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.

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
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

\[ \Box = 4 \]

Horn-Schunck
Image from Hamburg Taxi seq

optical flow
Lucas-Kanade with Pyramids
Optical Flow
Video Compression
Example

Example of Forward Motion Estimation
For best coding efficiency, prediction error should have low energy.

![Diagram showing previous and current picture blocks with prediction error]

Sprite

![Sprite representation with examples of motion and transformation]
Tracking

Tracking & Object Detection In Single Camera
Motion Recognition

Activities
Detecting Violence

Video Registration
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. Lucas 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