

Lecture #15

Motion Detection

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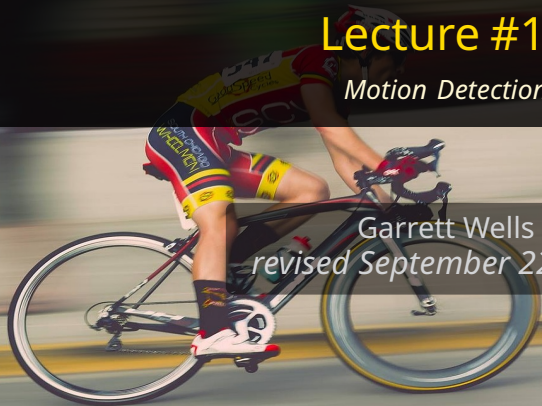


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Review

Foreground Detection and Image Segmentation

- ▶ Image Segmentation
 - ▶ Introduced some terms:

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 - ▶ Image Segmentation (Semantic & Instance)

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 - ▶ Labeling pixels...
 - ▶ either binary, *i.e.* foreground and background...
 - ▶ ...or by grouping into multiple areas.
 - ▶ We are ignoring ML segmentation (more classes), except to introduce semantic & instance segmentation

Review

Segmentation Algorithms

- ▶ By Pixel Value & Connectivity:

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Segmentation Algorithms

- ▶ By Pixel Value & Connectivity:
 - ▶ Connected Components

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- ▶ By Pixel Value Distribution:
 - ▶ Clustering Algorithms (K-Means, Gaussian Mixture...)

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 - ▶ GrabCut
- ▶ By Change in Pixel Value Over Time:
 - ▶ Background Subtractors

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 - ▶ Background Subtractors
- ▶ By Area, Distance, Topology:
 - ▶ Contours and Masking

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 - ▶ Distance Transform

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- ▶ By Area, Distance, Topology:
 - ▶ Contours and Masking
 - ▶ Watershed
 - ▶ Distance Transform
- ▶ Fun Tools: Flood Fill

Motion Detection

Scooby Door🔗

Donkey Kong🔗

Motion Detector Examples

1. WebCam Motion Detector [1]
2. OpenCV Motion Detection [2]
3. Streaming Live Motion Detection Using OpenCV [3]

Motion Detection

Easy Version...

Note: Pretty similar to background subtractors...

1. Take still picture
2. Assign still as "background"
3. Subtract subsequent images from background image
4. Difference should indicate motion

Motion Detection

Problems with the easy version...

1. Assumes static setup:
 - ▶ no camera movement
 - ▶ consistent lighting
2. Assumes changes background doesn't have moving objects
 - ▶ doors
 - ▶ natural elements

Motion Detection

Proposed improvements...

1. Construct background from static images with no foreground elements on initialization
 - ▶ Still constrained by the assumptions of the “easy” motion detection
 - ▶ Therefore, not good for dynamic applications
2. Average background over several images
 - ▶ As mask is updated, we continue to see information from the past
 - ▶ Leads to “ghosting”, motion lag from previous images

Temporal Average Filter

Averaging with time...

- ▶ Estimates background as median
- ▶ Helps filter out small changes
 - ▶ lighting/shadows
- ▶ May not catch all noise
- ▶ Small, fast-moving objects
 - ▶ Leaves, etc.

Motion Detection Issues

1. Size of Motion

Motion Detection Issues

1. Size of Motion
 - ▶ Area?

Motion Detection Issues

1. Size of Motion
 - ▶ Area?
2. Localizing Motion

Motion Detection Issues

1. Size of Motion
 - ▶ Area?
2. Localizing Motion
 - ▶ Where is the motion in the scene?

Motion Detection Issues

1. Size of Motion

- ▶ Area?

2. Localizing Motion

- ▶ Where is the motion in the scene?
- ▶ Are there multiple points of motion?

Motion Detection Issues

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 - ▶ Where is the motion in the scene?
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3. Visualizing & Reporting Motion

Motion Detection Issues

1. Size of Motion
 - ▶ Area?
2. Localizing Motion
 - ▶ Where is the motion in the scene?
 - ▶ Are there multiple points of motion?
3. Visualizing & Reporting Motion
 - ▶ How to visualize?

Motion Detection Issues

1. Size of Motion

- ▶ Area?

2. Localizing Motion

- ▶ Where is the motion in the scene?
- ▶ Are there multiple points of motion?

3. Visualizing & Reporting Motion

- ▶ How to visualize?
- ▶ How to report?

Motion Detection Good Practices

- ▶ Model background
- ▶ Segment foreground (motion) from background
- ▶ Determine motion size
- ▶ Determine motion location
- ▶ Report/Visualize motion

Background Modeling

- ▶ Still image, average of images
- ▶ Temporal Average Filter

Segment Foreground from Background

- ▶ Connected Components
- ▶ Edge Detection/Thresholding/Contour Masking
- ▶ Background Subtractors
- ▶ Watershed
- ▶ GrabCut
- ▶ etc.

Size of Motion

- ▶ Probably only want motion above a certain threshold
- ▶ Threshold by area
- ▶ Examples:
 - ▶ Trail Cameras



Ignore these bears.

Size of Motion

- ▶ Probably only want motion above a certain threshold
- ▶ Threshold by area
- ▶ Examples:
 - ▶ Trail Cameras



Watch out for these bears.

Size of Motion

- ▶ Probably only want motion above a certain threshold
- ▶ Threshold by area
- ▶ Examples:
 - ▶ Security Cameras



Determine Motion Size

- ▶ Edge Detection
- ▶ `cv.findContours(...)` → `cv.contourArea(...)`
- ▶ Area calculation to eliminate smaller motions

Localizing Motion

- ▶ Detect where motion in scene is
 - ▶ Output coordinates of center
 - ▶ Draw a box
 - ▶ *etc.*
- ▶ Can be done using contours, *etc.*

Visualizing and Reporting Motion

- ▶ Steps:

1. Boundary Box
2. Contours
3. Output Coordinates

- ▶ `cv.findContours(...)` → `cv.contourArea(...)` → `cv.rect(...)`

Bibliography I

- [1] "WebCam Motion Detector in Python," GeeksforGeeks. (Nov. 23, 2017), [Online]. Available: <https://www.geeksforgeeks.org/webcam-motion-detector-python/> (visited on 09/22/2024).
- [2] D. R. V. Rodriguez, "Computer Vision: Write Your Motion Detection Code Using OpenCV," AIM. (Sep. 23, 2020), [Online]. Available: <https://analyticsindiamag.com/ai-mysteries/computer-vision-write-your-motion-detection-code-using-opencv/> (visited on 09/22/2024).
- [3] R. Agrawal, "Streaming Live Motion Detection using OpenCV | Analytics Steps," (), [Online]. Available: <https://www.analyticssteps.com/blogs/streaming-live-motion-detection-using-opencv> (visited on 09/22/2024).

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