Transcoding in Heterogeneous Communication Systems

Digitising Joint Source-Channel Coded (JSCC) Symbols

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Outline

- An introduction to transcoding in Joint Source-Channel Coding.
- Current results.
- Future work.
The BEATS Project – JSCC Part

WIRELESS MULTIMEDIA TERMINAL (transmitter)
Heterogeneous Networks

Discrete Time, Continuous Amplitude.

Discrete Time, Discrete Amplitude.

SOURCE → JSC Coder → Wireless Channel → JSC Decoder → Transport Network → Receiver

Recode to digital representation or digitise JSCC symbols
Transcoding JSCC Symbols

Alt.1 – No Transcoding

Alt.1 – With Transcoding

TRANSCODER
Shannon Mappings

• Provides bandwidth expansion or compression.
• Allow channel noise as a part of the source distortion.
• The sent channel symbols have continuous amplitude.
  ➢ Must digitise received symbols in the case of storage or further transmission on digital networks.

Possible scenarios:
• Minimise the rate given a distortion.
• Minimise the distortion given a rate.
• Minimise the delay given a rate.
Quantizing 2:1 Dimension Changing Mappings

Uniform Scalar Quantizer + Entropy Coder.

• Intuitional idea: Quantize more coarsely as the channel gets worse:

\[ \Delta_{Quant} = k \cdot \sigma_n \]
Results – 2:1 Archimedes’ Spiral

Quantizing 2:1 mapping
(Archimedes’ spiral, Gaussian source and AWGN channel)

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Results – Channel Input Distribution

- Optimal input PDF for AWGN channel is the Gaussian.
  - How much is lost when the input PDF is Laplacian?

\[ C_z = I(X;Y) \bigg|_{f_X(x) = f_Z(z)} = C_{AWGN} - k. \]
\[ I(X;Y) = h(Y) - h(Y \mid X) = h(Y) - h(N). \]
\[ h(Y) = h(Y^*) - D(f_Y(y) \parallel f_Y^*(y)). \]
\[ D(f \parallel f^*) = \ln \left( \frac{\sqrt{2\pi}\sigma_G}{2\lambda e^{1/2}} \right) \left( \frac{\sigma_Y^2}{\sigma_G^2} \right) \rightarrow \frac{1}{2} \ln \left( \frac{\pi}{e} \right) \approx 0.104 \text{bits}. \]

Using the SQ measure SNR = 6.02R - constant, ~0.6dB of the 1.1dB gap to OPTA comes from incorrect PDF.
Preliminary Results

- Analytical expressions for
  - Optimal spiral parameters. (*Optimising the wireless link only.*)
  - Optimal spiral parameters and quantization step. (*Co-optimising the wireless link and the digital representation.*)
Future Work – Short Term

- Finish analysis of 2:1 Shannon Mapping, with simulations and analytical results.
- Optimal bit distribution when operating with several different dimension changing mappings.
- Further exploration of separate optimisation of wireless link and bit-representation versus joint-optimisation of the two.
Future Work – Long Term

• Implement transcoding in the existing image coder simulator.
• Explore possibilities for transcoding from digital representation (e.g. JPEG2000) to JSCC format (i.e. downlink JSCC).