CSSE463: Image Recognition Day 29

- This week
  - Today: Surveillance and finding motion vectors
  - Tomorrow: motion and tracking
  - Lab 7: due Wednesday
  - Thursday: Bayesian classifiers
  - Friday: project workday in class, **status report** due in dropbox by noon.
- Questions?

Motion

- New domain: image sequences.
- Additional dimension: time
- Cases:
  - Still camera, moving objects
    - Detection, recognition
    - Surveillance
  - Moving camera, constant scene
    - 3D structure of scene
  - Moving camera, several moving objects
    - Robot car navigation through traffic

Surveillance

- Applications:
  - Military
  - Hospital halls during night

- Stationary camera, moving objects
- Separate background from objects

Finding moving objects

- Subtract images

- What next…
  - How could you use this to find moving objects?
  - Discuss with a classmate
  - Share with class

Processing ideas

- Subtract images
- Mark those pixels that changed significantly (over threshold)
- Connected components. Fill?
- Toss small regions
- Morphological closing to merge neighboring regions
- Return bounding box

Issues with image subtraction

- Background model
  - Simplest: previous frame
  - General: find mean M and variance of many frames
  - Consider the hospital hallway with a window
    - How to handle "drift" due to illumination changes?
    - For each pixel p with mean M: $M_{new} = \alpha M_{old} + (1-\alpha)p$
  - Consider what happens when a person enters the scene
    - Background model adapts to her
    - What happens when she leaves?
      - Mean changes, so detects background as foreground
      - Variance remains high, so can't detect new arrivals.
    - Answer: multiple models

Motion vectors

- Difference in motion of specific objects
- Show examples for pan.
- Create ones for zoom in/out.

- How to find?
  - 2 techniques

What is image flow?

$image_T$

0	0	0	0	0	0	0	7
0	4	4	4	4	4	0	10
0	0	4	6	6	4	0	9
0	0	0	4	6	4	0	10
0	0	0	0	4	4	0	8
0	0	0	0	0	4	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

$image_{T+\Delta T}$

0	0	0	0	0	0	0	7
0	0	0	0	0	0	0	10
0	4	4	4	4	4	0	9
0	0	4	6	6	4	0	10
0	0	0	4	6	4	0	8
0	0	0	0	4	4	0	0
0	0	0	0	0	4	0	0
0	0	0	0	0	0	0	0

- Notice that we can take partial derivatives with respect to x, y, and time.

Image flow equations

- Goal: to find where each pixel in frame t moves in frame $t+\Delta t$
  - E.g. for 2 adjacent frames, $\Delta t = 1$
  - That is, **Δx, Δy are unknown**
- Assume:
  - Illumination of object doesn't change
  - Distances of object from camera or lighting don't change
  - Each small intensity neighborhood can be observed in consecutive frames: $f(x,y,t) \rightarrow f(x+\Delta x, y+\Delta y, t+\Delta t)$ for some Δx, Δy (the correct motion vector).
- Compute a Taylor-series expansion around a point in (x,y,t) coordinates.
- Gives edge gradient and temporal gradient
- Solve for $(\Delta x, \Delta y)$

Limitations

- Assumptions don’t always hold in real-world images.
- Doesn’t give a unique solution for flow
  - Sometimes motion is ambiguous
  - “Live demo”