



Lahore University of Management Sciences

EE 573/CS 652 Image and Video Coding

Fall 2023-24

Course Catalog Description

Image and Video data and its processing is the backbone of many current and emerging technologies including IOT, Driverless Cars, Robotics, Augmented reality, Industrial Vision, Drones, Multimedia Systems, Security systems, Medical systems, and Video Communication Systems. The resolution and quality of this data is increasing and giving rise to High Dynamic range and Ultra High Definition Images and Videos. As the data is huge it is present in encoded and compressed form. Hence any designer/developer/researcher needs to understand its principles and standards to effectively work on the aforementioned technologies in real-life. Even development of efficient Data analytics and data mining techniques is possible if one knows the nature and format of the incoming data (without wasting energy and computation to convert it to raw formats).

After reviewing some basics of knowledge of digital images and videos, this course is meant to familiarize students with the principles and standards of coded image and video available in today's world and to enable them to appreciate and understand the ongoing research in this area include neural/deep learning (non-conventional) approaches. Assignments/ Home work & Project will be geared towards this goal.

Basic background in Computer programming is expected for joining this class. Background in Signal and systems/ Digital Signal Processing, Digital Image Processing/Computer Vision is helpful but will also be built in the course to the extent required.

Course Basics

Credit Hours	3			
Lecture(s):	Nbr of Lec(s) Per Week	2	Duration	75 min
Recitation/Lab (per week):	Nbr of Lec(s) Per Week	on announcement	Duration	
Tutorial (per week):	Nbr of Lec(s) Per Week	on announcement	Duration	

Course Distribution

Core	
Elective	Elective course for EE/CS/undergraduate and graduate students
Open for Student Category	EE/CS Senior Students; EE/CS Graduate Students; EE/CS Junior
Close for Student Category	Freshman, Sophomore

COURSE PREREQUISITE(S)

<ul style="list-style-type: none">•••	EE/CS Graduate level standing OR EE/CS Senior level standing Some programming knowledge/experience (like Matlab, C, C++ and/or Python etc.) required Prior course from Signal and image processing stream and/or Computer Vision is helpful but not necessary
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Instructor	Nadeem Ahmad Khan
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Secretary/TA	TBA



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TA Office Hours	
Course URL (if any)	Course website on LMS

COURSE OBJECTIVES	
<ul style="list-style-type: none">•	<p>Familiarize the students with the theory and standards of image and video compression/coding starting from its foundation and leading them to a point where they can understand the ongoing latest developments.</p> <p>Conduct research in this area regarding nonconventional approaches (neural and deep learning) methods and emerging tools and standards</p>

COURSE OVERVIEW			
Week/ Lecture/ Module	Topics	Reading Material	Learning objectives / mode
Module 1: Introduction to Digital Image & Video Data			
Session 1-2	<p>Introduction Introduction and history of Image and Video Coding Standards, Course outline and policy</p> <p>Digital Video Basics Analog and digital video, Color models: RGB, YUV, Digital Image formats, Assessment of picture quality</p>	Book/Handouts	<p>Provides orientation to students about course structure</p> <p>Review basic concepts of digital images and video that are used subsequently</p> <p>Learning mode: Taught classes</p>
Module 2: Principles of Digital Image & Video compression			
Session 3-8	<p>Spatial redundancy reduction (Predictive coding, DCT coding, Wavelet coding), Quantization,</p> <p>Temporal redundancy reduction (Motion estimation, Block matching algorithms) Fast Motion Estimation Algorithms</p> <p>Variable length coding (Huffman coding, arithmetic coding)</p> <p>Video codec: General outline</p>	Book/Handouts	<p>Explains the building blocks of a modern compression/coding engine used in standards</p> <p>Learning mode: Taught classes</p>



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Module 3: Designing of Standards and Evolution of Tools

Session 9-17	<p>Overview of the structure of coded images and Video (JPEG, H.261, MPEG-1, MPEG-2, MPEG-4 standards)</p> <p>Evolution of standardized tools: Entropy Coding, Motion Compensation, Loop filtering, Rate Control, Scalability, Object Coding, Error Resilience, Multi-view video</p> <p>Midterm Exam</p>	Book/Handouts	<p>Familiarizes the student with the requirements, format and tools in practical modern standards</p> <p>Learning mode: Taught classes</p>
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Module 4: Recent Standards of Coded Digital Video

Session 18-22	<p>Video Coding Standards: H.264 & SVC HEVC Versatile Video Coding (VVC, FVC)</p>	Review papers from journals	<p>Overview of tools and structure of the most recent Coded Video and Image standards</p> <p>Learning mode: Interactive taught classes</p>
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Module 7: Recent Trends in Digital Video- Guided research work

Session 23-28	<p>Research topic examples:</p> <p>Deep Learning approaches towards Video compression (Learned Image Compression, End-to-End trained, auto-encoder based schemes)</p> <p>HDR (High Dynamic Range) Images and Video</p> <p>New tools for Upcoming & Emerging Standards</p> <p>8-K & Super-Resolution Video</p> <p>Medical Images</p> <p>360 degree video for Immersive & Augmented reality</p>	<p>Assigned & selected research papers</p> <p>Group project on a chosen topic of interest under Instructor guidance</p>	<p>Students are required to study and present literature on a selected topic with Instructor guidance</p> <p>Write a research paper/review paper based on guided research work in the same area.</p> <p>Learning mode: Guided research work</p>
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Prepared by:	Nadeem Ahmad Khan
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