Outline

› Research Topics @ Ericsson Research
› System Identification related applications at SMN
› Important issues when dealing with real-world problems
Research Topics
@ Ericsson Research

› Ericsson Research Blogg
  › http://labs.ericsson.com/research-topics/communication/blogg

› Topic Examples
  › 5G
  › Context Aware Communication
  › Data and Knowledge
  › Internet of Things
  › LTE
  › Media Coding
  › Security

– ntext aware communication
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Contextual Communication
Remote Excavation

WebRTC and Real-Time Video with an Eye on 5G

Demo at Mobile World Congress in Barcelona 2014
Remote Excavation

› Cooperation between two Ericsson Research departments
  – User Experience Lab
  – Services, Multimedia and Networks

› Technologies
  – Spatial scene capture, both video and audio
  – Spatial scene rendering, both video and audio
  – Low latency real time communication
  – Low latency remote control
System Identification Related Applications at MMT

› Audio and Speech Coding
› Audio Media Processing
  – Acoustic Echo Cancellation
  – Noise Suppression
  – Voice Activity Detection
  – Spatial Audio Capture
  – Spatial Audio Rendering
› Video Coding (2D and 3D)
› Objective Quality Estimation of Encoded Audio and Video
› Congestion Control in IP Networks
Audio and Speech Coding

- Clean speech signals can be modeled very efficiently with Code-Excited Linear Prediction (CELP) encoders (Based on ARX model of the speech signal)
- Music signals are better encoded with transform encoding methods (Subband filter banks, MDCT)
- Signal classification and hybrid encoding used to obtain efficient encoding of audio signals of varying content
- EVS (Enhanced Voice System) in the final stages of 3GPP standardization
CELP Speech Model

Fixed codebook

Fixed codebook gain

Excitation $e[n]$

Synthesis filter $1/A(z)$

Adaptive codebook

Adaptive codebook gain

$e[n-T]$

Past subframe

Delay
### EVS Speech/Audio Codec prototype HL structure

<table>
<thead>
<tr>
<th>Mode</th>
<th>Technology</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>TD</td>
<td>Improved AMR-WB technology</td>
<td>Linear Pred. + ACELP FCB variable sf.</td>
</tr>
<tr>
<td>TD-BWE</td>
<td>Parametric high band</td>
<td>Linear prediction, energy/gain</td>
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<tr>
<td>FD</td>
<td>G.719-like</td>
<td>Transform (LD-MDCT), block switching</td>
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</tbody>
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### Audio BW [kHz]

- TD: AMRWB-like, TD-BWE
- FD: G.719 like FD-coding, parametric

### Bandwidths

- WB: 4 ~ 6 kHz
- SWB: 8 kHz
- FB: 16 ~ 20 kHz
Acoustic Echo Cancellation

- Long echo impulse reponses: 300-500 msec
- At 48 kHz sampling: 14,400 – 24,000 samples
Spatial Audio Capture

› Microphone arrays
› Filter design in the spatial and frequency domains
› Beamforming techniques
› Adaptive tracking of the most active speakers in a room
Spatial Audio Rendering

› Spatial hearing
› 3D binaural rendering through Head Related Filtering (HRF)
› Very useful in 3D gaming and evolved communication solutions
› Spatial audio rendering onto any loudspeaker configuration
Spatial Hearing
Acoustic Wave Reception

The listener's median plane

Sound wave

Left Head Related Filter (HRF)

Listener

Contralateral ear

Ipsilateral ear

Length L

ITD = L/c
where c = speed of sound
Important issues when dealing with real-world problems

› Understand the strengths and weaknesses of the different identification methods

› Preprocessing the data before the optimization can be crucial

› Choose the minimization criterion with care and adapt it to the problem at hand
  – Different type of regularization components in the criterion can make the difference between success and failure
  – Sometimes a criterion having components in both the time and frequency domains will work, when single domain criterions fail.
Important issues when dealing with real-world problems

› Many systems have to deal with spurious events
  – This will require the detection of such events and special model updates when they are detected
  – Monitoring of system model
  – Hypothesis testing and estimation
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