

## **ENG EC520: Digital Image Processing and Communications**

### **2008-2009 Catalog Data:**

Digital Image Processing and Communication Prerequisites: ENG EC 381 and ENG EC 416 or equivalents. Review of signals and systems in multiple dimensions. Sampling of still images. Quantization of image intensities. Human visual system. Image color spaces. Image models and transformations. Image enhancement and restoration. Image analysis. Image compression fundamentals. Image compression standards (JPEG, JPEG-2000). Homework will include MATLAB assignments. 4 cr.

### **Class/Lab Schedule:**

Lecture: 4 hours/week, Lab: self-directed within homework

**Status in the Curriculum:** Elective

### **Textbooks and other required materials:**

J.W. Woods, "Multidimensional Signal, Image and Video Processing", Academic Press 2006

### **References:**

A. Jain, "Fundamentals of Digital Image Processing", Prentice Hall

A. Bovik Ed., "Handbook of Image and Video Processing", Academic Press, 2005 (2<sup>nd</sup> edition)

### **Coordinator:**

Janusz Konrad, Professor, ECE Department

### **Prerequisites by topic:**

ENG EC381 (probability)  
ENG EC416 (digital signal processing)  
or equivalents

### **Goals:**

- Thorough understanding of the theoretical underpinnings of digital image processing and compression
- Extensive experience in the design, implementation and testing of various image processing and compression algorithm

### **Course Outcomes:**

- 1) *Understand* how images are formed, sampled, quantized and represented digitally.
- 2) *Understand* how image are processed by discrete, linear, time-invariant systems
- 3) *Understand* how images are perceived by humans
- 4) *Understand* how color is represented
- 5) *Understand* how image information can be modeled analytically
- 6) *Understand* transform-domain representation of images (Fourier, DCT, Haar, WHT)
- 7) *Understand* how images are enhanced to improve subjective perception
- 8) *Understand* how images are restored based on the knowledge of acquisition system
- 9) *Understand* how image are analyzed to extract features of interest
- 10) *Understand* the principles of image compression
- 11) *Design* FIR filters for optimal image down- and up-sampling
- 12) *Design* median filters for image enhancement
- 13) *Implement and test* FIR and median filters.
- 14) *Implement and test* optimal linear image predictors
- 15) *Implement and test* Markov random field image model
- 16) *Implement and test* scalar luminance quantization
- 17) *Implement and test* image down- and up-conversion.
- 18) *Discover* practical color spaces used in video transmission using the internet

- 19) *Discover* practical applications of image processing in daily live using the internet
- 20) Complete a project, *write report and present in class* on a topic in image processing
- 21) *Assess the societal impact* of image processing *and the engineer's responsibilities* in this regard.

**Course Outcomes mapped to Program Outcomes:**

|                  |      |       |       |    |      |    |    |    |       |    |       |
|------------------|------|-------|-------|----|------|----|----|----|-------|----|-------|
| <b>Program:</b>  | a    | B     | c     | d  | e    | f  | g  | h  | i     | j  | k     |
| <b>Course:</b>   | 1-10 | 13-17 | 11-12 | 20 | 1-10 | 21 | 20 | 21 | 18-19 | 21 | 13-17 |
| <b>Emphasis:</b> | 5    | 5     | 4     | 2  | 5    | 2  | 3  | 2  | 2     | 1  | 4     |

1=not at all; 5=a great deal;

**A:** Understanding- (laws and principles), **B:** Laboratory – design & conduct experiments,  
**C:** Design, **D:** Collaboration, **E:** Understanding-(problem solving),  
**F:** Educational Breadth- (professional and ethical responsibility), **G:** Communication,  
**H:** Educational Breadth- (technology and society), **I:** Discovery  
**J:** Educational Breadth- (contemporary issues), **K:** Laboratory – tool use, **M:** Integrated View,

**Topics: Lectures**

Overview of applications, current and future challenges  
 2-D signals, 2-D linear shift-invariant systems, 2-D Fourier transform  
 Image sampling, quantization, color representation  
 Human visual system  
 2-D image models, image bases and transforms  
 Sampling grid conversion  
 Intensity and color transformation  
 Image smoothing and sharpening  
 Image restoration  
 Edge detection and boundary extraction, image segmentation  
 Fundamentals of entropy coding (lossless compression)  
 Fundamentals of rate-distortion theory (lossy compression)  
 Still image compression (including basics of JPEG and JPEG-2000),  
 Elements of video compression

**Project Assignments:**

Still-image copy detection  
 Discovery of camera network topology  
 Moving vehicle classification  
 Content-aware image decimation  
 Bayer array demosaicking  
 Crab counter  
 Outlier color classification for search and rescue  
 Red-eye detection and correction

**Contribution of Course to Meeting the Professional Component:**

Engineering topics: 80%  
 Math & Basic Science: 15%  
 General Education: 5%

**Status of Continuous Improvement Review of this Course:**

**Date Last Reviewed:** Fall 2001

**Reviewed by:** ECE Graduate Committee

**Prepared by:** Janusz Konrad, Associate Professor

**Date:** Sep. 2, 2008