RESIDUAL SIGNALS MODELING FOR LAYERED IMAGE/VIDEO SOFTCAST WITH HYBRID DIGITAL-ANALOG TRANSMISSION

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Abstract

- This paper proposes a layered SoftCast scheme to integrate the high efficiency part of the digital transmission and analog-like transmission.
- This paper studies the relationship between the residual spectrum and the base layer bit rate.
- This paper presents a bit rate selection scheme based on the rate-residual model to achieve optimal overall performance

Overview of Layered SoftCast

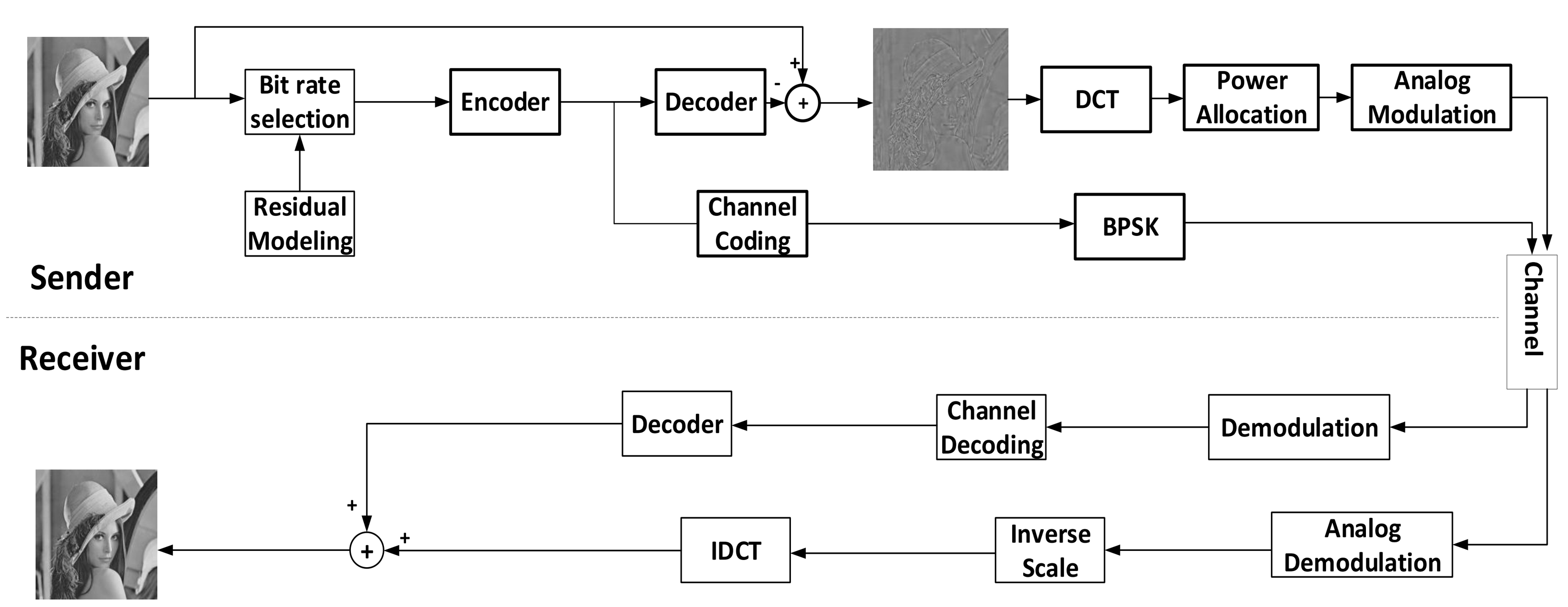
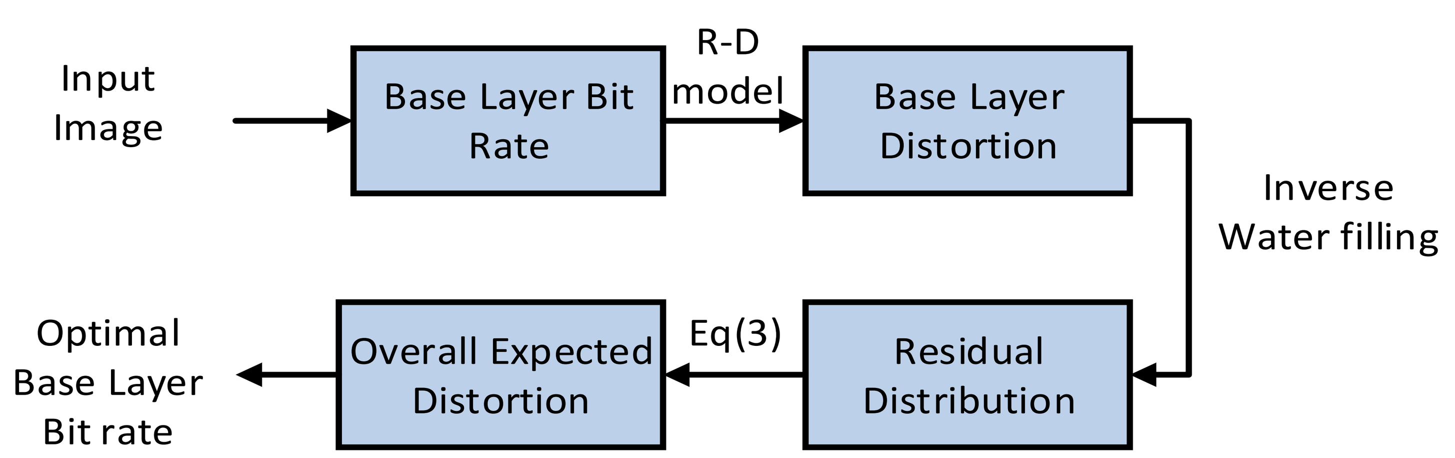


Fig. 1: The framework of layered SoftCast

- For the digital transmission, enough energy are allocated to fight the noise. The overall distortion of reconstruction is equal to the distortion produced in analog transmission.
- For the analog-like transmission, the scaling factors are determined by a power-distortion optimization (PDO) procedure. The overall performance with PDO is

$$D_r = \frac{\sigma_N^2}{P_r} \cdot \left(\sum_w \sqrt{E[X_r^2(w)]}\right)^2 \quad (1)$$

Proposed Method



A. Rate-Residual Modeling

A higher base layer bit rate means higher bandwidth and power consumption in the base layer, but also means less energy remained in the residual signal $X_r(w)$.

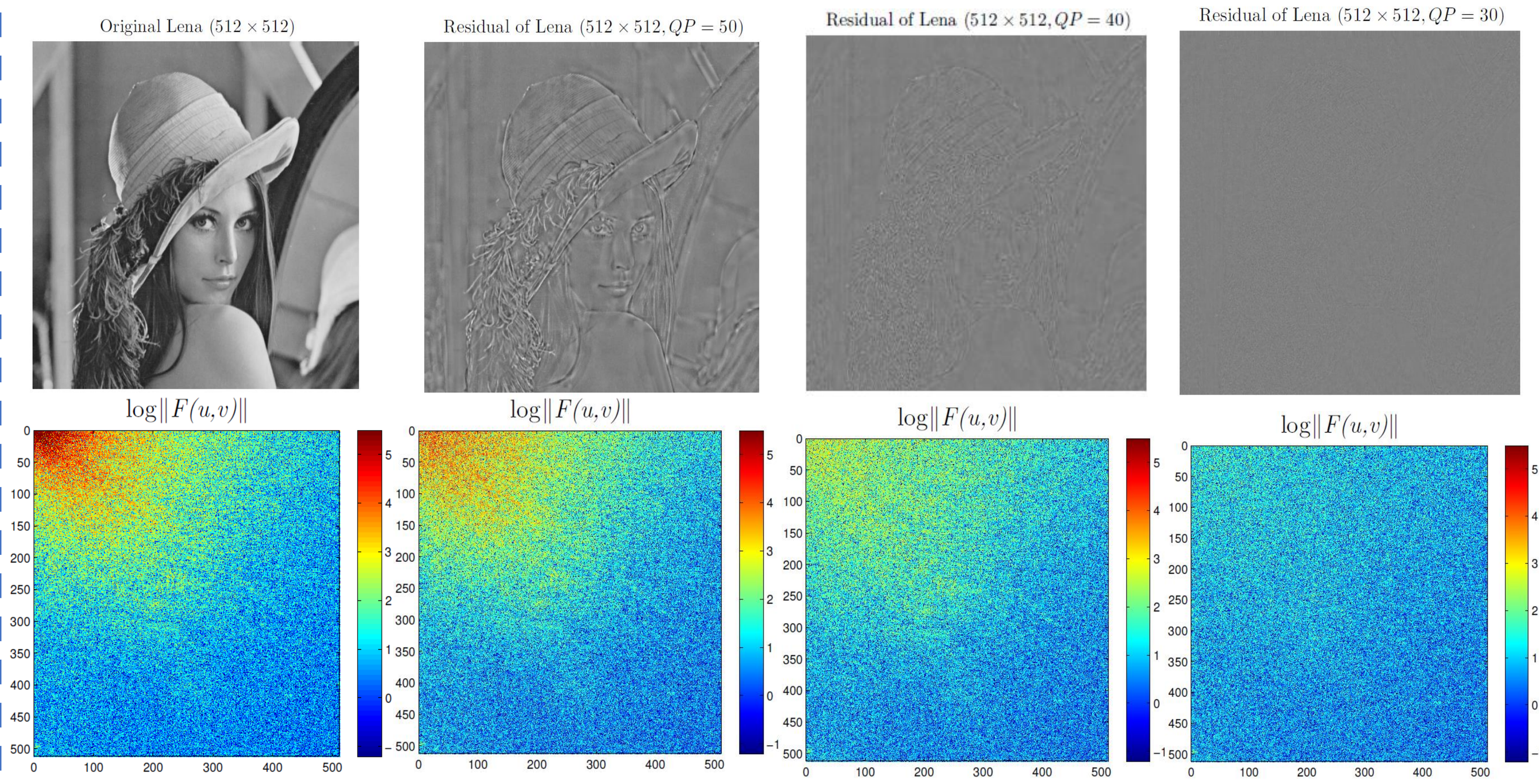


Fig. 2. Examples of residual images and their DCT spectrums. $F(u, v)$

We first study the relationship between base layer bit rate R and the residual complexity $H(X_r)$:

a. Estimate the total energy of residual signal $X_r(w)$ using R-D model $D(R) = cR^{-k}$

b. Adopt the inverse water-filling model (as shown in Fig. 3) to further estimate $X_r(w)$: $\widehat{X_r(w)} = \min(X(w), \theta)$

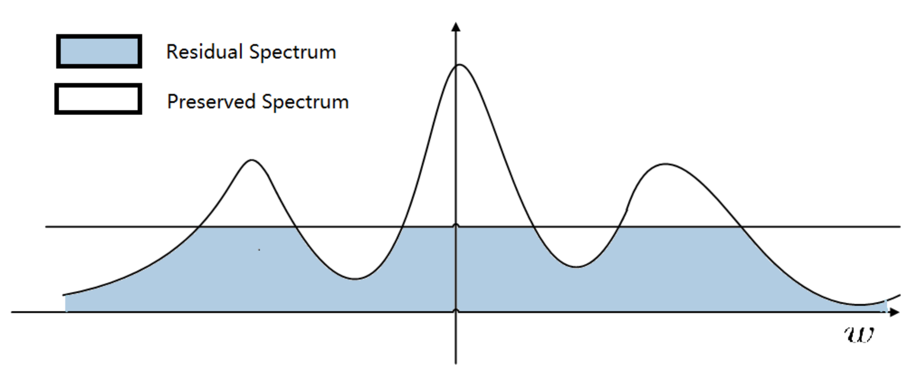
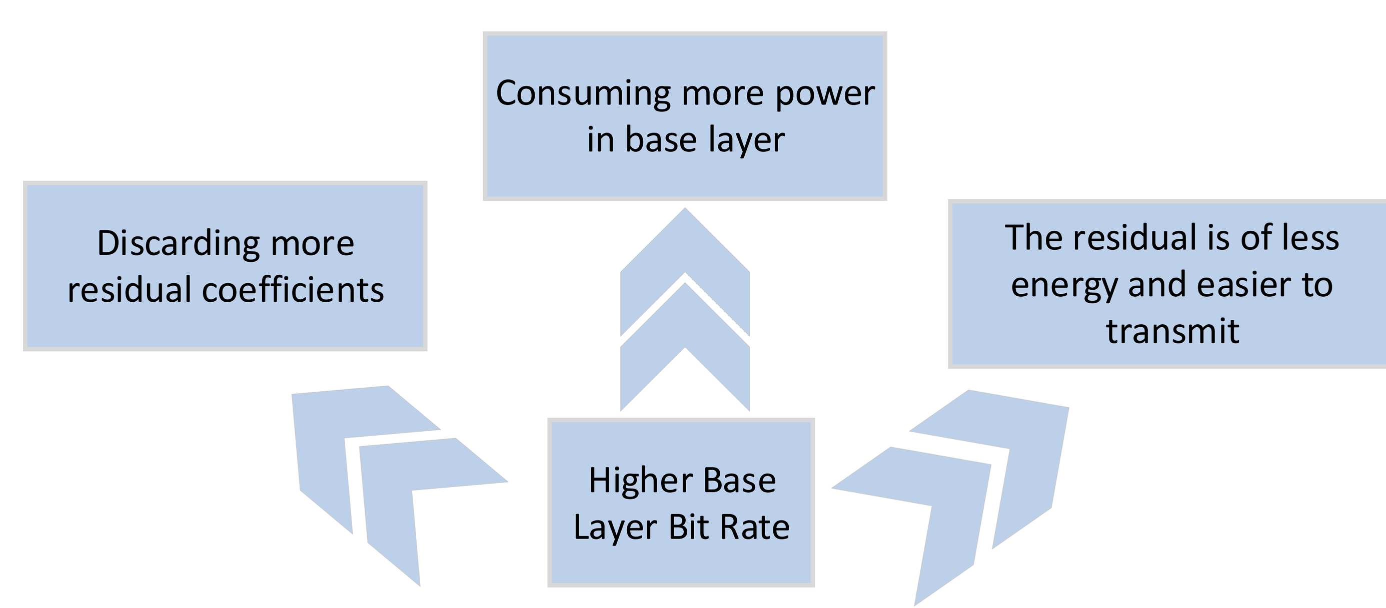


Fig. 3. Inverse water filling of the spectrum

B. Optimal Base Layer Bit Rate Selection



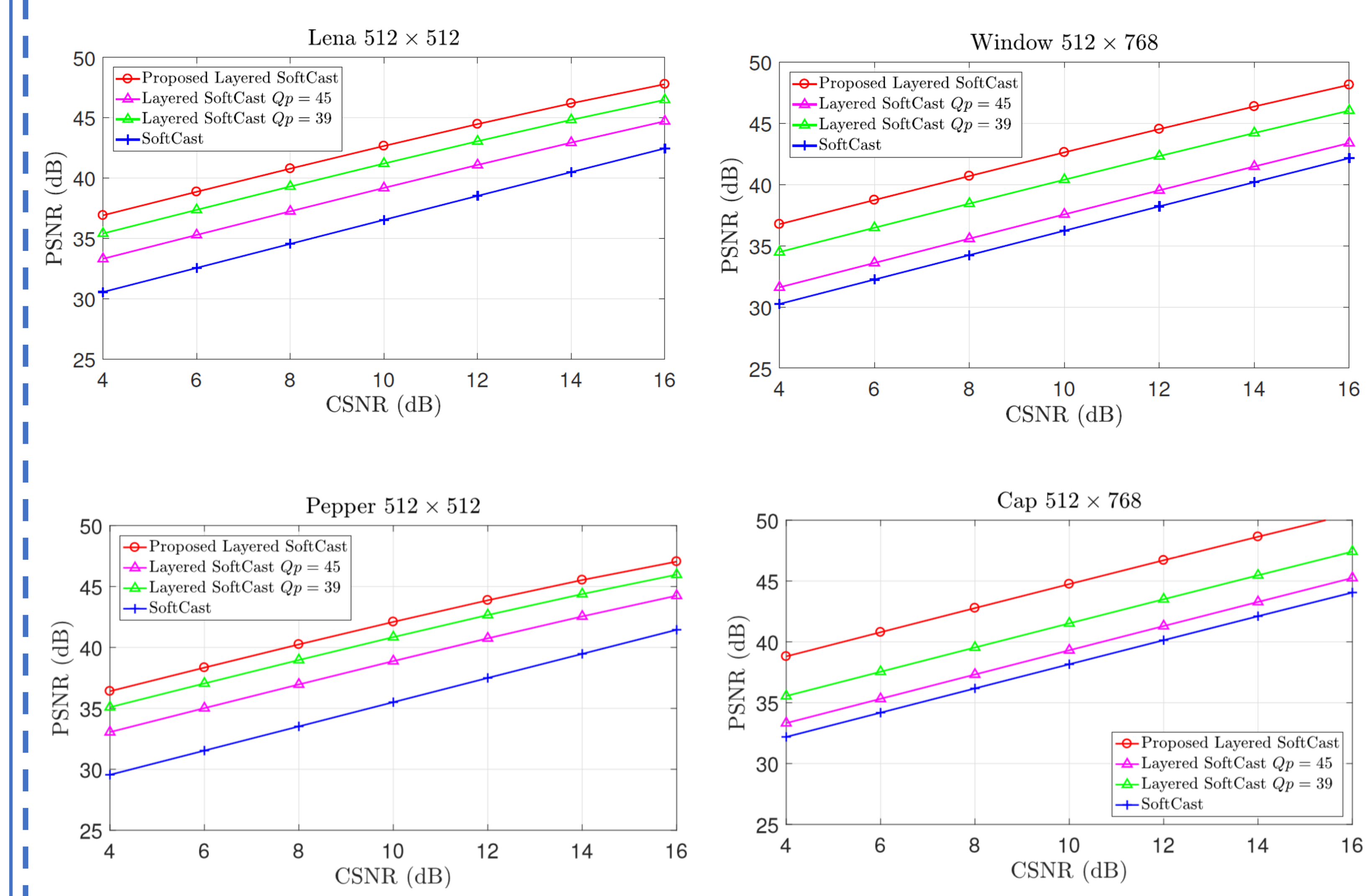
To achieve the best performance, a optimal base layer bit rate should be chosen by:

$$R = \arg_R \min D_{total} \qquad s.t. P \leq P_{total} \quad (2)$$

The total expected distortion can be described as

$$D_{total}(R) = \sum_{w \in W_d} X_r^2(w) + \frac{\sigma_n^2}{P_{total} - R \cdot P_0} \cdot \left(\sum_{w \in W_t} \sqrt{E[X_r^2(w)]}\right)^2 \quad (3)$$

Results



Reference

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