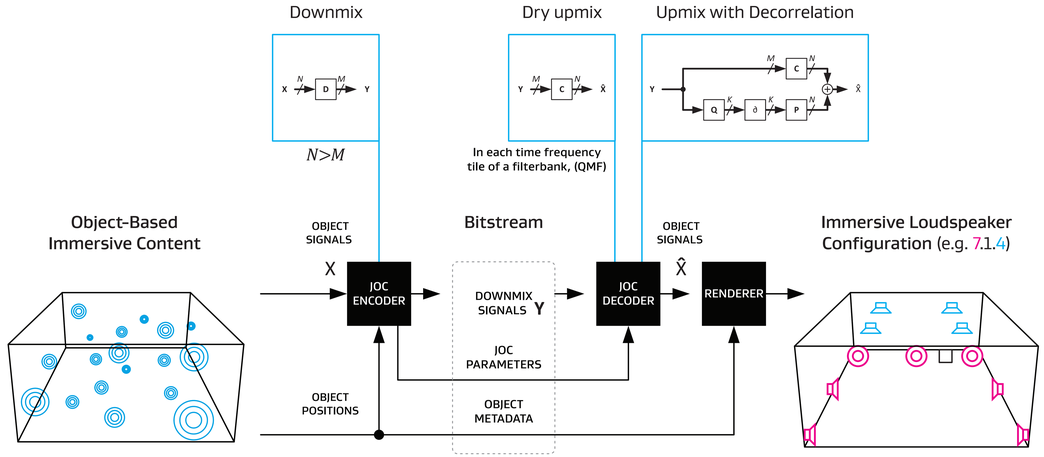
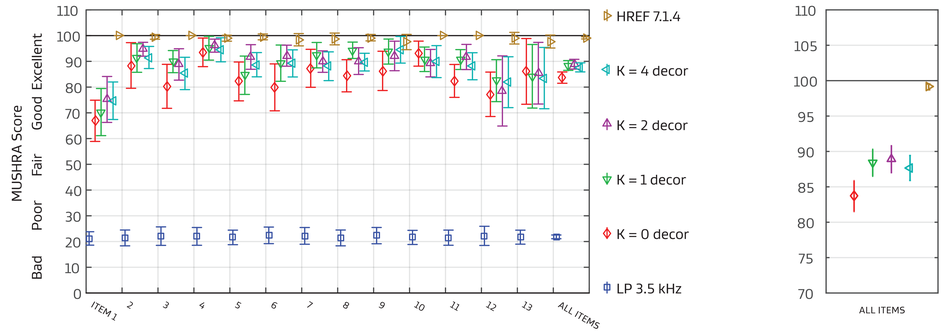
Decorrelation for Audio Object Coding

Lars Villemoes, Toni Hirvonen, and Heiko Purnhagen | Dolby Sweden AB, Stockholm, Sweden

Efficient Delivery of Immersive Experiences with Joint Object Coding (JOC)



Test Results



INTRODUCTION

- Immersive object-based audio (e.g. Dolby Atmos) can be efficiently delivered using a reduced number of downmix channels and upmix parameters

PROBLEM

- Rank lossy dry upmix can give spatial and timbral distortions

OBJECTIVE

- Recover the missing dimensions by introducing object domain decorrelation
- Strive for covariance reinstatetment
- Keep number of decorrelators low

DECORRELATORS?

- Ideally, they preserve energy and signal character while having output orthogonal to other signals under consideration
- In practice, all-pass filters

PARAMETER FORMAT

- Transmit $\mathbf{C}$ and $\mathbf{P}$ and derive $\mathbf{Q}=|\mathbf{P}|^{\top}\mathbf{C}$
- Facilitates future encoder tuning
- Reduces cross object decorrelator leakage

EXPERIMENT

- N = 7 objects from M = 3 downmix channels with K = 0, 1, 2, 4 decorrelators
- Rates for $\mathbf{C}$ and $\mathbf{P}$: 8, 11, 14, 20 kb/s
- Render to 7.1.4

ENCODER UNDER TEST

- Reinstate covariance with $K=N-M$
- For $K< N-M$, keep largest decorrelator contributions (and adjust total energy)

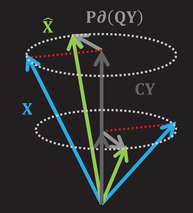
$$\hat{\mathbf{X}} = \mathbf{C}\mathbf{Y} + \mathbf{P}\partial(\mathbf{Q}\mathbf{Y})$$

$$\hat{\mathbf{R}}_{\mathrm{XX}} = \mathbf{C}\mathbf{R}_{\mathrm{YY}}\mathbf{C}^{\mathrm{T}} + \mathbf{P}\,\underbrace{\mathrm{diag}\left(\mathbf{Q}\mathbf{R}_{\mathrm{YY}}\mathbf{Q}^{\mathrm{T}}\right)}_{\mathbf{\Lambda}}\,\mathbf{P}^{\mathrm{T}}$$

$$\mathbf{C} = \mathbf{R}_{\mathrm{XY}}(\mathbf{R}_{\mathrm{YY}} + \varepsilon\mathbf{I})^{-1}$$

$$0 \preccurlyeq \mathbf{R}_{\mathrm{XX}} - \mathbf{C}\mathbf{R}_{\mathrm{YY}}\mathbf{C}^{\mathrm{T}} \approx \mathbf{V}\mathbf{V}^{\mathrm{T}} \qquad (\mathrm{rank}\ K)$$

$$\mathbf{P} = \mathbf{V}\mathbf{\Lambda}^{-1/2} \qquad (\mathbf{C} \to g\mathbf{C})$$



CONCLUSIONS

- One decorrelator improves quality
- Two is better than one for some items
- More can be less

The method is part of the advanced joint object coding tool in the Dolby AC-4 system standardized by ETSI