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HANDONG GLOBAL UNIVERSITY
WORLD CHANGING

Background Subtraction

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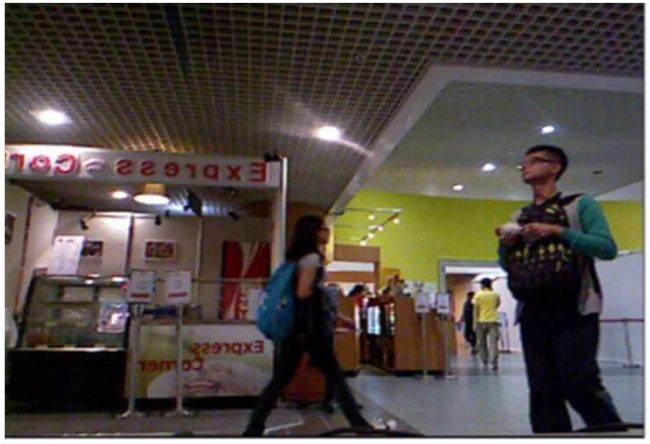
Introduction

- What is video segmentation?
  - Process of partitioning a frame into multiple regions
  - Application
    - Chroma-keying
    - Surveillance camera

Introduction

- What is video segmentation?



Introduction

Background subtraction

Morphological operation

Lee JH, Choi JS, Jeon ES, Kim YG, Le TT, Shin KY, Lee HC, Park KR, "Robust pedestrian detection by combining visible and thermal infrared cameras," Sensors (Basel) (2015)

Background subtraction

- Given a video, identify the foreground objects in that video
  - In most cases, objects are of interest, not the scene

Image at time t:
$I(x, y, t)$

$-$

Background at time t:
$B(x, y, t)$

$| > Th$

Background subtraction

- Concept
  - Assume we have two image frames $f(x, y, t)$ and $B(x, y, t)$
  - We detect changes between two images pixel by pixel
  - $d(x, y, t) = \begin{cases} 1 or 255 & if |f(x, y, t_i) - B(x, y, t)| > T \\ 0 & otherwise \end{cases}$
  - The difference with value 1 are considered the result of object motion
  - Assumption
    - Two images are registered spatially
    - Illumination is relatively constant

Background subtraction

- Key to successful background subtraction
  - We should handle sudden or gradual illumination changes
  - Repetitive motion
    - Tree leaves
    - Waves
  - Long-term scene change
    - Unattended bag
    - Parked car

→Estimating good background is the key!

Background subtraction

- Background estimation
  - Mean filter
    - Background is the mean of the previous n frames
    - $B(x,y,t) = \frac{1}{n}\sum_{i=0}^{n-1} f(x,y,t-i)$ $\quad or$
    - $B(x,y,t) = \frac{1}{n}\sum_{i=0}^{n-1} f(x,y,i)$

n=10 n=20 n=50

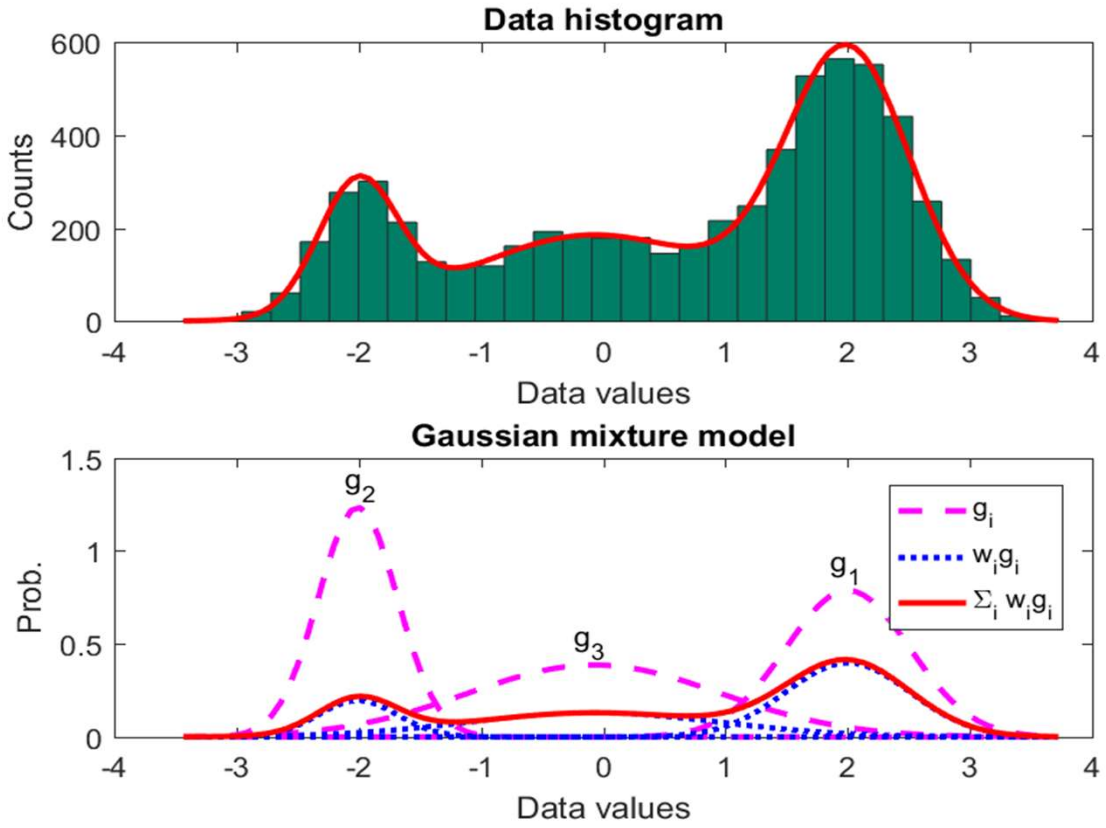
Background subtraction

- Background estimation
  - Median filter
    - Background is more likely to appear in a scene
    - $B(x, y, t) = median\big(f(x, y, t - i)\big)\ or$
    - $B(x, y, t) = median(f(x, y, i))$

n=10 n=20 n=50

Background subtraction

- Background estimation using GMM



Background subtraction

- Background estimation using GMM
  - Determine the number of mode of GMM
  - At the training stage, estimate mean and variance of each Gaussian model with the training data

    →estimate $p(A|B)$

    Background image is totally white

    P(255|Background) = 1

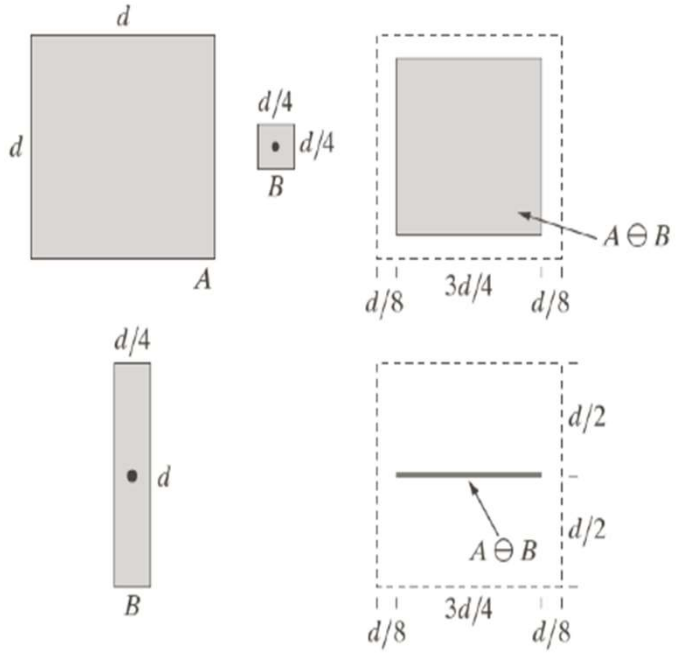
    P(0|Background) = 0
  - Each pixel is classified into background/foreground by calculating$p(B|A)$
    - P(background|255) = high
    - P(background|0) = low
    - P(background|128) = half

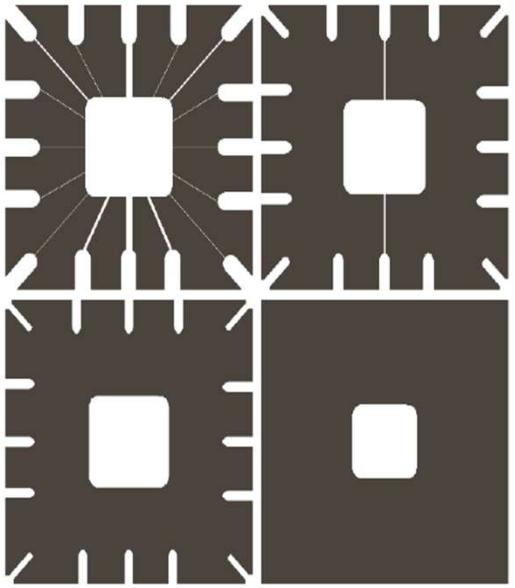
Morphological Operation

Sung Soo Hwang

Morphological operation

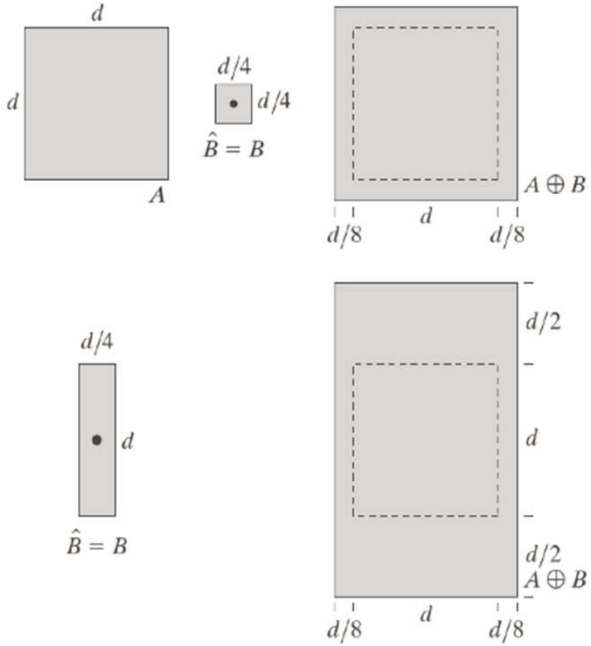
- Erosion
  - Erosion of A by B: the set of all points z such that B, translated by z is contained in A
  - Erosion shrinks or thins objects in a binary image

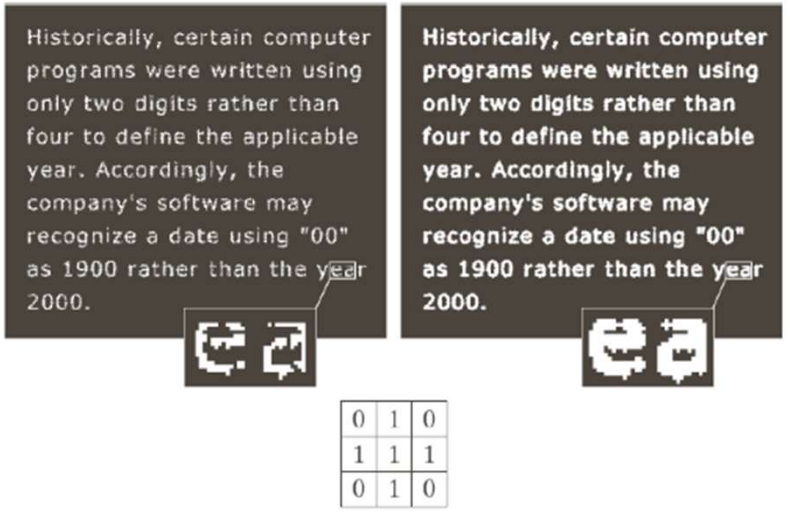




Morphological operation

- Dilation
  - Dilation of A by B: the set of all displacements, z, such that $\hat{B}$ and A overlap at least one element
  - Dilation grows or thickens objects in a binary image





Morphological operation

- Opening
  - The erosion of A by B, followed by a dilation of the result by B
  - Smoothens contours, breaks narrow isthmuses, and eliminates small island and sharp peaks
- Closing
  - The dilation of A by B, followed by a erosion of the result by B
  - Smoothens contours, but fuses narrow breaks and long thin gulfs, and eliminates small holes

Morphological operation