

CAP 6411 Computer Vision Systems

- Instructor: Dr. Mubarak Shah, shah@cs.ucf.edu,
238 CSB,
<http://www.cs.ucf.edu/courses/cap6411>
- Office Hours:
 - 2PM to 3PM Mon, 4PM-5PM Tu, 5:15PM-6:15 PM
Wed
- Grading
 - Mid term 20%, Final 25%, Programs 45% , Homework
10%
- Recommended Book, but not required.
 - Digital Video Processing, A. M. Tekalp, Prentice Hall.

Multimedia

- Text
- Graphics
- Audio
- Images
- Video

Imaging Configurations

- Stationary camera stationary objects
- Stationary camera moving objects
- Moving camera stationary objects
- Moving camera moving objects

Video

- sequence of images
- clip
- mosaic
- key frames

Sequence of Images



Clip



Mosaic



Key Frames



Steps in Video Computing

- Acquire (CCD arrays/synthesize (graphics))
- Process (image processing)
- Analyze (computer vision)
- Transmit (compression/networking)
- Store (compression/databases)
- Retrieve (computer vision/databases)
- Browse (computer vision/databases)
- Visualize (graphics)

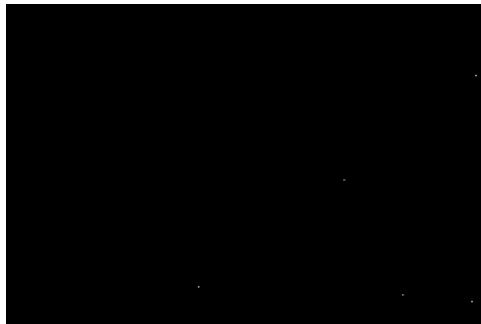
Computer Vision: Motion

- Motion Detection
- Motion Measurement (optical flow)
- Tracking
- Structure from motion (derive 3-D motion & shape)
- Motion Recognition
- Motion-based Recognition

A Video Clip



Consecutive Frame Difference



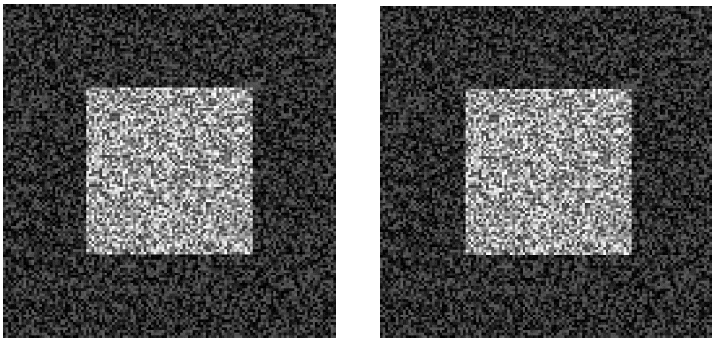
Background Difference



Optical Flow

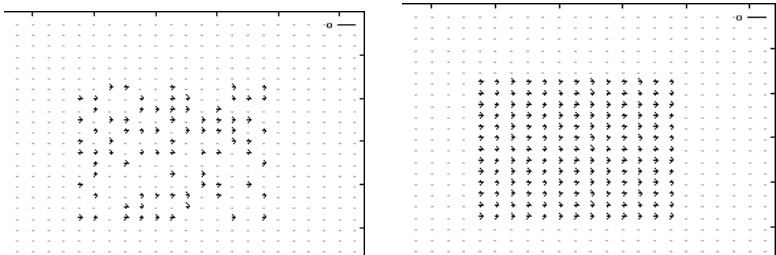
Measurement of motion at each pixel

Synthetic Images



(Random dot stereogram)

Results



One iteration

10 iterations

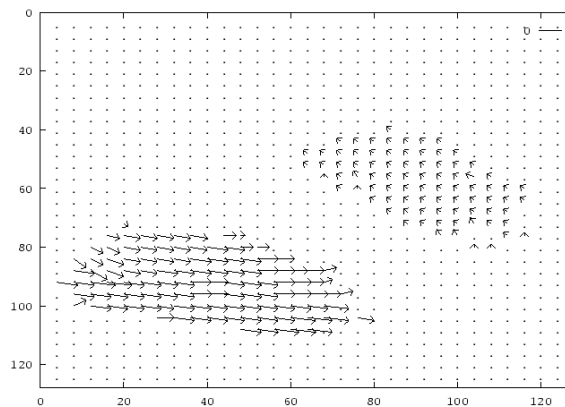
$$\sigma = 4$$

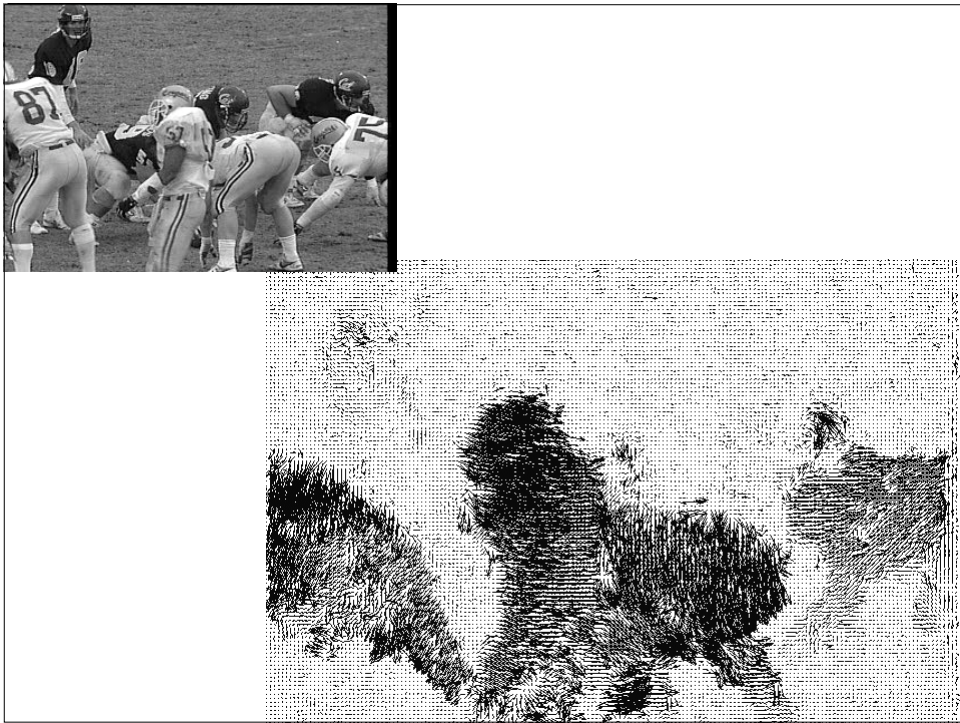
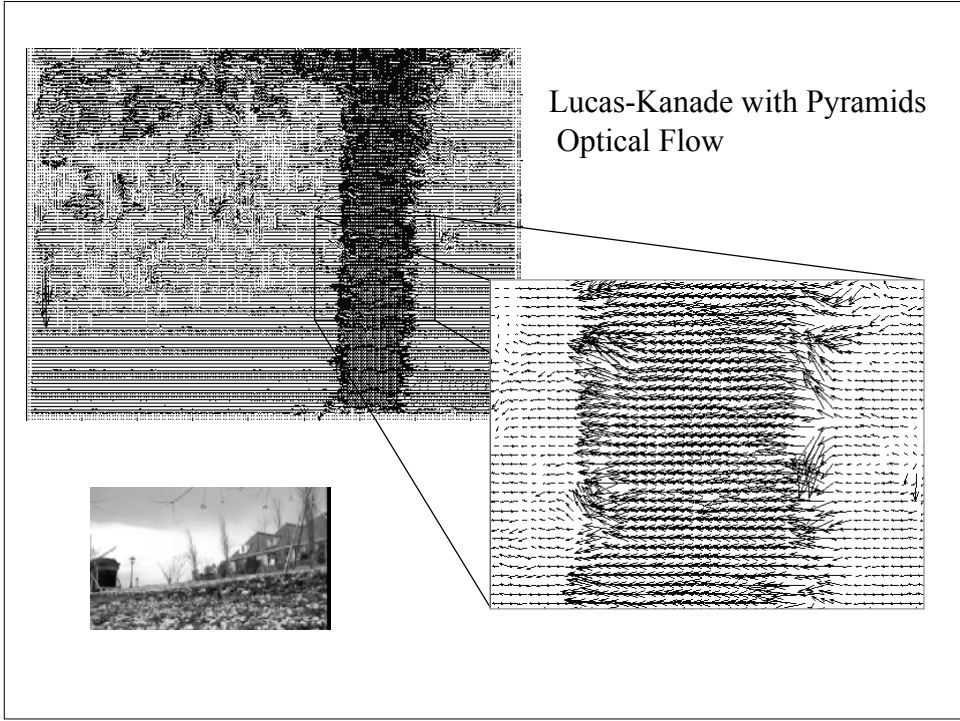
Horn-Schunck

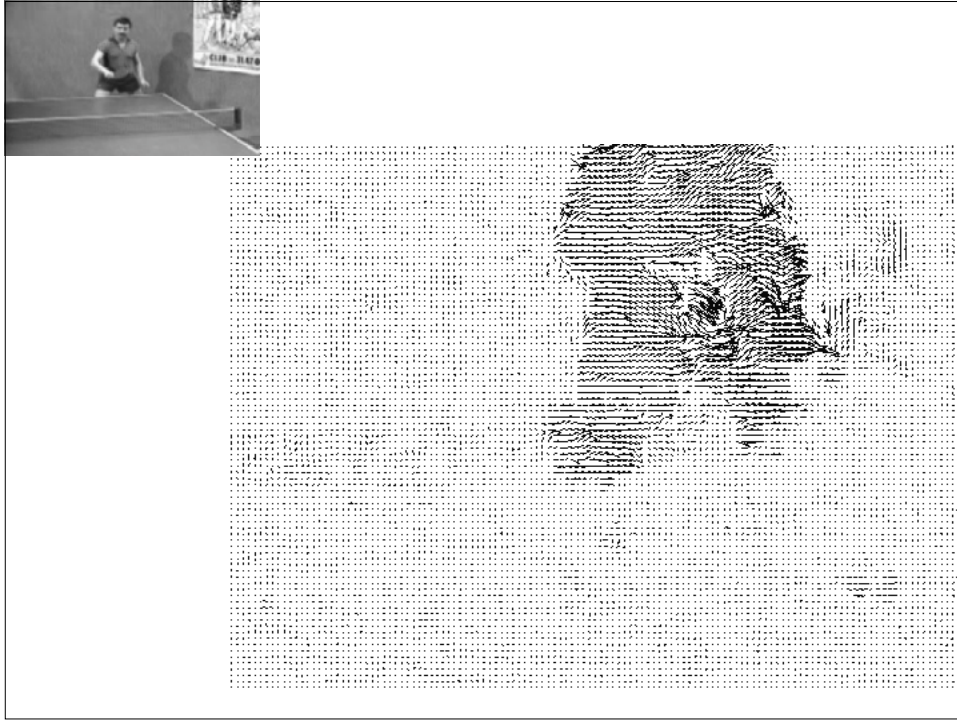
Image from Hamburg Taxi seq



optical flow





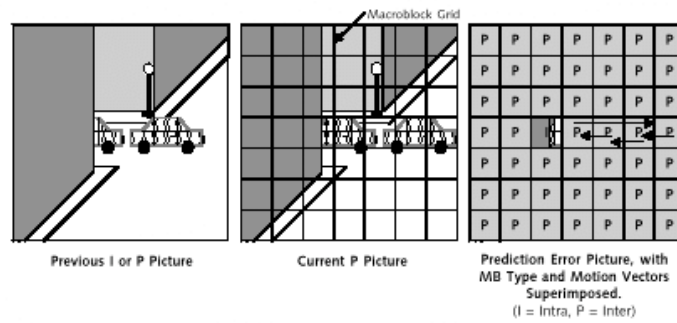


Video Compression

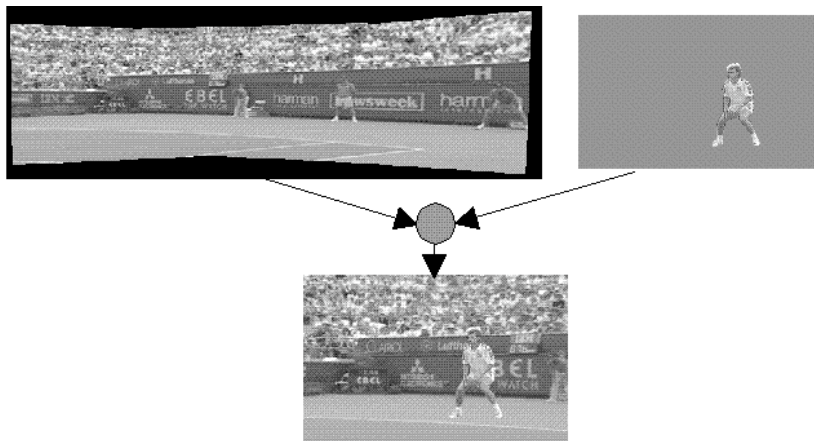
Example

Example of Forward Motion Estimation

For Best Coding Efficiency, Prediction Error should have low energy.



Sprite



Tracking

Tracking & Object Detection In Single Camera

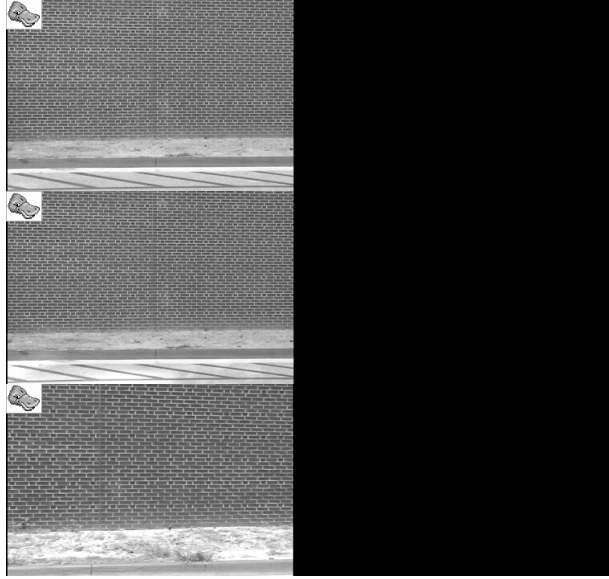


Motion Recognition

Activities



Detecting Violence

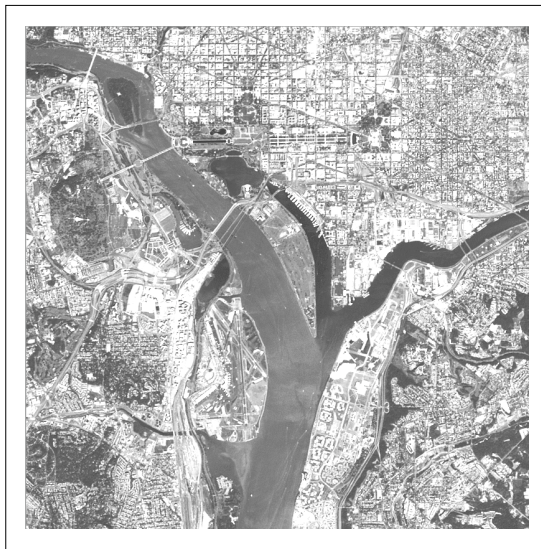


Video Registration

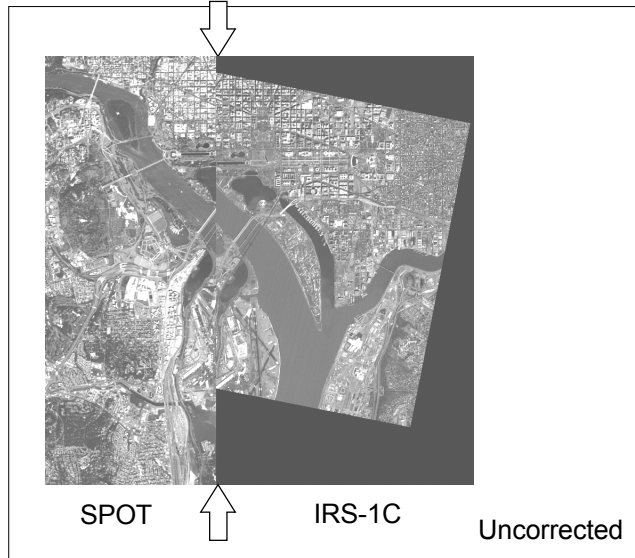
IRS-1C - Washington, DC



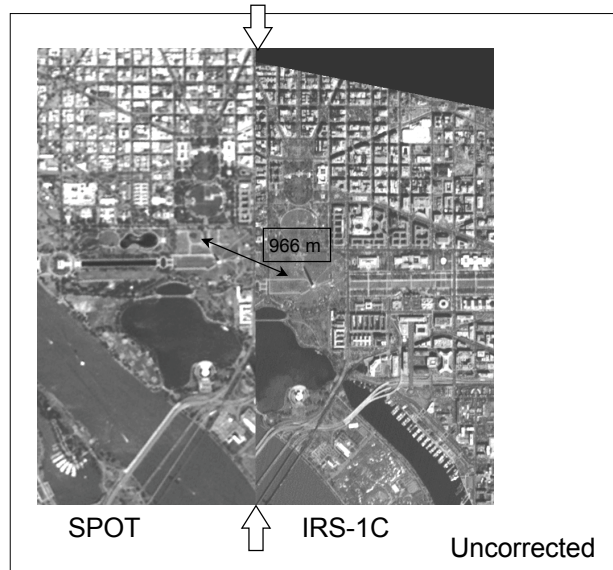
SPOT - Washington, DC



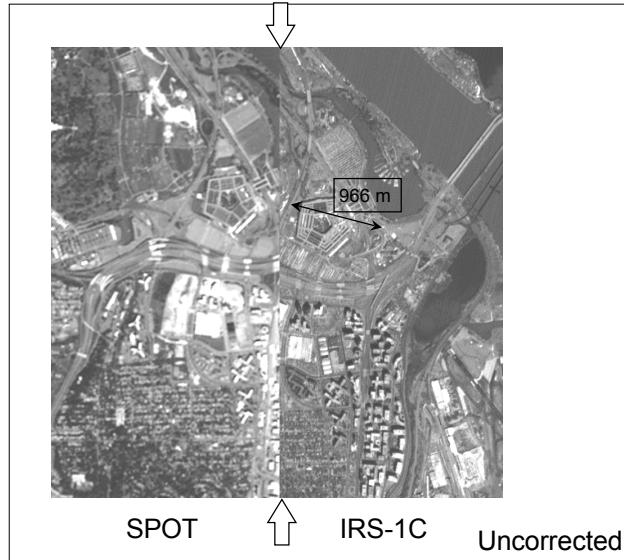
SPOT/IRS-1C Uncorrected



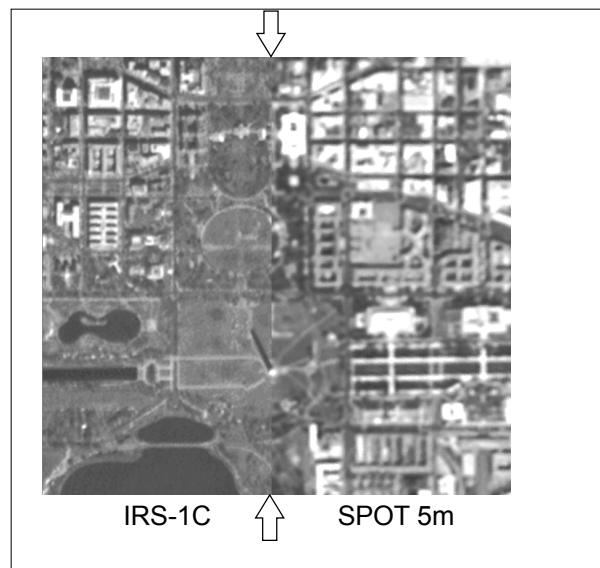
SPOT/IRS-1C Uncorrected



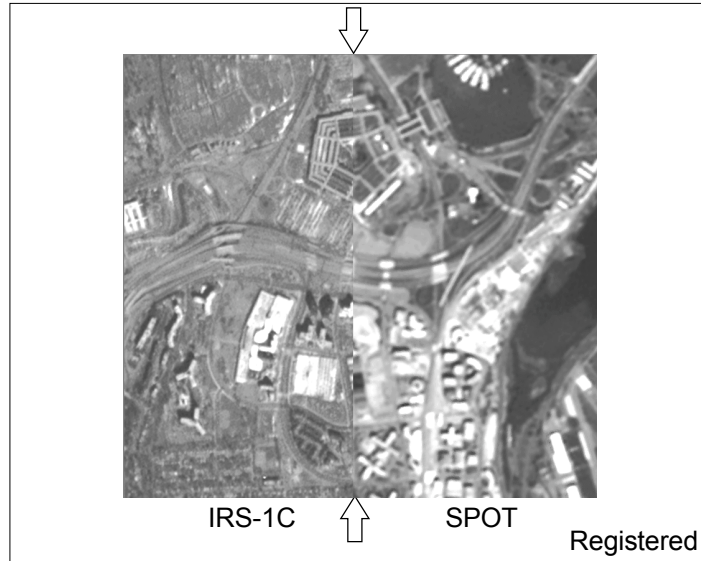
SPOT/IRS-1C Uncorrected



IRS-1C/SPOT Registered



Registered IRS-1C to SPOT



Video Segmentation





Image Processing

- Filtering
- Compression
 - MPEG-1
 - MPEG-2
 - MPEG-4
 - MPEG-7 (Multimedia Content Description Interface)

Databases

- Storage
- Retrieval
- Video on demand
- Browsing
 - skim
 - abstract
 - key frames
 - mosaics

Networking

- Transmission
- ATM

Computer Graphics

- Visualization
- Image-based Rendering and Modeling
- Augmented Reality

Contents

1. Introduction
2. Motion models
3. Computing 2-D motion
4. Computing 3-D motion and depth
5. Video tracking
6. Video segmentation
7. Video mosaics
8. Visual gesture recognition
9. Visual lipreading
10. Facial expression recognition
11. Human activity recognition
12. Video compression
13. Tools

Contents

1. Introduction
2. Motion models
 1. 3D Rigid Motion Model
 2. Image Projection Models
 1. Perspective Projection
 2. Orthographic Projection
 3. Image Motion Models
 4. Relationship between Image Motion 3D Rigid Motion
3. Computing Image motion
 1. Computing Local Motion
 1. Horn and Schunck Optical Flow Method
 2. Lucas and Kanade
 2. Computing Global Motion
 1. Anandan
 2. Szeliski
 3. Mann and Piccard
 3. Correlation
 1. Motion Compensation

Detailed Contents

1. Computing 3-D motion and depth
 1. Tomassi and Kanade
 2. Heeger and Jepson
2. Video tracking
 1. Change Detection
 1. Generating Background Model
 2. Pfinder
 3. Mixture of Gaussian
 4. W4
 5. Kanade
 6. Color based tracking
 7. Skin Detection
 8. Correlation

Detailed Contents

1. Generating Trajectories
 1. Token Detection
 1. Moaravec's Interest Operator
 2. Lucaas Kanade Operator
 2. Motion Correspondence
 3. Kalman filter for motion correspondence

Detailed Contents

1. Video mosaics
 1. Introduction
 2. Projection surfaces
 1. Plane
 2. Sphere
 3. Cylinder
 3. Static Mosaic
 4. Synopsis Mosaic
2. Visual gesture recognition
 1. Jim
 2. Andrew
 3. Pentland
3. Visual lipreading
 1. Shawn

Detailed Contents

1. Facial expression recognition
 1. Yacoob and Black
2. Human activity recognition
 1. Polana and Nelson
 2. Jim
 3. Model-based Activity Recognition
3. Video compression
 1. Brief Introduction to JPEG
 2. Brief Introduction to MPEG-1
 3. Brief Introduction to MPEG-2
 4. Model-based Compression
 1. Video phones
 2. Szeliski
 3. Making faces
 5. MPEG-4
 6. MPEG-7

Detailed Contents

1. Tools
 1. Pyramids
 2. Interpolation
 3. Color Science
 4. Image Warping
 5. Kalman filter
 6. Hidden Markov Models
 7. Finite State Machine
 8. Dynamic Time Warping