Course Projects

Class 4. 8 Sep 2010
Administrivia

- Homework questions?
  - Pls. post on google group
Course Projects

- Covers 50% of your grade
- 10-12 weeks
- Required:
  - A seriously attempted project
  - Demo if possible
  - Project report
  - Poster presented in poster session

- Project complexity
  - Depends on what you choose to do
  - Complexity of project will be considered in grading
  - Projects can range from researchy to implementation of existing techniques
    - In the latter case, the implementation is important
Course Projects

- Projects will be done by teams of students
  - Ideal team size: 3
  - Find yourself a team
  - If you wish to work alone, that is OK
    - But we will not require less of you for this
  - If you cannot find a team by yourselves, you will be assigned to a team
  - Teams will be listed on the website
  - All currently registered students will be put in a team eventually

- Will require background reading and literature survey
  - Learn about the the problem

- Grading will be done by team
  - Team members will grade one another
    - Final grade is combination of two
Projects

- A list of possible projects will be presented to you in the rest of this lecture
- This is just a sampling
- You may work on one of the proposed projects, or one that you come up with yourselves

Teams must inform us of their choice of project by 20th September 2010

- The later you start, the less time you will have to work on the project
Projects from last year

- Unsupervised face clustering in video
- Multi-rate Event Detection for Energy-Aware Green Design Facilities: Techniques to improve event detection in nonintrusive systems
- De-identification of speech
- Emotion recognition and synthesis in speech
- Rehearsal audio stream segmentation and clustering
- Personalization of head-related transfer functions from a limited number of acoustic measurements
- Source separation with character matching
- Non-intrusive load monitoring
Projects from last year

- Dynamic foreground/background extraction based on segmented image
- Support vector correlation filters
- Robust image logo removal
- Music information retrieval
- Talk-along Karaoke
- Song retrieval systems using HMMs
- Damage recognition for structural health monitoring
Projects

- Projects range from simple to very difficult
  - Important to work in teams

- Guest lecturers with project ideas
  - Ajay Divakaran (Sarnoff)
  - Mark Reilly (Deputy Coroner, Fayette)
  - Rita Singh (LTI)
  - John McDonough (LTI)
  - Marcel Bergerman (RI)
  - Narges Memarsadeghi (NASA)
    - Not presenting

- Important: Be realistic
  - Partially completed projects will still get grades *IF*:
    - The work performed is a serious attempt at completing it
  - Remember – grading uses peer review
Enabling Appliance-Specific Energy Feedback in Residential Buildings

Mario Berges – Carnegie Mellon University

Problem

- Electricity conservation efforts benefit from having detailed information.
- Tracking individual appliance consumption is currently hardware and labor intensive, thus expensive.

Proposed Approach

- Single measurement point (main electrical feed).
- Non-intrusive load disaggregation/monitoring
- Machine Learning/Signal Processing techniques

Possible Applications

- Automated detailed feedback to homeowners
- Leveraging social networks and disaggregated information for behavior modification
NASA’s Encompass Project

- Supervisors/Collaborators: Nargess Memarsadeghi (NASA), Fernando de La Torre (RI), Bhiksha Raj (LTI), Rita Singh (LTI)
- “The project consists of several computational case studies based on NASA science applications on Earth Sciences, Planetary Sciences and Astrophysics”
  - Collaborative with Universities
  - MLSP 11755/18797 one of three official partners in program
EnCompass: Case studies

- [http://encompass.gsfc.nasa.gov/cases.html](http://encompass.gsfc.nasa.gov/cases.html)

- SAR Data Processing: Slant to Ground Range Conversion
  - Characterizing Radar resolution as a function of angle

- Characterizing Moving Particles
  - Analyzing particle image velocimeter images
EnCompass: Case studies

- Light a Single Candle: Studying Supernovae
  - Analyzing luminiscence and particle beams from supernovae

- Hyperspectral Data Processing: Cryospheric Change Detection
  - Using hyperspectral satellite images for analyzing cold regions of the earth

- Where is My Moon?
  - Searching telescope images for planets/satellites
Encompass

- A single project must
  - a) Complete at least 3 case studies
  - b) Analyze problem and propose means of quantification of results
  - c) Identify interesting questions/problems not already covered by case studies
    - And make an attempt at answering them
The Doppler Effect

- The observed frequency of a moving sound source differs from the emitted frequency when the source and observer are moving relative to each other.
  - Discovery attributed to Christian Doppler (1803-1853)

Person being approached by a police car hears a higher frequency than a person from whom the car is moving away.
Example of Doppler effect

- Spectrogram of the horn from a speeding car
  - Informs you about the *velocity* of the car
  - Informs you about the distance of the car from the mic
Problem

- Analyze audio from speeding automobiles to detect velocity
  - Using the Doppler effect
- Find the frequency shift and track velocity/position
- Supervisor: Dr. Rita Singh
Pitch Tracking

- Frequency-shift-invariant latent variable analysis
- Combined with Kalman filtering
- Estimate the velocity of *multiple* cars at the same time
Seam carving for word spotting (Rita Singh)

- Seams in spectrograms: Word specific
- Characterize seams to recognize/detect words
  - Combine with conventional methods for improved performance
Song lyric recognition (Rita Singh)

- Recognize the lyrics in songs
- Not like conventional automatic speech recognition
  - Stylized voices
  - Mispronunciations
  - Overlaid music
- Can assume any framework
  - E.g. select lyric from a collection of lyrics
  - Know words, but not lyrics
  - Etc.
Dereverberation

Sound recorded in an Auditorium

Dereverberated (with artifacts)

- Develop a *supervised* technique that can dereverberate a noisy signal
  - Knows what is spoken, and has prior information about speaker
  - Will work with artificially reverberated data

- Issues:
  - Modeling the data
  - Learning parameters
  - Overcomplete representations
Geolocation

Different places sound different

Question: What can we say about a location’s geography or location based on sound

- E.g. It's in a high-traffic area
- Near the sea
- A windy place
- “Sounds like Chicago..”
A Strange Observation

A trend

The pitch of female Indian playback singers is on an ever-increasing trajectory

Mean pitch values: 278Hz, 410Hz, 580Hz
I’m not the only one to find the high-pitched stuff annoying

- Sarah McDonald (Holy Cow): “.. shrieking…”
- Khazana.com: “.. female Indian movie playback singers who can produce ultra high frequencies which only dogs can hear clearly..”
- www.roadjunky.com: “.. High pitched female singers doing their best to sound like they were seven years old ..”
A Disturbing Observation

- A trend

The pitch of female Indian playback singers is on an ever-increasing trajectory

![Graph showing pitch over time]

- Mean pitch values: 278Hz, 410Hz, 580Hz

Average Female Talking Pitch

Glass Shatters

Shamshad Begum, Patanga
Peak 310 Hz

Lata Mangeshkar, Anupama
Peak: 570 Hz

Alka Yangnik, Dil Ka Rishta
Peak: 740 Hz
Subjectivity of Taste

- High pitched female voices can often sound unpleasant

- Yet these songs are very popular in India
  - Subjectivity of taste

- The melodies are often very good, in spite of the high singing pitch
“Personalizing” the Song

- Retain the melody, but modify the pitch
  - To something that one finds pleasant
  - The choice of “pleasant” pitch is personal, hence “personalization”

- Must be able to separate the vocals from the background music
  - Music and vocals are mixed in most recordings
  - Must modify the pitch without messing the music

- Separation need not be perfect
  - Must only be sufficient to enable pitch modification of vocals
  - Pitch modification is tolerant of low-level artifacts
    - For octave level pitch modification artifacts can be undetectable.
Separation example

Dayya Dayya original (only vocalized regions)

Dayya Dayya separated music

Dayya Dayya separated vocals
Some examples

- Example 1: Vocals shifted down by 4 semitones
Some examples

- Example 1: Vocals shifted down by 4 semitones
- Example 2: Gender of singer partially modified
Song “Personalizer”

- Modify vocals as desired
  - Mono or Stereo
  - “Knob” control to modify pitch of vocals

- Given a song
  - Separate music and song
  - Modify pitch as required
  - Adjust parameters for minimal artifacts
  - Add..

- Issues:
  - Separation
  - Modification
  - Use of appropriate statistical model and signal processing
Recognizing Gender of a Face

- A tough problem
- Similar to face recognition
- How can we detect the gender of a face from the picture?
  - Even humans are bad at this
Image Manipulation: Filling in

- Some objects are often occluded by other objects in an image
- Goal: Search a database of images to find the one that best fills in the occluded region
Image Manipulation: Filling in

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Image Manipulation: Modifying images

- Moving objects around
  - “Patch transforms”, Cho, Butman, Avidan and Freeman
  - Markov Random Fields with complicated a priori probability models
Applications – Subject reorganization

Input image
Applications – Subject reorganization

User input
Applications – Subject reorganization

Output with corresponding seams
Applications – Subject reorganization

Output image after Poisson blending
Structure from Motion:
- Given several images of the same person under different pose changes build a 3D face model.
Image Composition

- Solving for correspondence across viewpoint:
  - Given several faces images of the same person across different pose, expression and illumination conditions solve for the correspondence across facial features.
  - The frontal image will be labeled with 66 landmarks.

- Similar to patch models
  - Finding correspondences that match