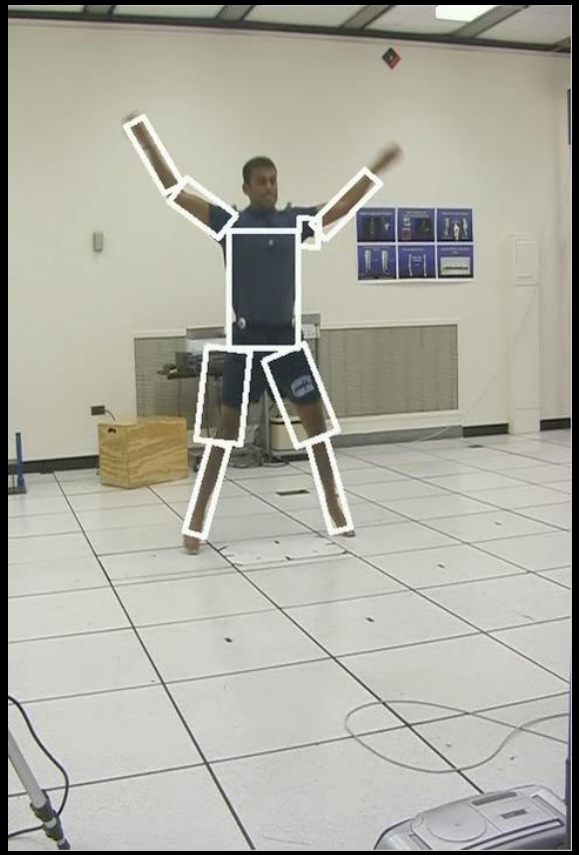
CS4495/6495
Introduction to Computer Vision

7A-L1 *Introduction to tracking*

Some old(er) examples of tracking

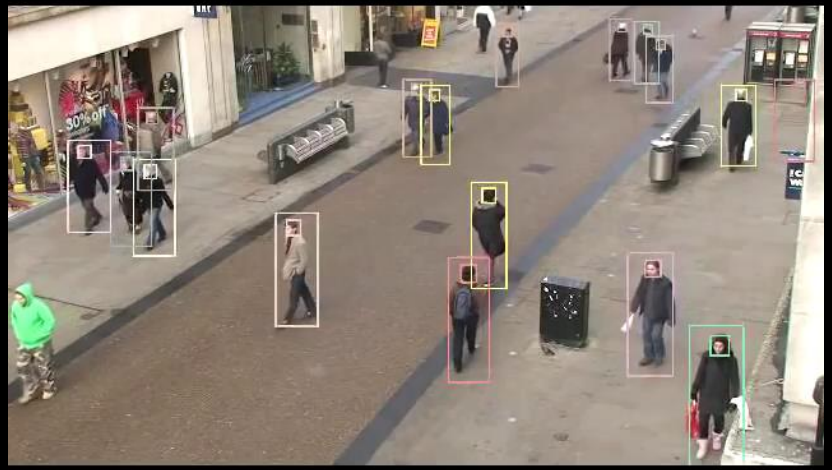
Isard and Blake CONDENSATION tracking

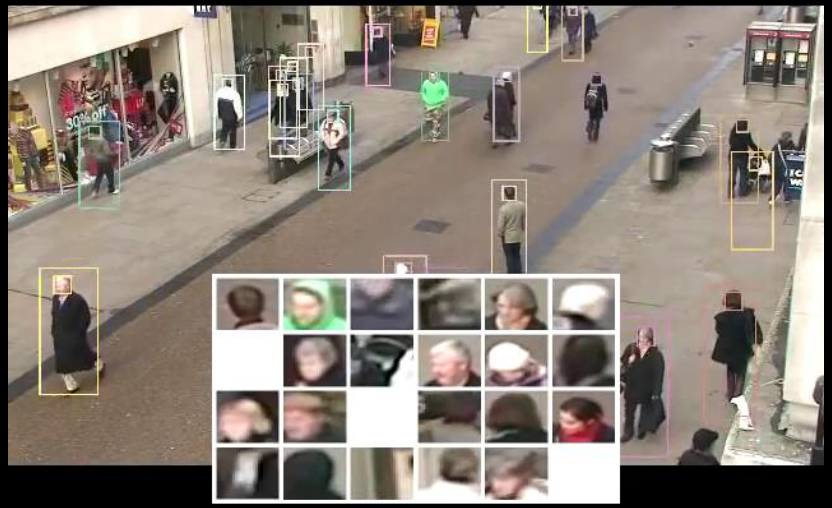
Some old(er) examples of tracking



D. Ramanan, D. Forsyth, and A. Zisserman "*Tracking People by Learning their Appearance*". PAMI 2007

Some new(er) examples of tracking





Stable Multi-Target Tracking in Real-Time Surveillance Video
B. Benfold and I. D. Reid, CVPR 2011

Tracking challenges

1. Many places it's hard to compute optical flow.
2. There can be large displacements since could be moving rapidly.

    Probably need to take dynamics into account.
3. Errors would compound – or drift.
4. Occlusions, *disocclusions*

Shi-Tomasi feature tracker

"Only compute motion where you should"

Find good features using eigenvalues of second-moment matrix – *you've seen this now twice!*

- Key idea: "good" features to track are the ones that can be tracked reliably

J. Shi and C. Tomasi. Good Features to Track. CVPR 1994.

Shi-Tomasi feature tracker

1. From frame to frame, track with Lucas-Kanade and a pure translation model
   - More robust for small displacements, can be estimated from smaller neighborhoods

Shi-Tomasi feature tracker

2. Check consistency of tracks by affine registration to the first (or earlier) observed instance of the feature
   - Affine model is more accurate for larger displacements
   - Comparing to the first or early frame helps to minimize drift

Tracking example

Figure 1: Three frame details from Woody Allen's *Manhattan*. The details are from the 1st, 11th, and 21st frames of a subsequence from the movie.

Figure 2: The traffic sign windows from frames 1,6,11,16,21 as tracked (top), and warped by the computed deformation matrices (bottom).

J. Shi and C. Tomasi. Good Features to Track. CVPR 1994.

Tracking with dynamics

Key idea: Given a model of expected motion, predict where objects will occur in next frame, even before seeing the image

- Restrict search for the object
- Improved estimates since measurement noise is reduced by trajectory smoothness

Tracking with dynamics

- The idea of using prediction is the difference between tracking and just detecting.

Detection vs. tracking


t=1


t=2

...

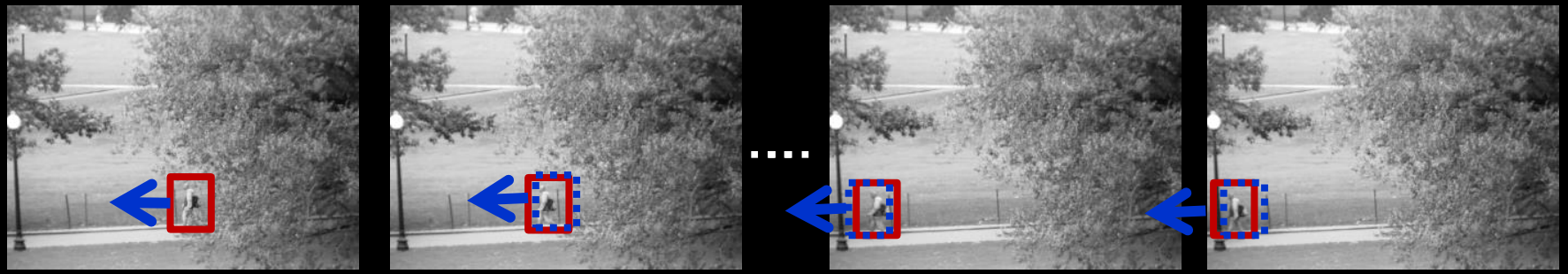

t=20


t=21

Detection vs. tracking

Detection: We detect the object *independently* in each frame

Detection vs. tracking



Tracking: We *predict* the new location of the object in the next frame using *estimated dynamics.* Then we *update* based upon measurements.

Tracking with dynamics

Key idea: Given a model of expected motion, predict where objects will occur in next frame, even before seeing the image

Goals:

- Do less work looking for the object, restrict the search.
- Get improved estimates since measurement noise is tempered by smoothness, dynamics priors.

Tracking with dynamics

Key idea: Given a model of expected motion, predict where objects will occur in next frame, even before seeing the image

Assumption – continuous (modeled) motion patterns:

- Objects do not disappear and reappear in different places in the scene
- Camera is not moving instantly to new viewpoint
- Gradual change in pose between camera and scene