The contributions of this work are:

1. A lifting-based illumination adaptive transform (LIAT) to exploit inter-frame redundancy in the presence of illumination variations;
2. Modelling illumination changes with a mesh-based affine model which does not impose artificial block boundaries;
3. A highly scalable, embedded compression framework with rate-distortion optimal termination points for frames and illumination information.
4. Exploiting illumination change in the context of richer transforms, incorporating both predict and update steps is more beneficial.

Illumination Modelling

\[ f_i[x] = \alpha[x] + \beta[x] \]

Representation of \( \alpha \) and \( \beta \) should be compact!

We achieve this by:

- Using a coarse mesh to model \( \alpha \) and \( \beta \),
- Incorporating regularization into the estimation algorithm.

Rate-Distortion Optimization for Highly Scalable Compression

- Post-compression R-D optimization is applied for LIAT sub-band frames: Temporal high-pass \( (h) \), low-pass \( (l) \) and illumination field \( (\alpha) \).

- The rate-allocation problem is to find the optimal truncation points in Embedded Block Coding with Optimized Truncation (EBCOT) so as to minimize overall distortion s.t. an overall bit-rate constraint.

The main idea

- Illumination compensation for lifting-based temporal transforms. Suitable for scalable video compression applications.
- Avoiding Piecewise Constant (i.e. block) illuminations models which produce block boundary artefacts!
- Employing Piecewise Smooth illumination models using mesh-based affine models!

Estimation of \( \alpha \) and \( \beta \)

\[
\begin{align*}
\min_{\alpha,\beta} & \quad C = \|f_i - \hat{f}_i\|^2 + \gamma (\alpha^TL\alpha + \beta^TL\beta) \\
\hat{f}_i &= D_0\alpha + A\beta \\
A &: \text{Sparse affine interpolation matrix} \\
D_0 &: \text{Diagonal matrix of the elements of } f_0, \text{ i.e. } (D_0)_{ii} = (f_0)_{ii} \\
\deg(v_i) &= 6, \\
\mu &= \begin{cases} -1, & \text{if } i \neq j \text{ and } v_i \text{ and } v_j \text{ are adjacent} \\
0, & \text{Otherwise} \end{cases}
\end{align*}
\]

Results

Compressed sub-band samples  

- EBCOT for JPEG2000 for Highly scalable compression
- R_1  
- R_0  
- High-pass frame \( (h) \)  
- Low-pass frame \( (l) \)  
- Illumination field \( (\alpha) \)