# Anomaly Detection

# Hand-crafted features based methods

**Future frame prediction for anomaly detection** CVPR 2018

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# Contents

# 1. Introduction

- 최근 이상 탐지에서는 training data를 이용한 feature reconstruction을 일반적으로 사용
  I. Hand-crafted features based methods
  II. Deep learning based methods

- Hand-crafted Features Based Methods?
  1) Extracting Features = hand-crafted or training set 학습
  2) Model Learning = characterize the distribution or encode regular patterns
  3) Identify = isolated clusters or outliers as anomalies

# 2. Hand-crafted features based methods

- Feature extraction module,
  1) 규칙적인 패턴을 추출하기 위해 low-level trajectory features 사용

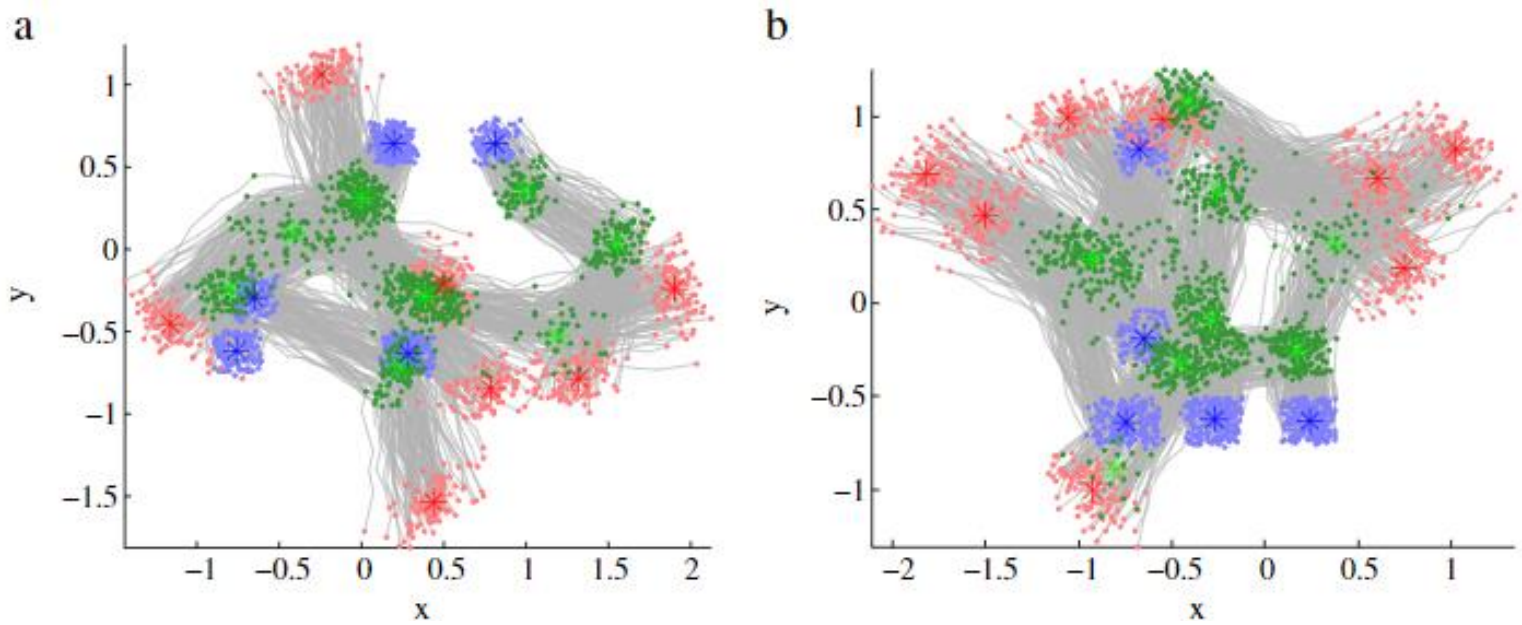


**Fig. 1.** Sample learned scene models for training sets from (a, b) Piciarelli et al.'s synthetic dataset [19]; (c) Dee and Hogg's carpark dataset [8–10]; (d) Naftel and Khalid's laboratory dataset [2]. Entry, turning, and exit points are indicated by blue, green, and red points respectively. Asterisks denote the component means of the entry, turning, and exit GMMs.

  - (a,b) Piciarelli et al.'s synthetic dataset
  - 시작점(Entry points): 파란색 / 회전점(turning points): 녹색 / 종료점(exit points): 빨간점

F. Tung, J. S. Zelek, and D. A. Clausi. Goal-based trajectory analysis for unusual behaviour detection in intelligent surveillance. Image Vision Comput., 29(4):230–240, 2011.

# 2. Hand-crafted features based methods

- Feature extraction module,

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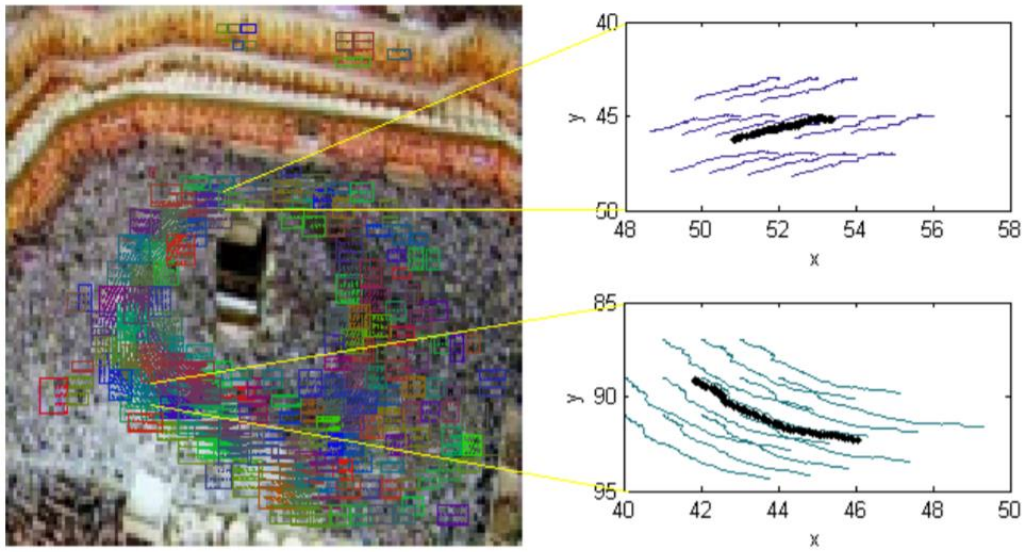



Figure 5. Trajectories clustered according to position information, (left) and representative trajectories for two clusters (right).

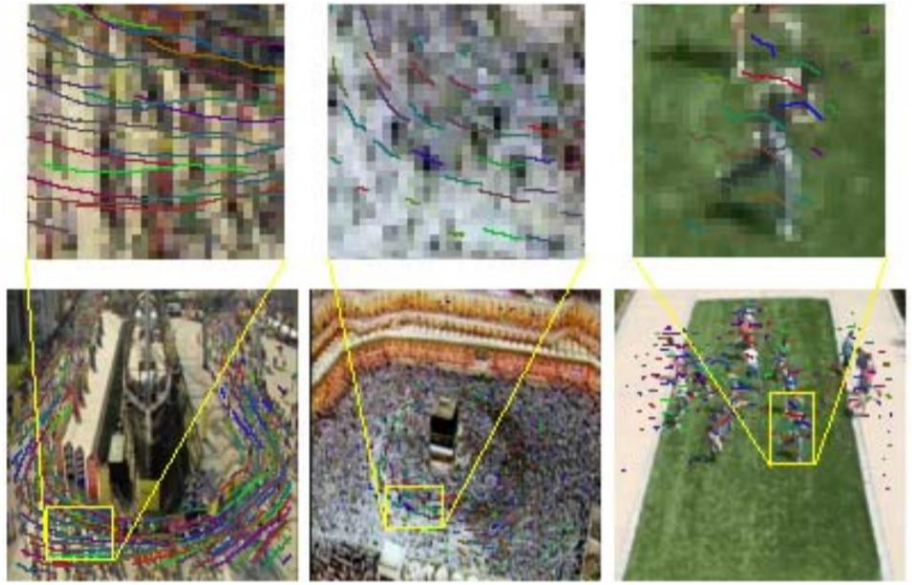


Figure 6. Representative trajectories for three scenes. Top row shows zoom-in view of parts of each scene.

  – Trajectory features: 객체 추적을 기반으로 하며, multiple occlusions이나 그림자가 있는 등의 복잡한 장면에서는 객체 추적이 실패하기 쉽다는 단점이 있음

S. Wu, B. E. Moore, and M. Shah. Chaotic invariants of lagrangian particle trajectories for anomaly detection in crowded scenes. In The Twenty-Third IEEE Conference on Computer Vision and Pattern Recognition, CVPR 2010, San Francisco, CA, USA, 13-18 June 2010, pages 2054–2060, 2010.

# 2. Hand-crafted features based methods

- Feature extraction module,
  2) Histograms of oriented gradients(HOG): 이미지 픽셀에 대한 변화량의 각도와 크기를 고려하여 히스토그램 형태의 특징을 추축하는 방법(일반적으로 사람이나 보행자 인식에 활용/low-level 시,공간적 특징 사용)

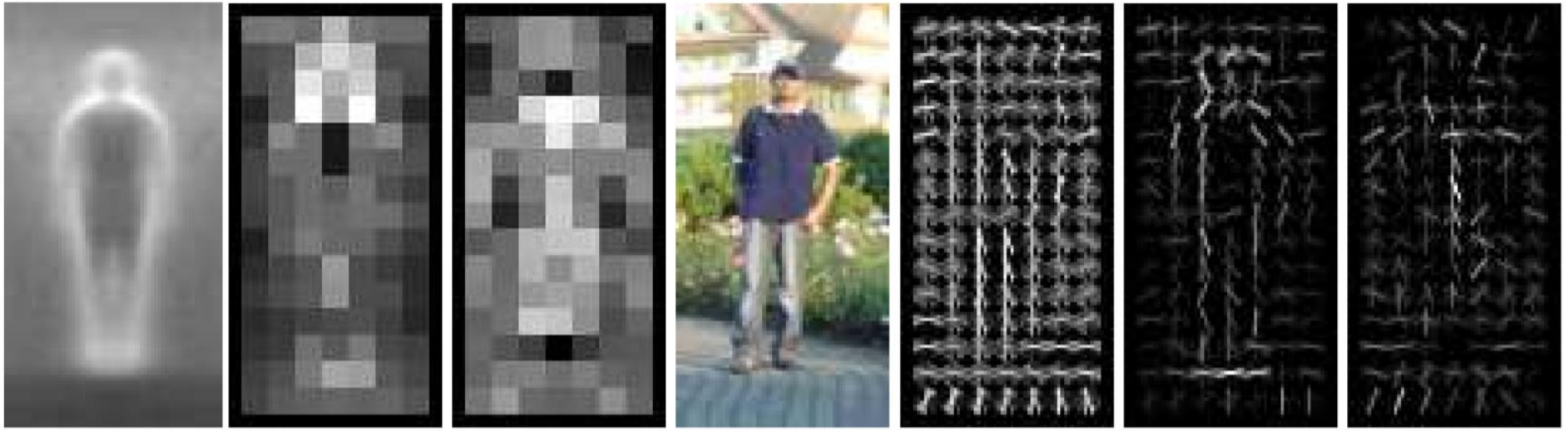


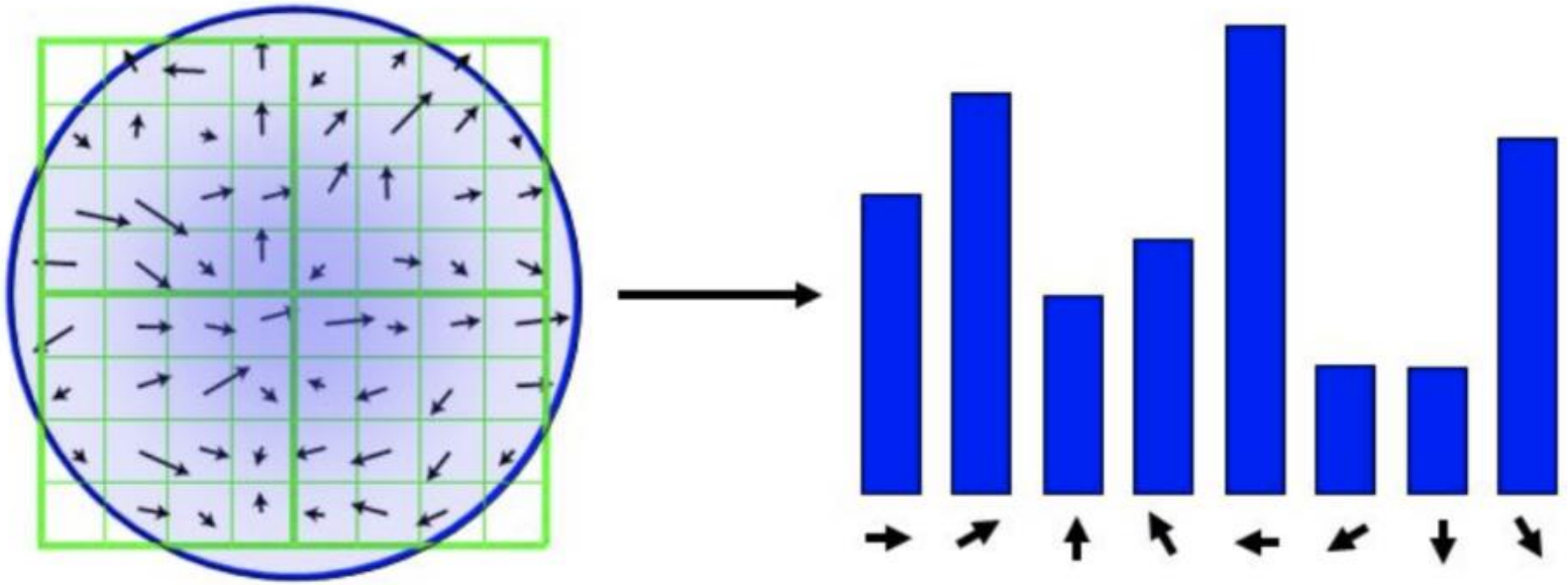

Figure 6. Our HOG detectors cue mainly on silhouette contours (especially the head, shoulders and feet). The most active blocks are centred on the image background just *outside* the contour. (a) The average gradient image over the training examples. (b) Each "pixel" shows the maximum positive SVM weight in the block centred on the pixel. (c) Likewise for the negative SVM weights. (d) A test image. (e) It's computed R-HOG descriptor. (f,g) The R-HOG descriptor weighted by respectively the positive and the negative SVM weights.

N. Dalal and B. Triggs. Histograms of oriented gradients for human detection. In 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR 2005), 20-26 June 2005, San Diego, CA, USA, pages 886– 893, 2005.

# 2. Hand-crafted features based methods

| | | | | | |
|---|---|---|---|---|---|
| 12 | 90 | 89 | 86 | 87 | 82 |
| 10 | 12 | 88 | 85 | 83 | 84 |
| 9 | 15 | 12 | 84 | 84 | 88 |
| 12 | 14 | 10 | 82 | 88 | 89 |
| 11 | 17 | 16 | 12 | 88 | 90 |
| 10 | 16 | 15 | 17 | 89 | 88 |

- Histograms of oriented gradients(HOG)
  - 픽셀의 변화량의 각도와 크기를 고려하여 히스토그램 형태의 feature를 추출하는 방법

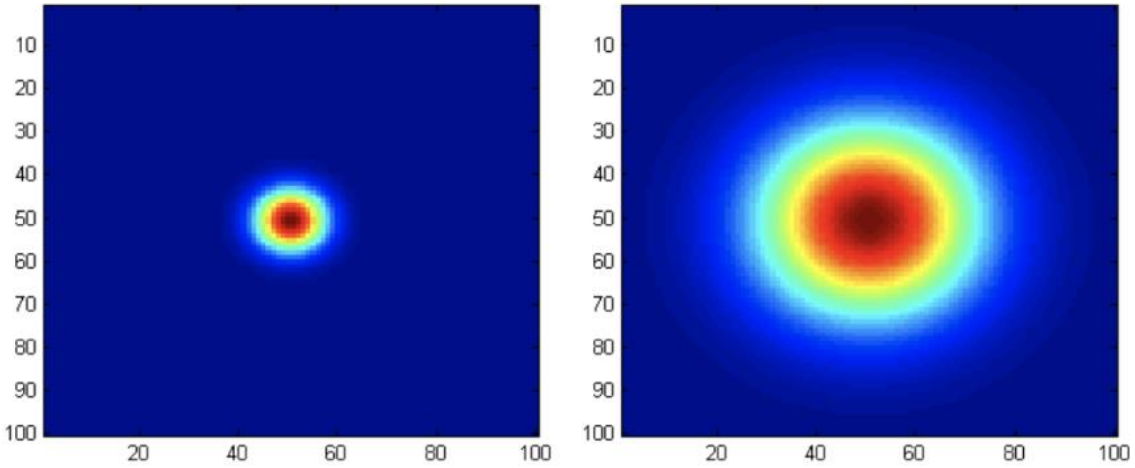


Gaussian filter(σ=0.1)를 사용해서 weighted magnitude를 표현

  - HOG(Keypoint Descriptor)는 픽셀 값의 변화량을 나타내는 척도로 주로 이미지의 texture를 표현

# 2. Hand-crafted features based methods

- Histograms of oriented gradients(HOG)
  - Gaussian filter: 정규분포, 확률분포에 의해 생성된 잡음을 제거하기 위한 필터



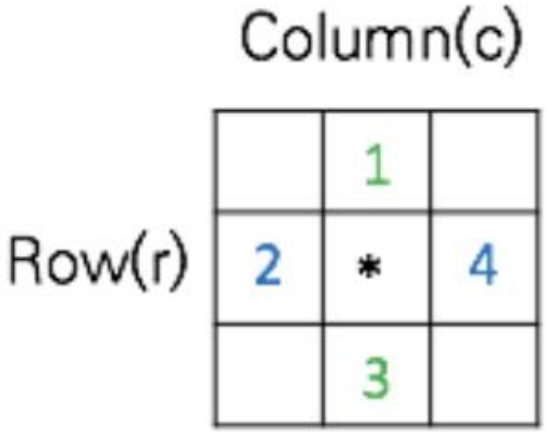

σ=2 인 30x30 Gaussian kernel(왼쪽)

σ=5 인 30x30 Gaussian kernel(오른쪽)


https://donghwa-kim.github.io/hog.html / https://codingcoding.tistory.com/24

# 2. Hand-crafted features based methods

- Histograms of oriented gradients(HOG)
  - 이미지 안 픽셀들의 방향의 변화(intensity)를 나타냄
  - 3 x 3 커널 주로 사용
  - 커널이 움직일 때마다, 커널의 중심점을 기준으로 인접한 행과 열의 차이 dx, dy 계산




$1: I(c, r-1)$
$2: I(c-1, r)$
$3: I(c, r+1)$
$4: I(c+1, r)$

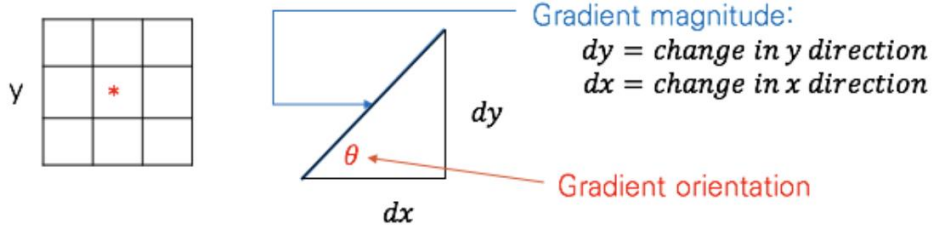
$$dy = I(c, r-1) - I(c, r+1)$$
$$dx = I(c+1, r) - I(c-1, r)$$

- Gradient orientation(방향)

$$\theta = tan^{-1}(\frac{dy}{dx})$$

- Gradient magnitude: intensity의 변화량(크기)

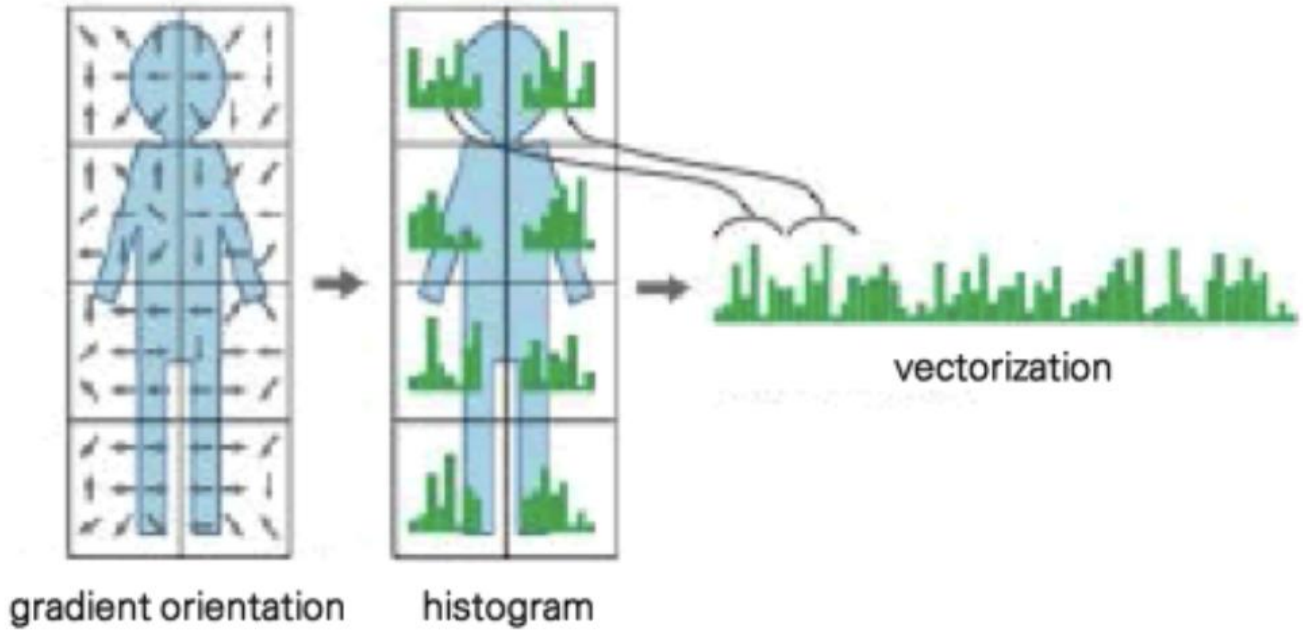
$$magnitude = \sqrt{dy^2 + dx^2}$$




https://donghwa-kim.github.io/hog.html

# 2. Hand-crafted features based methods

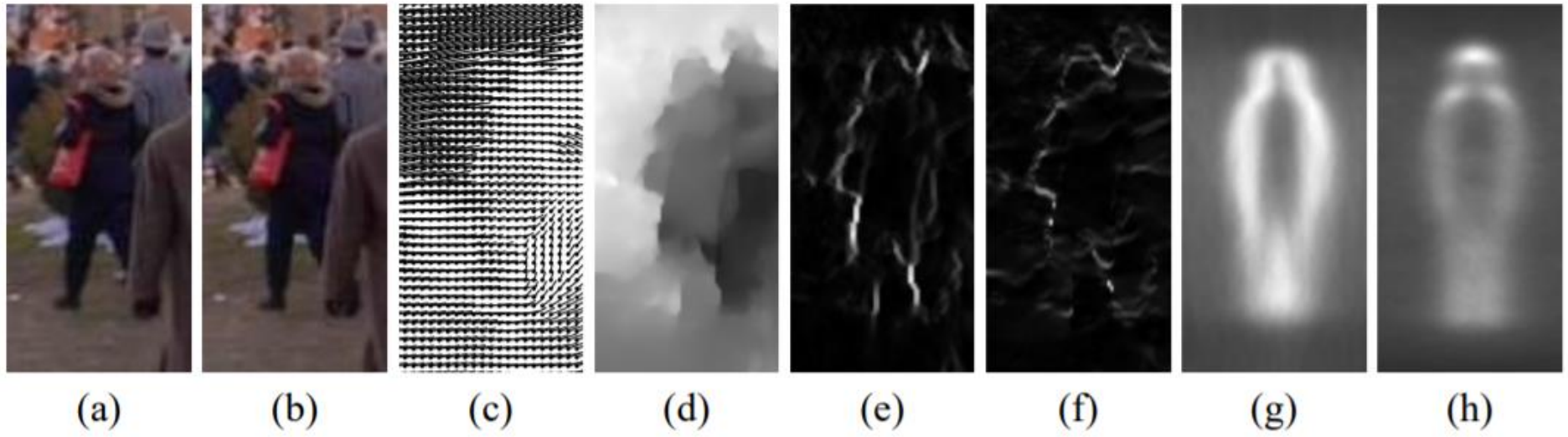
- Histograms of oriented gradients(HOG)
  - Gradient orientation: object(사람)의 경계면을 따라 gradient orientation이 다름
  - Gradient magnitude: 격자는 히스토그램 수를 의미하며 각 히스토그램을 Concatenation하여 하나의 벡터로 만듦 (vectorization)
  - Concatenation 벡터는 Keypoint Descriptor로 이미지 분석의 설명변수로 사용됨




https://donghwa-kim.github.io/hog.html

# 2. Hand-crafted features based methods

- Feature extraction module,
  3) Histograms of oriented flows(HOF): optical flow를 이용하여 히스토그램 형태의 특징을 추축하는 방법(low-level 시,공간적 특징 사용)

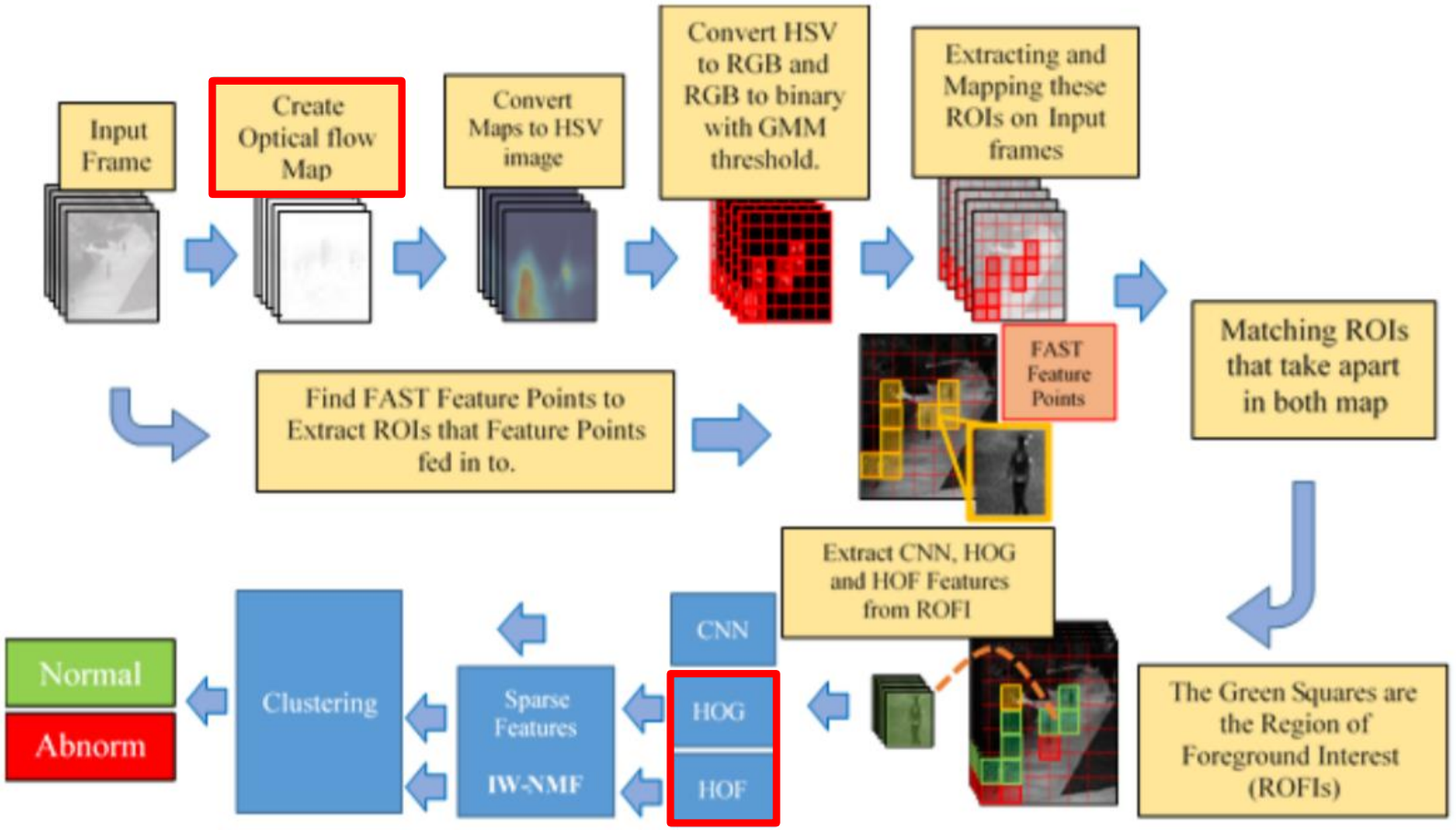



N. Dalal, B. Triggs, and C. Schmid. Human detection using oriented histograms of flow and appearance. In Computer Vision - ECCV 2006, 9th European Conference on Computer Vision, Graz, Austria, May 7-13, 2006, Proceedings, Part II, pages 428–441, 2006.

# Thank you!

# Etc.

- [2019_IEEE] Deep and Sparse features For Anomaly Detection and Localization in video



# Etc.

- [2017_IEEE] Video Anomaly Detection and Localization using 3D SL-HOF Descriptor

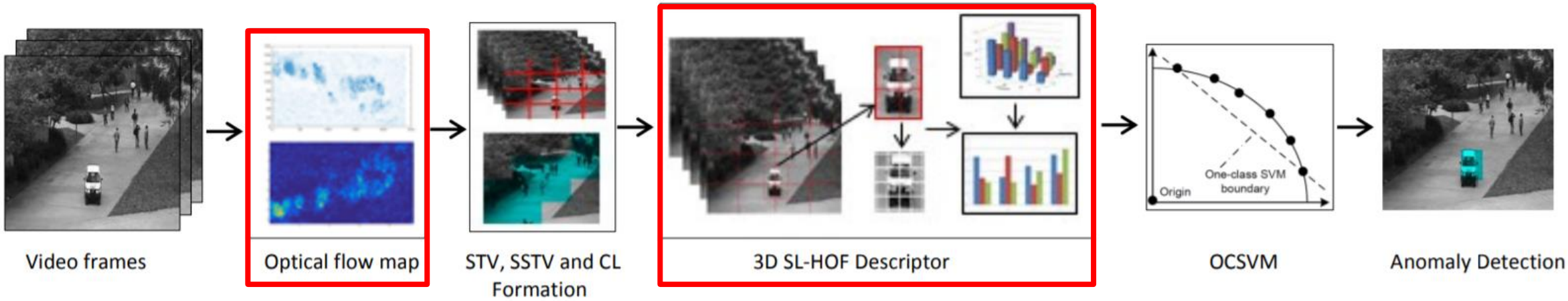



Fig. 1. Overview of proposed method