Multimedia and Video Communications
(SSY150, 7.5p)

1. Introduction

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Teachers

Lecturer and examiner: Prof. Irene Gu

Guest lecturers: Dr. Per Fröjdh, Ericsson research
Prof. Tommy Svensson, Chalmers

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Examination and Grading

1. 70% of exam grade is from 3 laboratory work + reports (20%, 22%, 28%) + group presentations.
   All laboratory work are mandatory.
2. 8% of the grade is from quiz questions from each lecture (8 in total).
3. 22% from the written exam in the end of the course (optional)

Pass with 4:
3 Labs. (20,22,28%) + quiz's (8%) + written exam
(22%, date: 2020-06-01, concepts, problems solving)
Pass:
$3 \geq 50\%,\ 4 \geq 70\%,\ 5 \geq 85\%$

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Literatures

Main course book:

Abdul H.Sadka, Compressed video communications (e-book available at Chalmers)

Other reference books:

(1) Fan Zhai and Aggelos Katsaggelos, Joint source-channel video transmission (e-book available);
(2) W.Simpson, Video over IP (e-book available)
(3) Ming-Ting Sun and Amy R. Reibman, Compressed video over networks;
(4) King N. Ngan, Chi W.Yap, Ken T.Tan, video coding for wireless communication systems;
(5) M.van der schaar, P.A.Chou, Multimedia over IP and wireless networks.
(6) L.R. Babiner, R.W. Schafer, digital processing of speech signals.

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Schedule

All lectures and tutorials will be conducted online

you may view each lecture by the corresponding ppt file where audio is embedded

Lectures (8 x 2 hrs): including 2 guest lectures.

- 24/3, 26/3, 2/4, 16/4, 23/4, 14/5; Guest lectures: 28/4, 12/5

Tutorials (3 x 2 hrs):

- 3 tutorial sessions for Lab demonstrations: 31/3, 21/4, 5/5

Labs. and project presentation:

* Deadlines for 3 lab. project reports: 17/4, 4/5, 17/5
* Deadline for upload project presentation: 18/5

Online consultation:

- Tuesdays and Thursdays: 10:00-11:30 am
  (detail information will be announced soon)

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Content

Fundamentals on:

1. **Compression and coding of multimedia signals**

* **Audio/speech signals**: modeling and compression
* **2D images**: transforms, subband filters and compression
* **Video**: motion compensation, compression and coding standards

2. **5G basics and its applications and recent advances in video compression**

3. **Transportation of compressed multimedia data through IP networks**

* IP networks, protocol stack for multimedia communications
* Erasure network modeling, packet delay, loss and protection
* Packet loss protection
* End-to-end performance optimization

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Having funs: hands-on learning through 3 laboratory work

Laboratory exercises (2 persons / group)

1. Speech/audio compression: modeling, analysis, synthesis

   dead line 2020-04-17, 23:55

2. Image and video compression

   dead line 2020-05-04 , 23:55

3. Multimedia communications over IP networks

   dead line 2020-05-17, 23:55

Late submission is subjected to a penalty (10% per day)!

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What we may learn from Lab.1:

Speech compression: LPC speech analysis, synthesis

- Record and save a sound or speech file to a computer, and then load the speech file from Matlab.
- Make a Matlab program for LPC (Linear predictive coding) analysis, then synthesis of (a) single tone sound (stationary); (b) a speech sentence (nonstationary). Listen to the resulting sound. From this, you can learn how speech compression is achieved: a block of speech signals (e.g. 10ms) only requires less than 20 parameters to characterize!
- Model the vocal cord excitations of speech by some impulses or white noise, as the input to the LPC model, and listen to the synthetic speech.
- Estimate the pitch period using the cepstrum method.

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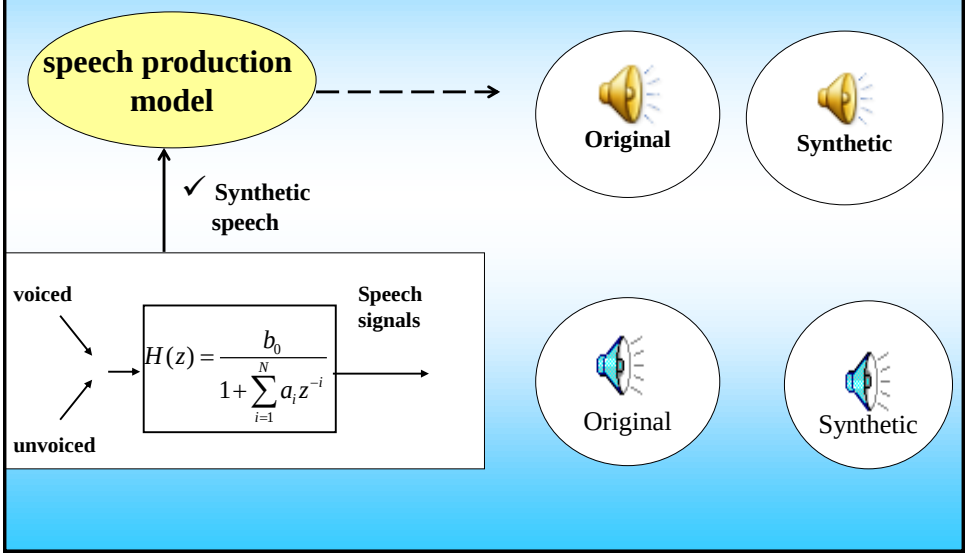
Examples of what you can achieve: Speech/audio compression and synthesis



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What we may learn from lab.2:

Image and video compression

Learn basic techniques in inter & intra modes for video compression

INTRA mode (2D image compression)

1. Block-based 2D DCT for image compression:

   Divide a *nonstationary* image into small (approx. stationary) blocks, apply compression to each DCT transformed image block.

2. 2D subband filters for image compression:

   Learn to use Matlab wavelet toolbox (under GUI): 'wavemenu', and perform this task.

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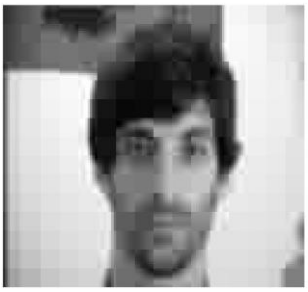
Example:
Image compression using block-based DCT

Apply: block-DCT (non-overlapping, 8x8 blocks)

Original image



Reconstructed image
(retain 4.2% coefficients)

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Example: Image compression from wavelets

(using biorthogonal spline wavelets)

Original Image

Compressed image

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INTER mode: Motion Compensation (MC)
along temporal direction (e.g between 2 frames)

1. Learn how to handle video data in Matlab
   e.g. read/save video files, play movies, extract video frames.

2. Learn how video compression is achieved by using a simple motion compensation (MC) method called "block matching".

3. Learn using some objective criteria (e.g., PSNR, SSIM) for evaluating the quality of compressed video.

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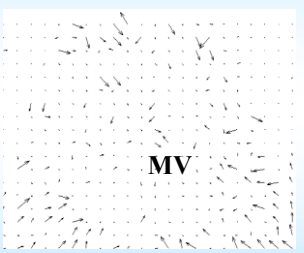
Example: inter frame motion compensation

e.g. Image 2 can be obtained by using block matching motion compensation from image1

Image 1

Image 2



Motion vectors
from optical flows

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What we may learn from Lab.3:

Multimedia data communications over IP networks

1. Building: Matlab programs for the blocks of a simple multimedia IP communication system (see the figure), using functions in the Matlab communication toolbox.

   include: image compression, zigzag scanning, scalar quantization, packetization, RS codec, matrix interleaving, and their inverse process.

2. Tests on IP networks for transporting compressed packets:

   The impact of packet losses (in the network layer) to the received image, under the erasure network model.

   The impact of bit errors (in the physical layer) to the received image.

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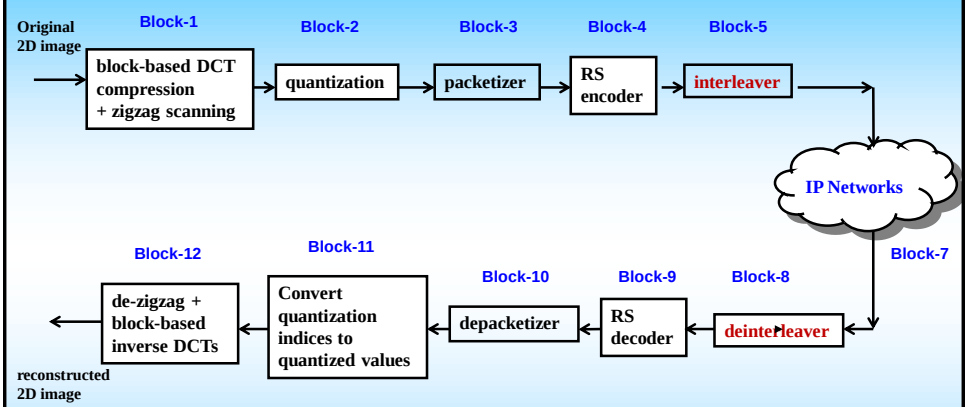

Lab 3: The block diagram of the system

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Example: Transporting compressed **video** through error prone networks

e.g. over erasure channels

20% losses, 70kbps

10% losses, 70kbps

(1 image=99 macroblocks, 1 packet = 25 macroblocks, Macroblock size= 16x16 pixels, random packet losses)

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What you need to do immediately after this lecture ?

- Form your own project group

  You are asked to form your own project group for these Labs.:

  each group consists of a maximum 2 persons.

- Register your group from the course website

  You shall register your group from the course website as soon as possible. You may start working on lab.1 after the lecture-2 on speech compression.

- Matlab Tutorial:

  You may find a simple Matlab tutorial in the course website.

- Finish the quiz problems: gain your first point from the course!

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Course Website

For details and new updates, please check the course website:

go to chalmers.se

click ’student portal’

click ’canvas’

Choose the course:

”Multimedia and video communications”

SSY150, lp4 VT20

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