**Motivation**

- Directional transforms avoid filtering across large discontinuities.
- Smaller high frequency coefficients in those locations.

**Goal:** Video encoder based on 3-D directional transforms.

**Related Work:** Lifting in the temporal domain for video coding [Secker and Taubman, 2003, Popescu and Bouthreau, 2001].

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**Key Novelties**

- **Introduction to the Transform:**
  - Describe the video sequence as a weighted graph of connected pixels.
  - Apply the lifting transform on this graph.

**Key Novelties:**

- Graph captures spatio-temporal correlation → spatio-temporal lifting.
- Non separable approach, against common Wavelet-based video coders (1+4).
- Coefficients reordering using graph information.

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**Lifting Transforms on Graphs**

**Lifting Transform:**
- To perform the transform and ensure its invertibility:
  - Update \((U_f)\)-Prediction (P) splitting.
  - Predict \((p)\) and update \((u)\) filters design.

**Update-Prediction Splitting:**
- Invertibility for any disjoint Update-Prediction splitting.
- Criterion we use: Maximize the total weight of the links between \(p_j\) and \(u_j\) → Maximun Cut.

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**Coefficient Reordering**

**Goal:**
- Reorder the coefficients generated by our Graph-based transform in an efficient way.

**Proposed Solution:**
- Reorder the coefficients using graph information:
  - Inter-Subband reordering.
  - Intra-Subband reordering.

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**Experimental Results**

**Experimental Setup:**
- Quantization: Subband dependent quantization.
- Scanning: Inter and Intra reordering.
- Run length encoding.
- Arithmetic coding.
- 5 levels of the transform.
- \(w_1=10; w_4=2\).

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**Low Complexity Transform**

**Problem:**
- Encoder complexity increases rapidly with the number of nodes.

**Proposed solution:**
- Create disjoint subgraphs.
- Maintain the temporal links.

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**Coefficient Reordering**

**Inter-Subband Reordering:**
- Group coefficients that belong to the same subband.
  \[ \text{coeff}_{\text{inter}} = [d^{w-N}, d^{w-N-1}, \ldots, d^1]. \]

**Intra-Subband Reordering:**
- Reorder the coefficients in each subband as a function of the reliability of their links.

**Results:**

- **Number of Subgraphs** vs. **Complexity Reduction**
  - Mobile: 82 vs. 48
  - Foreman: 14 vs. 4
  - Carphone: 1 vs. 1

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**Encoder and Decoder**

**Experimental Results**

<table>
<thead>
<tr>
<th>Foreman</th>
<th>Carphone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile</td>
<td>503 Kbps</td>
</tr>
<tr>
<td>Foreman</td>
<td>404 Kbps</td>
</tr>
<tr>
<td>Carphone</td>
<td>350 Kbps</td>
</tr>
</tbody>
</table>