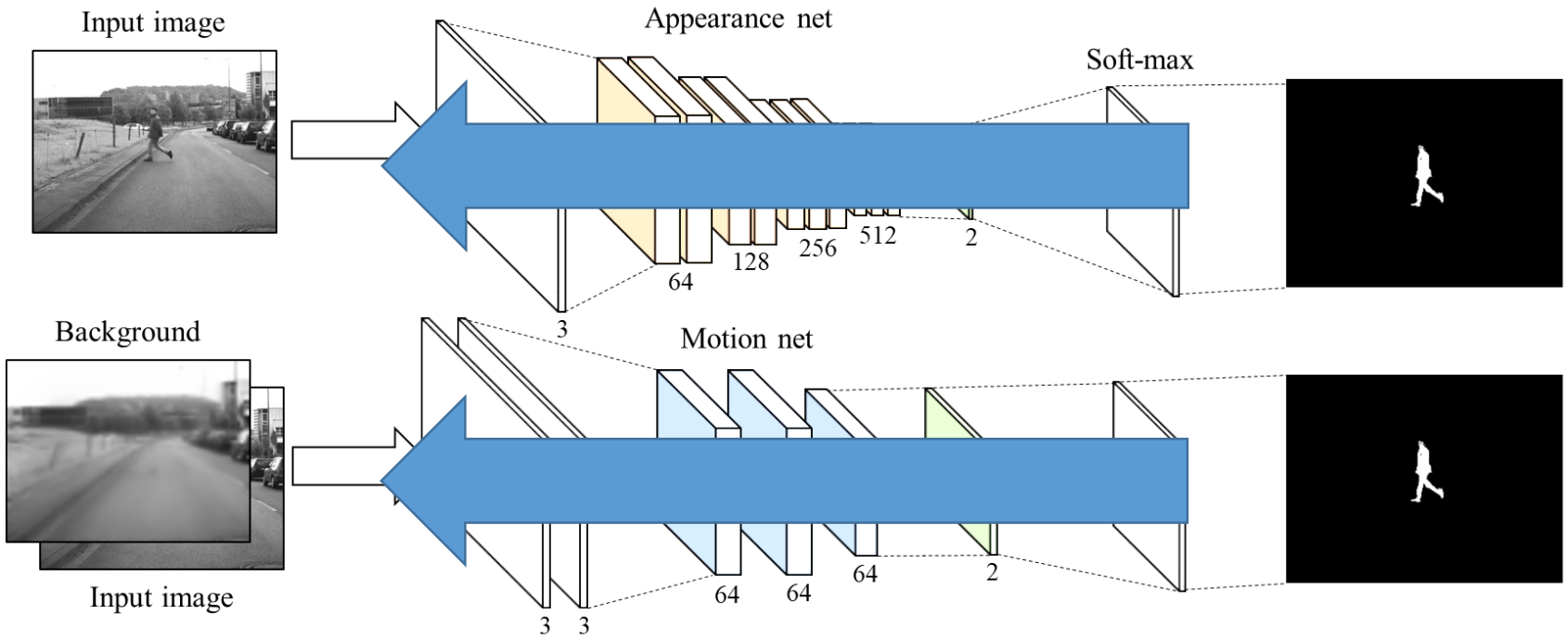

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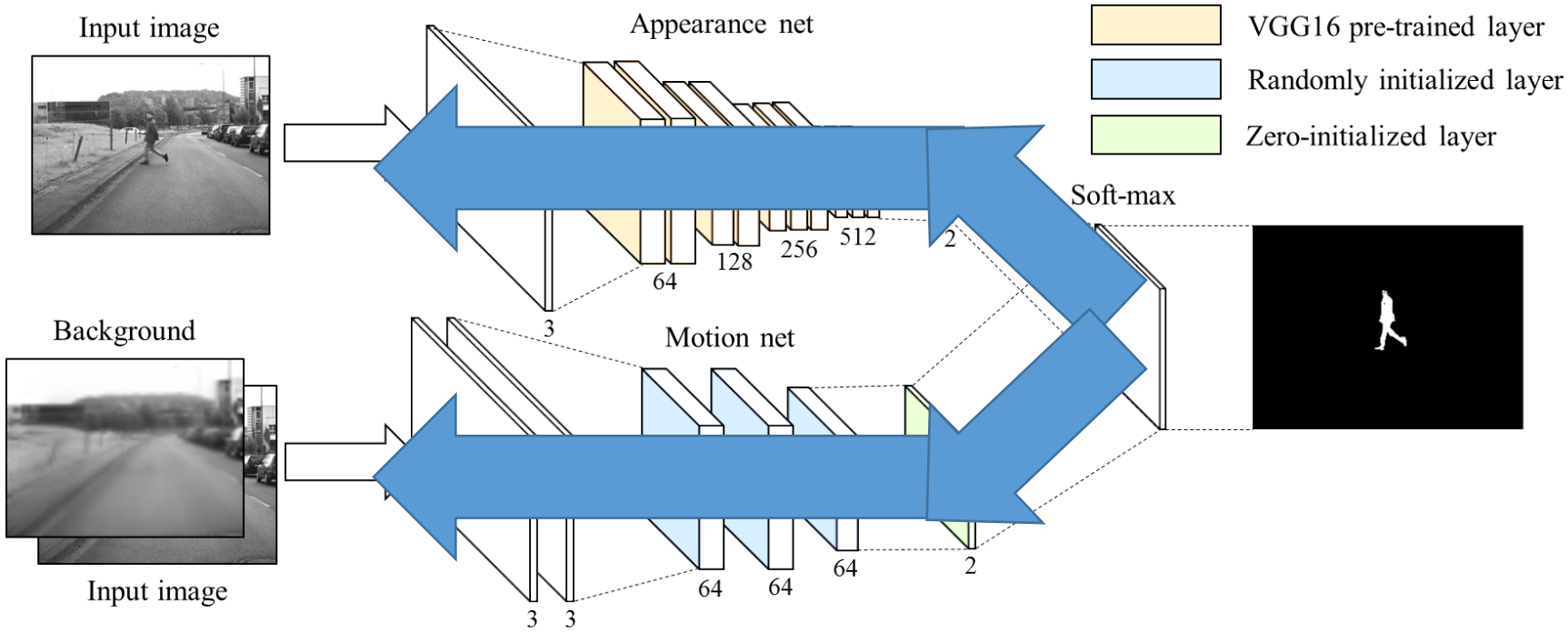
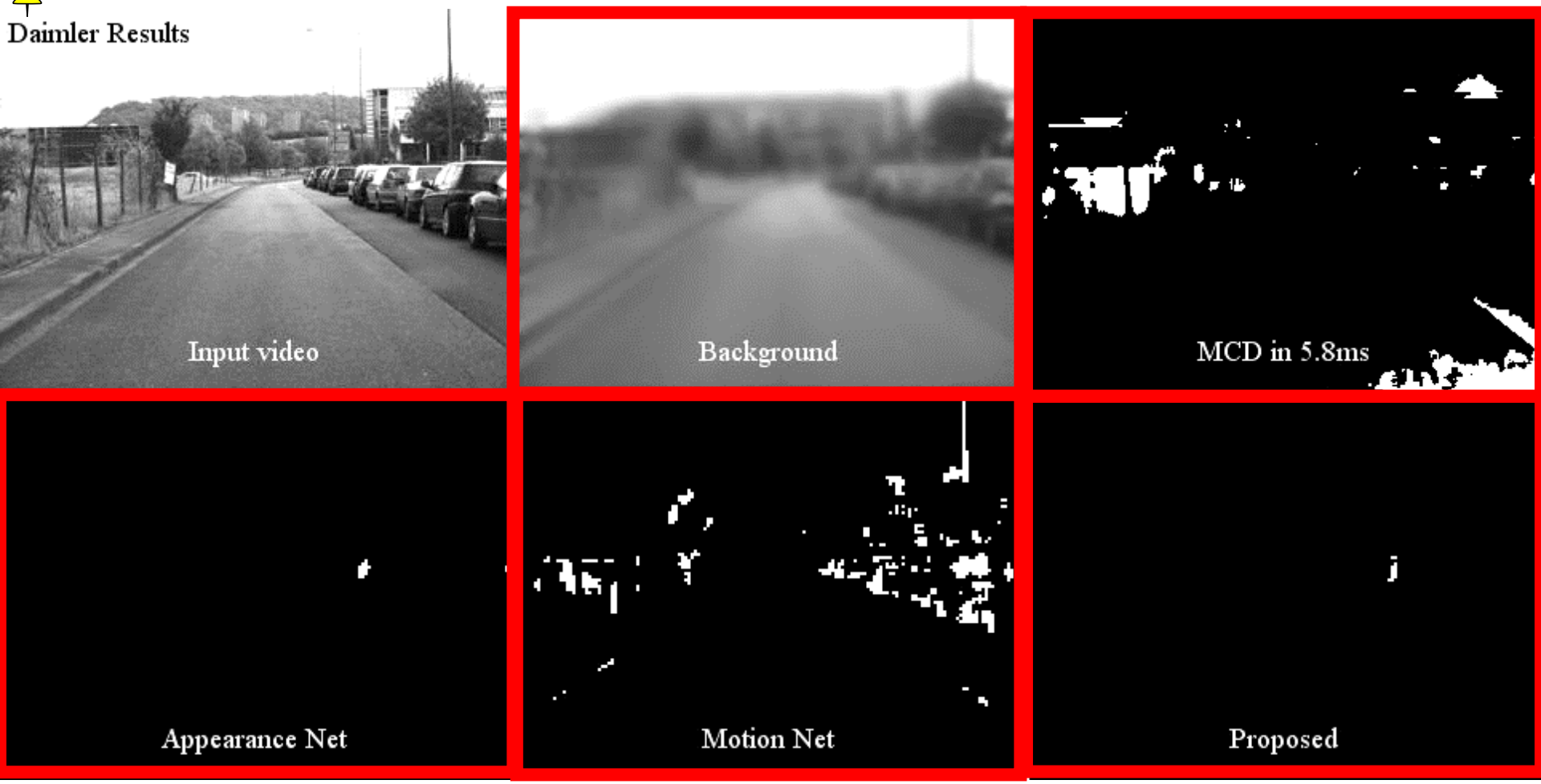


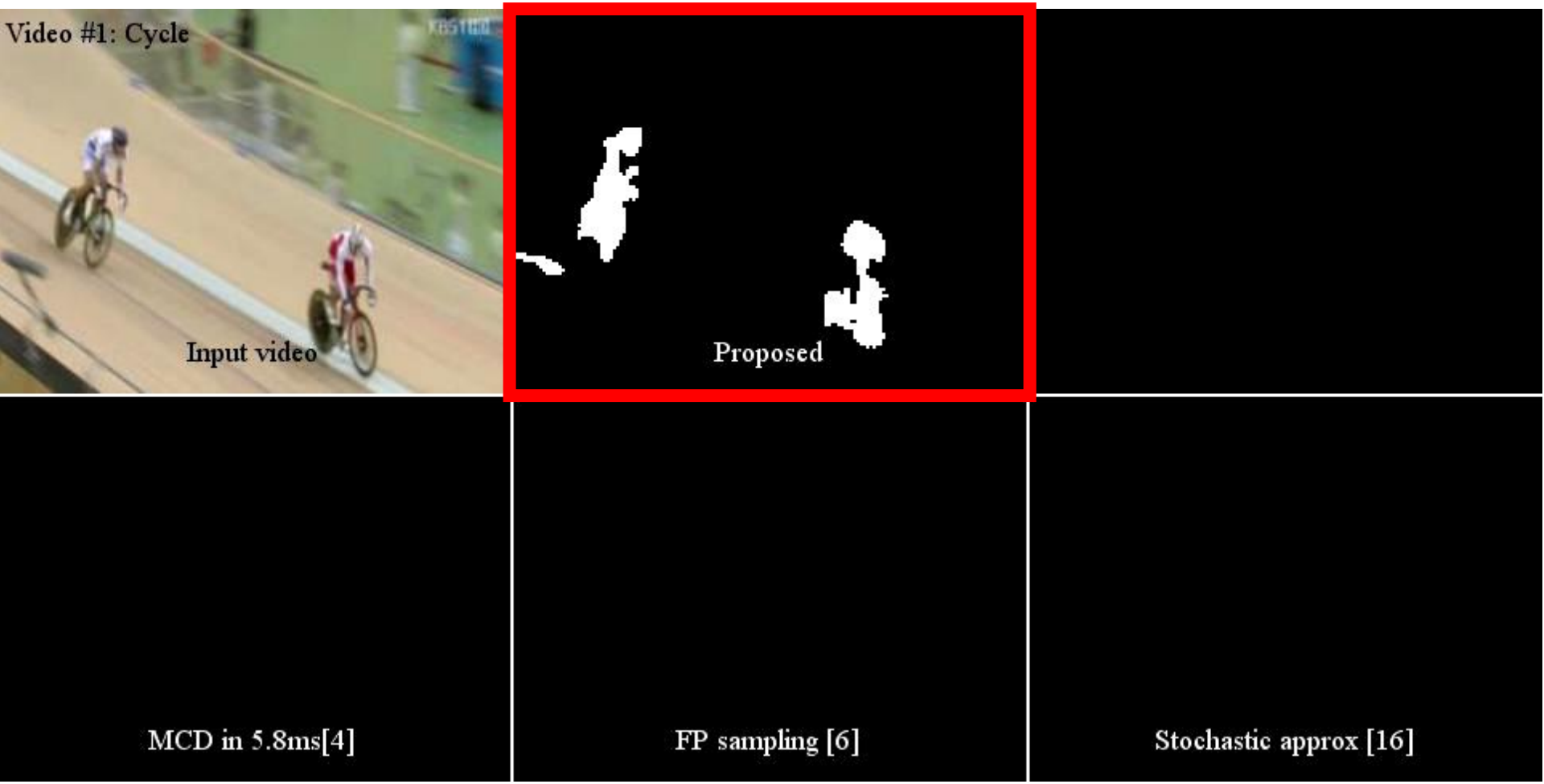
Experiments

- Analysis



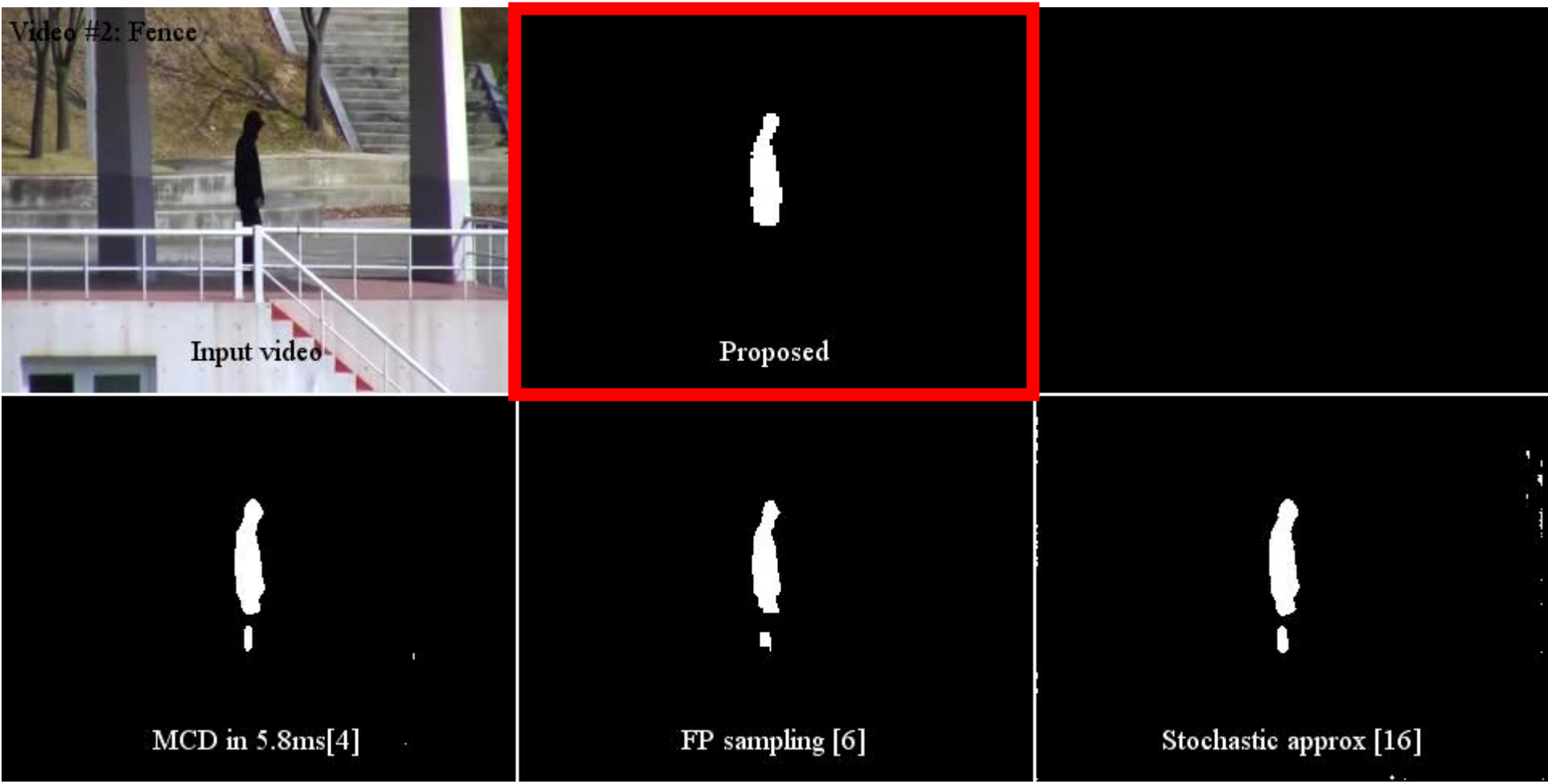
Experiments

- Results



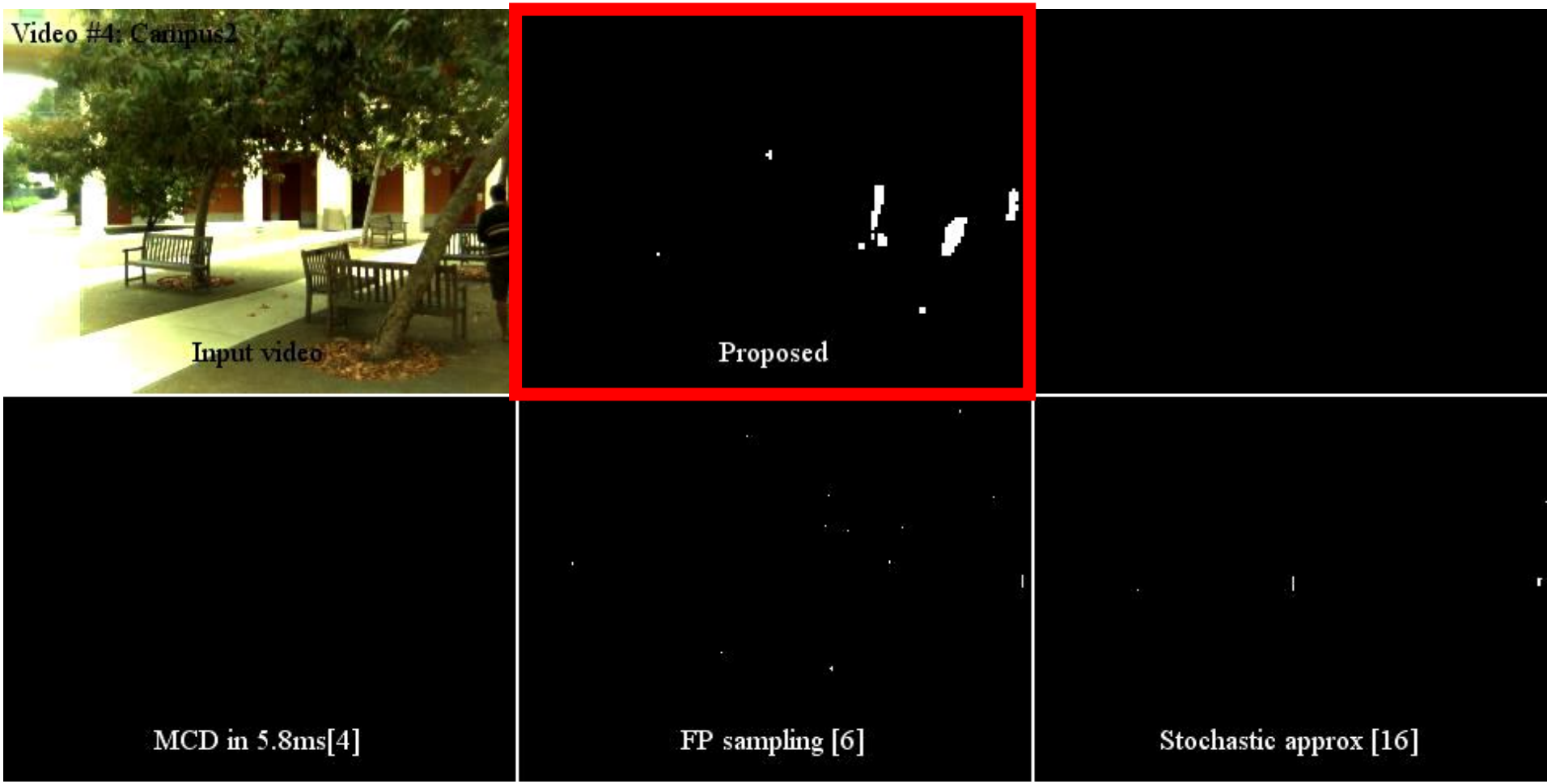
Experiments

- Results



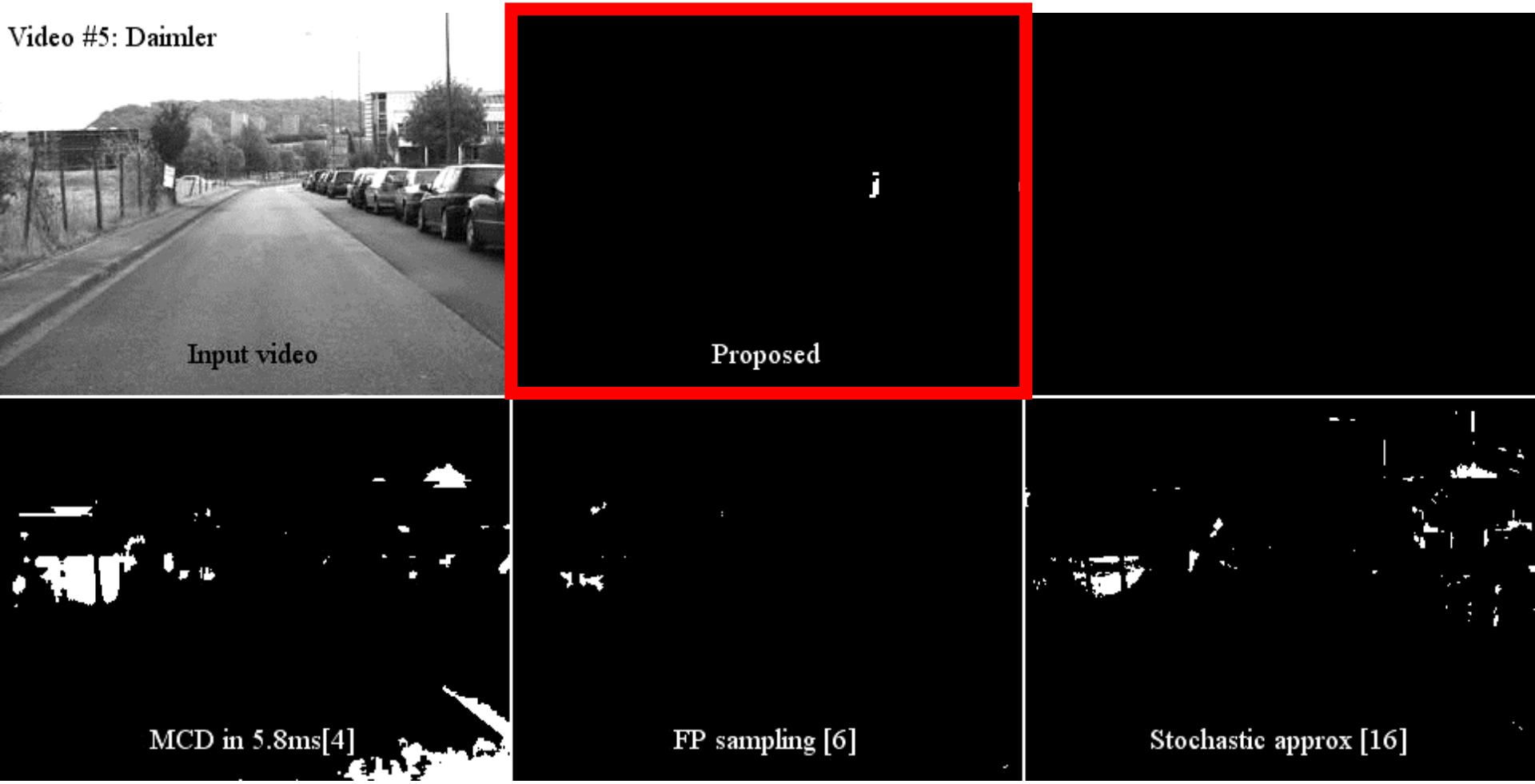
Experiments

- Results



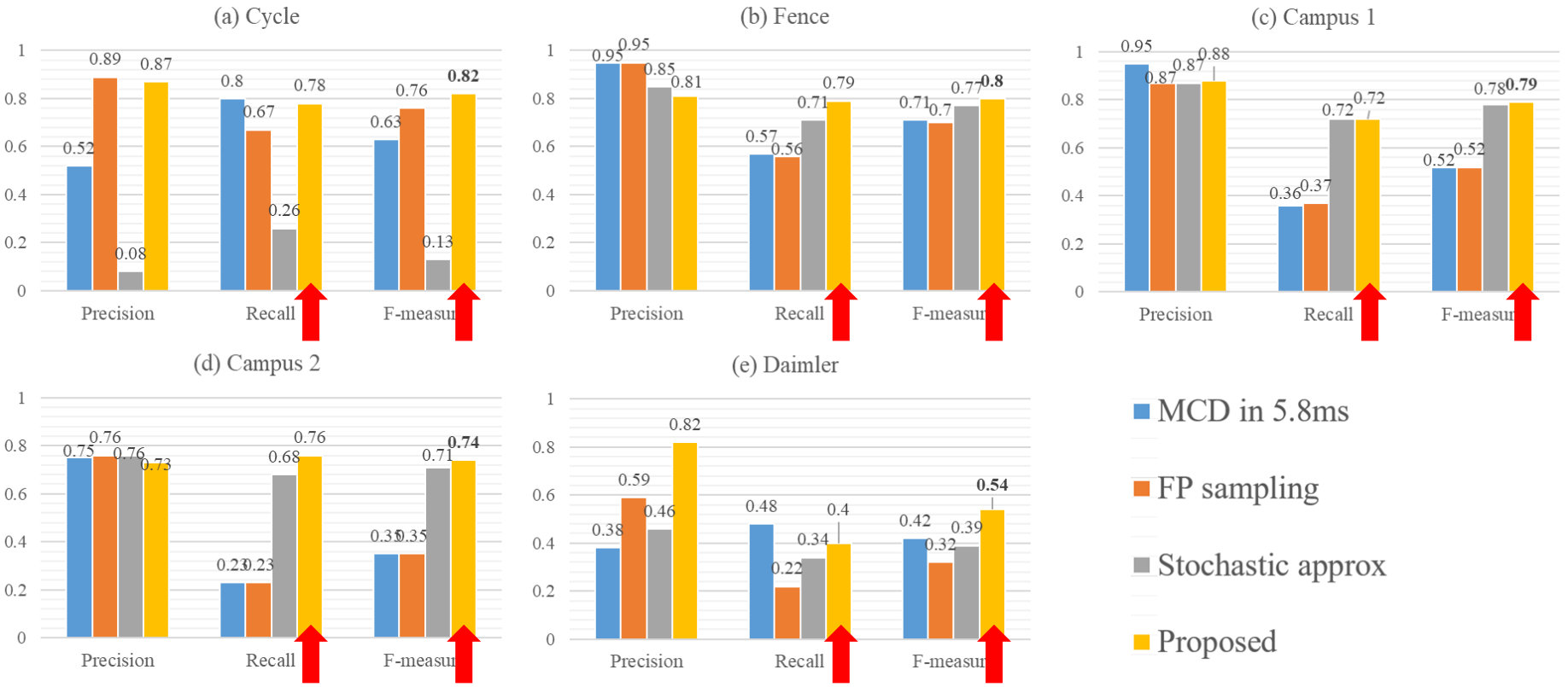
Experiments

- Results



Experiments

- Performance
  - Computation : 50 fps in GPU



MCD in 5.8 ms : “Detection of moving objects with nonstationary cameras in 5.8ms” in CVPR Workshops, 2013
FP sampling : “Robust and fast moving object detection in a non-stationary camera via foreground probability based sampling,” ICIP, 2015
Stocahstic approx : “Foreground detection for moving cameras with stochastic approximation,” PR Letters, 2015

Conclusion

- We proposed a deep learning architecture that detects a moving object in a moving camera based on a background model.

- To cope with background contamination, we designed the structure to use appearance information and learn the background pattern.

- The proposed method detects moving objects robust to the background contamination and shows better performance than state-of-the-art methods.

Thank you

Experiments

- Details
  - Training data : 14 videos
  - Test data : 5 videos
  - Input : 320 x 240 resolution
  - GPU : GTX 1070
  - Network : 14ms
  - Background : 6ms
  - Real-time 50fps