Digital Video Systems
ECE 634
Introduction: 1/10/17

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Outline

- Course contents; syllabus
- Applications
- Project ideas

- Check the web-site often

  http://engineering.purdue.edu/~reibman/ece634/index.html

Tell me about yourself

- Name
- Year; Masters or PhD program
- Advisor + area of emphasis
- Research topic
- Programming languages (Matlab, C/C++, Python,…)
- Courses taken (among ECE 637, 638, 641, 642, 624, 661; CS 334)

A little bit about me

- PhD in EE from Duke University
  - Distributed signal detection
- Assistant Professor Princeton University
  - Video compression for packet networks
- 23 years at AT&T Labs – Research
  - Video transmission
  - Video quality
- Full Professor at Purdue University since 2015
  - And also video analytics

Relationship to other ECE courses

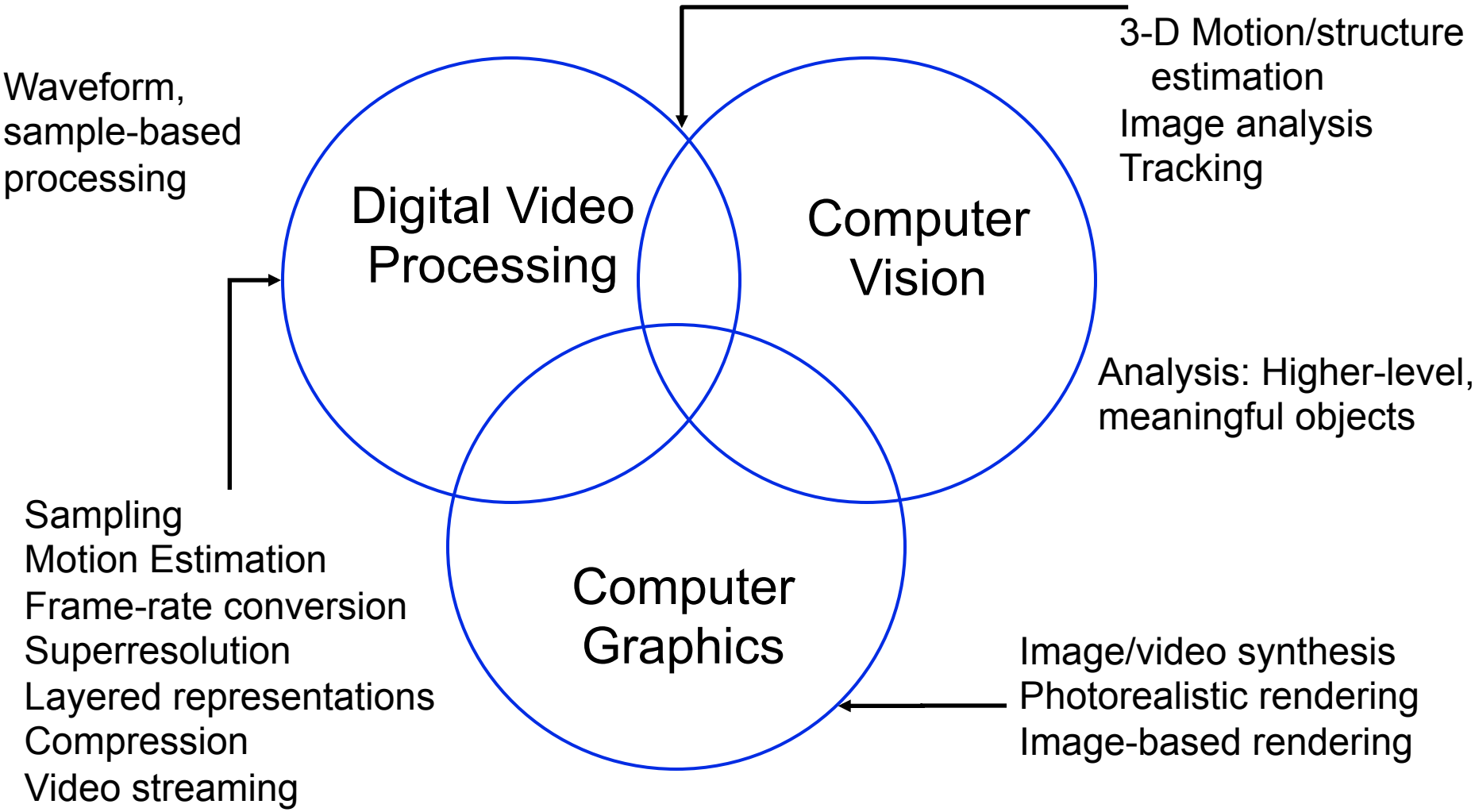
- ECE 637: Digital Image Processing 1
- ECE 638: Principles of Digital Color Imaging Systems
- ECE 641: Digital Image Processing 2
- ECE 642: Information theory and source coding
- ECE 661: Computer vision
- ECE 624: Multimedia systems

- CS 334: Fundamentals of Computer Graphics

This course

- Motion models, estimation, and tracking
- Video compression (theory and practice)
- Video transport (error resilience; scalable coding)
- Stereo, 3D video, lightfields and beyond
- Video quality and how we see
- Video enhancement, stabilization
- Scene understanding and video analytics

Other relationships



Grading

- 40% Programming assignments (5-6)
- 30% Project
- 30% Exam “mid-term”

Programming assignments (TBD)

- Understanding correlations inside video
- Block-based motion estimation
- Vector quantization
- Transform coding
- Stereo
- Wavelets
- Tracking
- Background estimation
- Stabilization
- Action analytics

Reading material

- No required book
- Y. Wang, J. Ostermann, and Y. Q. Zhang, *Video Processing and Communications,* Prentice Hall, 2002.
- A. M. Tekalp, *Digital Video Processing,* Prentice Hall (First edition 1995 or second edition 2015).
- A. C. Bovik (ed.), *The Essential Guide to Video Processing,* Elsevier 2009.
- R. Szeliski, *Computer Vision: Algorithms and Applications*, 2010 (available on-line http://szeliski.org/Book)
- Additional reading material posted as we go

Applications of digital video

- Entertainment
- Education
- Interactive communication
- Memorabilia, life-logging
- Medical and Scientific Imaging
- Information extraction
  - Surveillance, scene understanding

Applications of digital video

- Entertainment
  - Personal video devices, e.g., your smart-phone
  - Digital Cinema and 3D Cinema
  - Digital Television (Cable, satellite, terrestrial over-the-air broadcast)
  - Streaming over the Internet, and cellular (Hulu, YouTube, Netflix)
  - Video storage (e.g., DVD, HD-DVD, Blu-ray)

Technology to support entertainment

- Compression, streaming delivery
- Coping with things that go wrong
  - Congestion, packet loss, production errors
- Preserving income
  - Video copy detection for ad verification
  - Fingerprinting to protect against infringement
  - Quality monitoring to ensure high-quality delivery happened

Applications of Digital video

- Interactive communications
  - Skype, ooVoo, FaceTime, Polycom, HP
  - SIP-based video communications
  - HTML5, talky.io

Technology to support communication

- Compression
- Coping with things that go wrong
  - Congestion, packet loss
- Interactivity

Information extraction: Applications

- Human-computer interaction
  - Gesture recognition
- Surveillance
  - Anomaly detection, crowd behavior, person tracking and re-identification
- Elder care
  - Fall detection; detecting long, slow cognitive decays
- Retail markets
  - Multimedia search and retrieval
- Intelligent vehicle systems
  - Pedestrian detection and anticipation; wrong-way detections; lane estimation

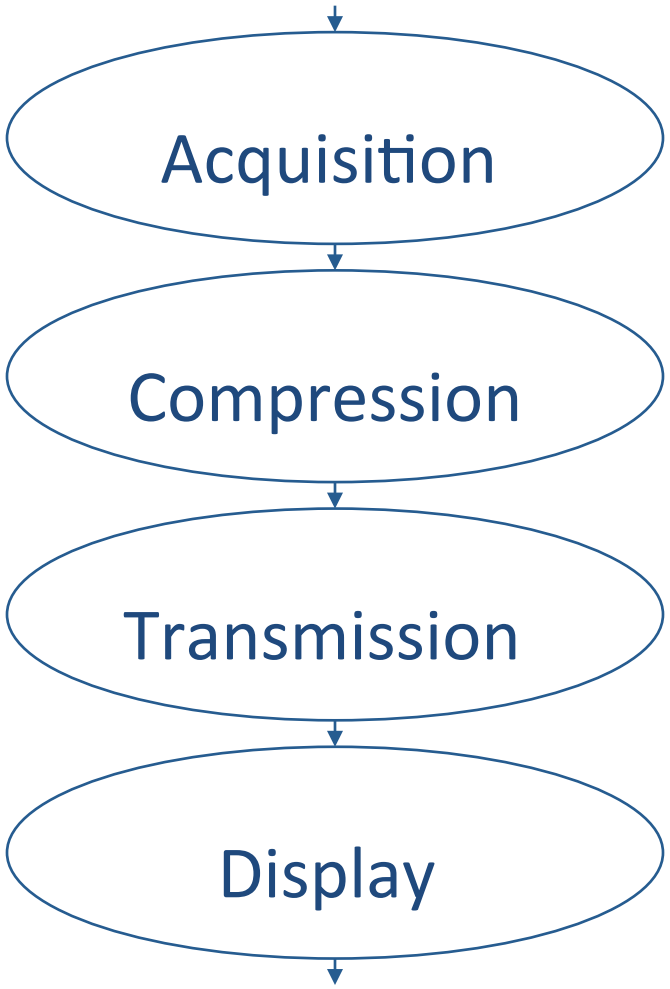
Information extraction: Approaches

- Identification:
  - Object detection
  - Background subtraction
  - Object tracking
- Interpretation:
  - Recognition of actions, activities, objects, events, facial expressions, ..
  - Scene understanding, Indoor/outdoor
- Lower-level: feature extraction
- Higher-level: Behavior analysis

Example: Surveillance and Entertain-news

- Security camera: colorlessness; jerkiness; blurriness
- Stored on disk: blockiness
- Played back on a monitor
- Recorded using another camera: (repurposed)
- Compressed and sent over Cable TV: blockiness
- Acquired by Hauppauge TV tuner: noise
- Compressed and stored: blockiness
- Sent to viewer over LAN: jerkiness
- Displayed on viewer's laptop

Image and video processing chain



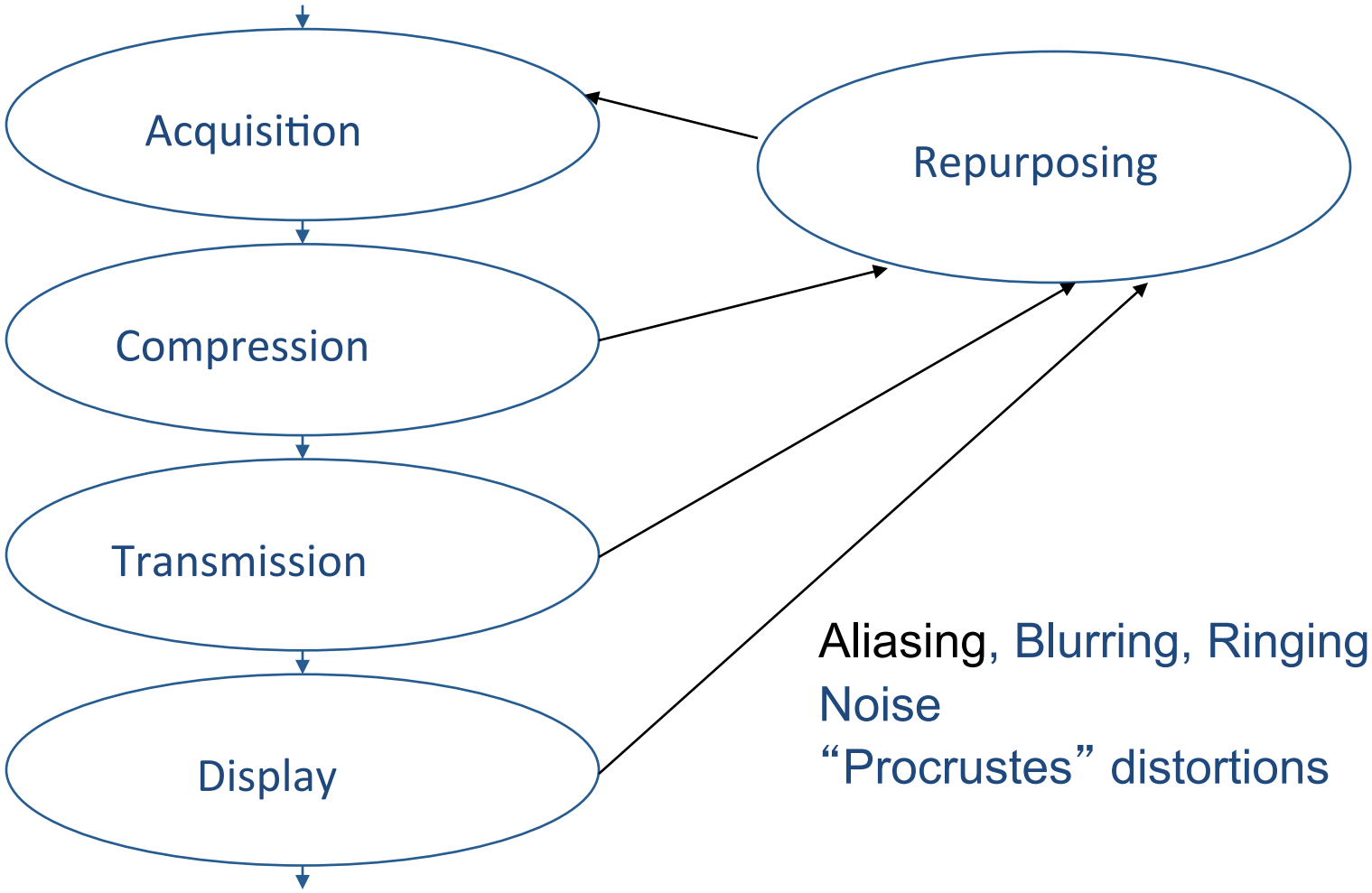
Aliasing, Blurring, Ringing
Noise, Contouring, Distortions

Blocking/Tiling, MC Edges
Aliasing, Blurring, Ringing
Flicker, jerkiness

Noise; jerkiness; blackout
Packet loss, macroblocking

Aliasing, Blurring, Ringing
Color, contrast artifacts
Interlacing, overscan

Image and video processing chain



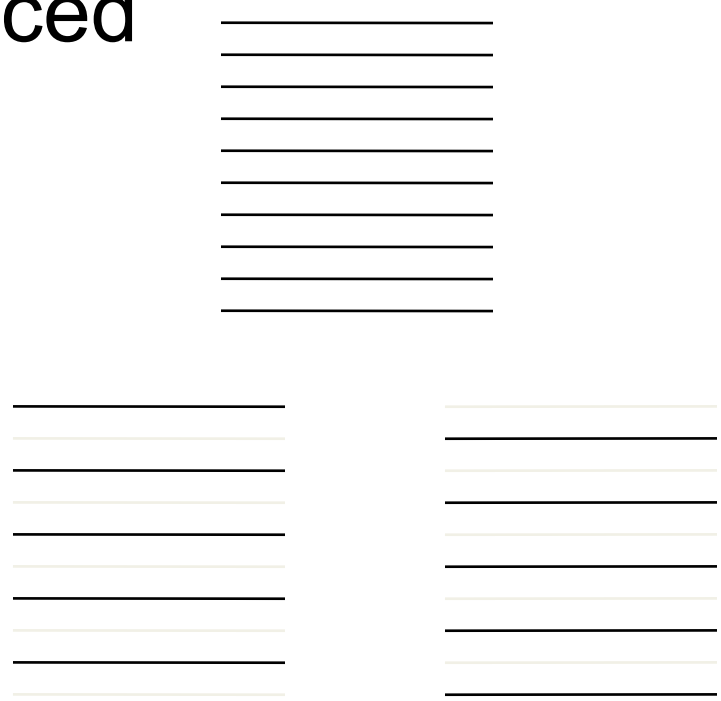
Super-resolution/Enhancement

What can go wrong?

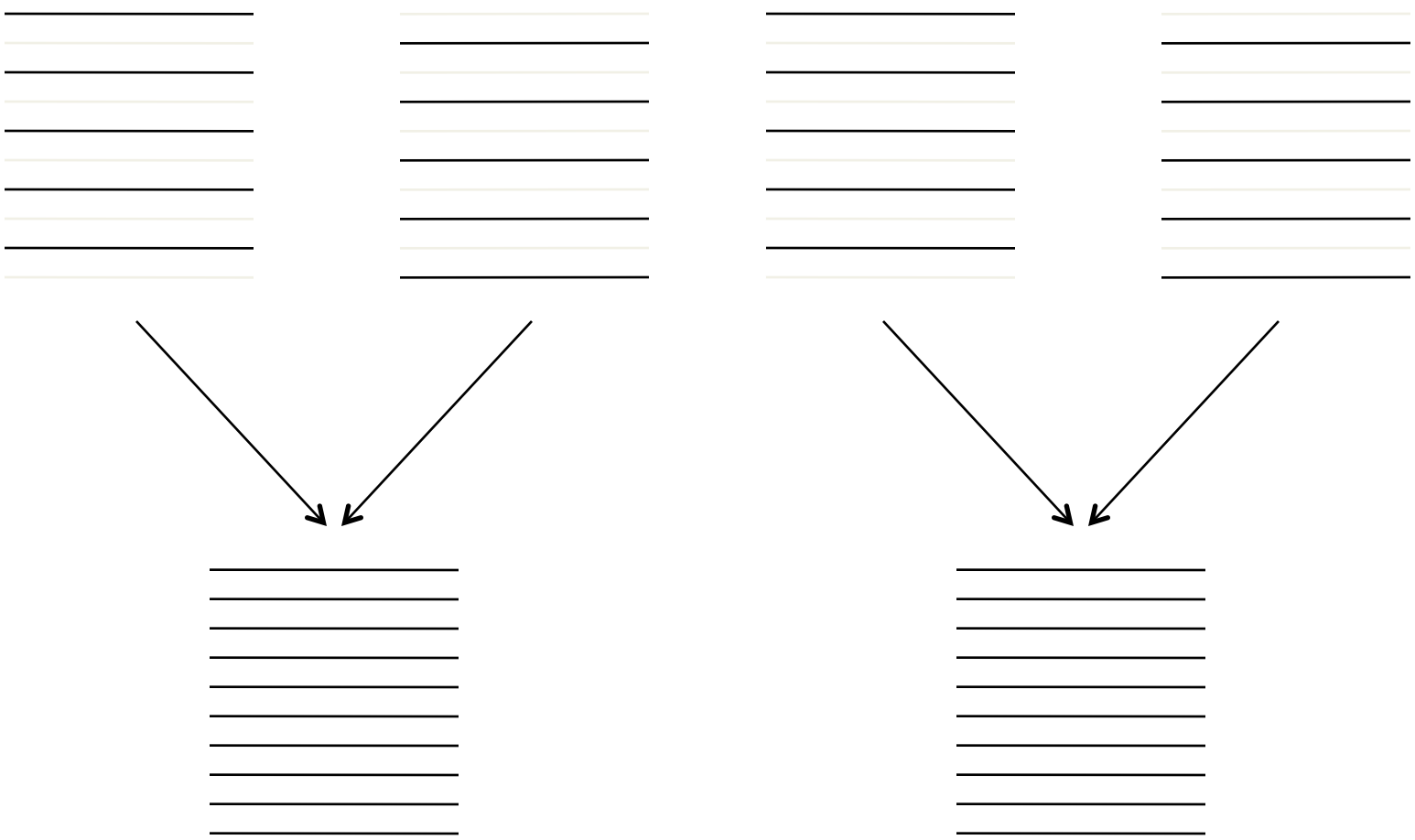
Interlacing

Interlacing

- (Almost) all Standard Definition video is interlaced



Interlaced video



Interlaced video