Bidirectional Hierarchical Anchoring of Motion Fields for Scalable Video Coding

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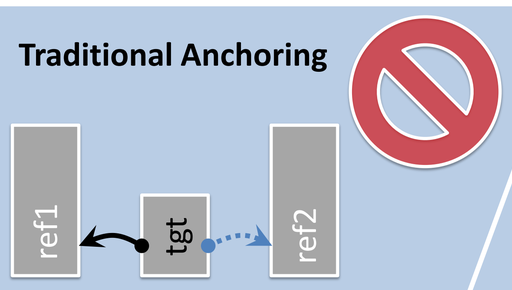
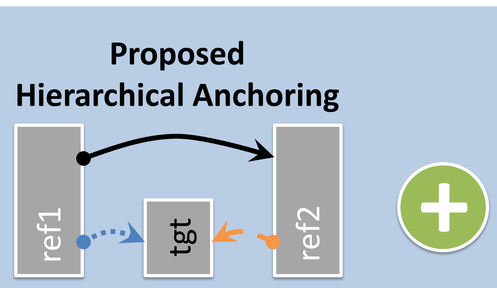
Overview



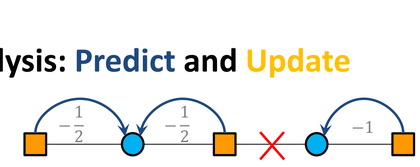


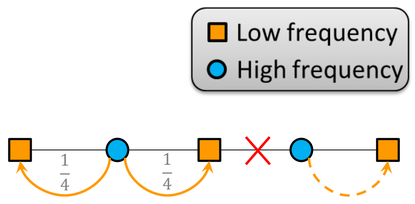
- **Consistent bidirectional prediction**
- **Obtain disocclusion and folding map** during the motion field warping process
- **High Scalability**

Breakpoint-Adaptive Wavelet Transform

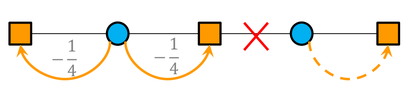
:: **Lifting-based wavelet implementation** allows to incorporate discontinuities. We use **breakpoints** to signal discontinuities.

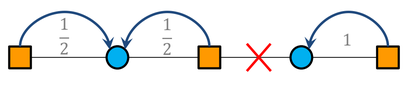
Analysis: Predict and Update





Synthesis: Undo Update, undo Predict

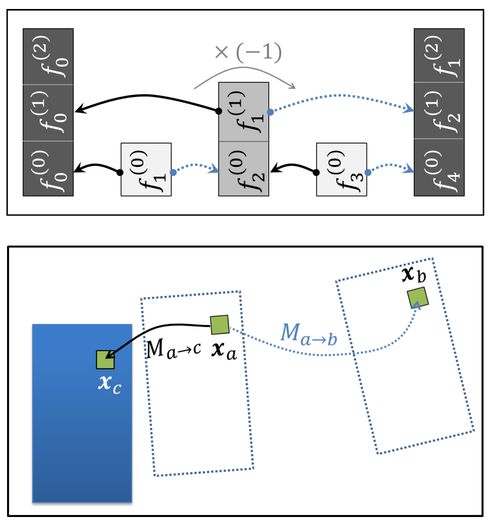




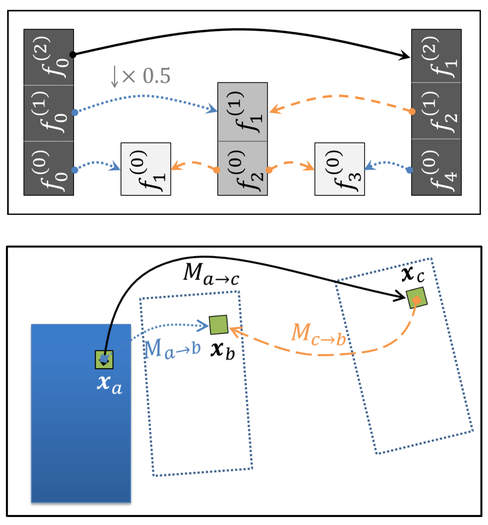
Novel Anchoring of Motion Fields

:: The proposed **hierarchical anchoring** of motion fields at reference frames allows to **reuse** them at finer temporal levels.

Traditional Anchoring



Proposed Hierarchical Anchoring



2^t-1	**Full**	1	**Full**
2^t-1	**Scaled**	2^t-1	**Scaled**
0	**Inferred**	2^t-1	**Inferred**

Scaling of Motion fields

$$\hat{M}_{a\to b} = \alpha M_{a\to c}$$

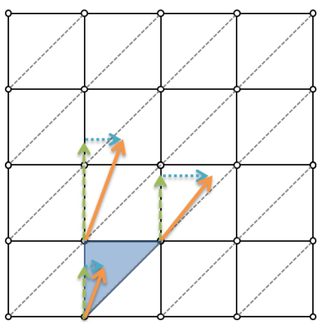
Inferring of Motion fields

$$\hat{M}_{c\to b} = M_{a\to b} \circ (M_{a\to c})^{-1}$$

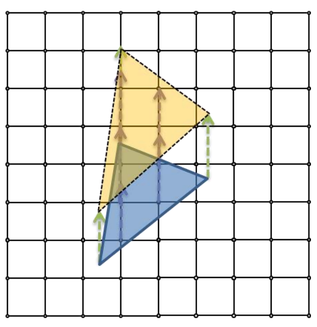
The warped motion fields are **consistent**. They can be used to **reconstruct credible frames** even if the used motion fields are highly quantized.

Motion Field Warping

:: Motion fields are **warped from reference to target** frames using a **cellular affine warping** process which is guaranteed to leave no holes.



Vertical Component

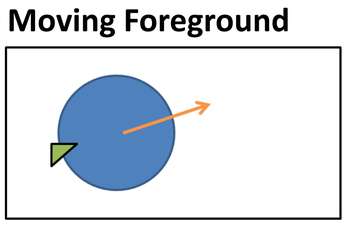


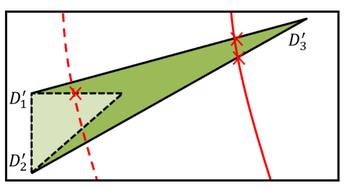
Horizontal Component

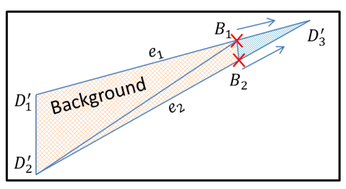
Handling Disoccluded Regions

:: **Breakpoints** are used to **identify fore-/background motion**. The **background** motion is then **extrapolated** in the disoccluded region.

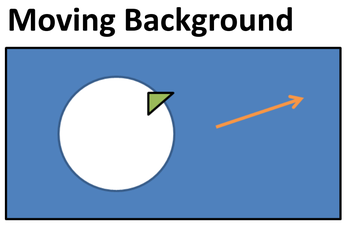
Moving Foreground

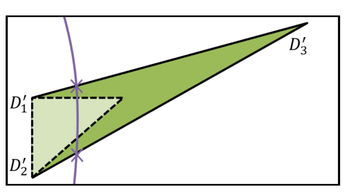


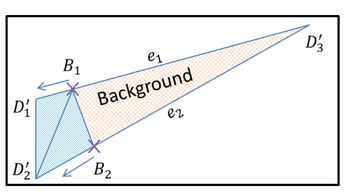




Moving Background

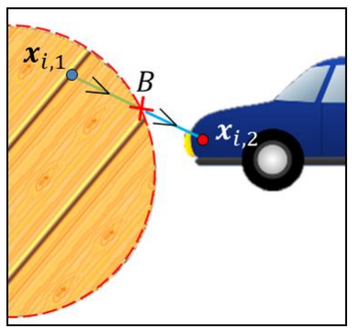




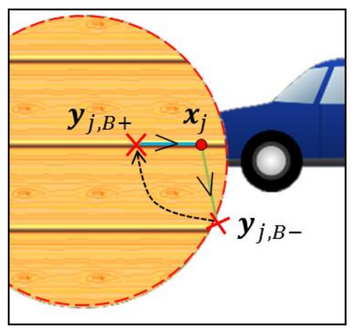


Resolving Double Mappings

:: The **foreground motion** is the one which **maps the motion discontinuity B closer to a discontinuity** in the target frame.



Reference frame



Target frame

We compute a **disocclusion and folding map**, which can be used to **guide the bidirectional prediction and update.**

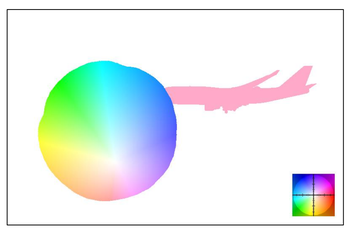
Experimental Results

:: Experiments on **synthetic data** show how the proposed scheme is able to reliably **infer** motion fields, which leads to **improved R-D performance**.

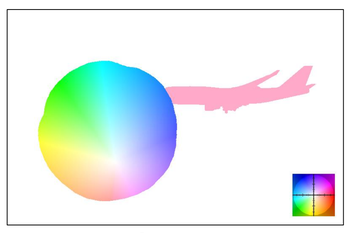
Synthetic Test Sequence

f_0 f_1 f_2 f_3 f_4

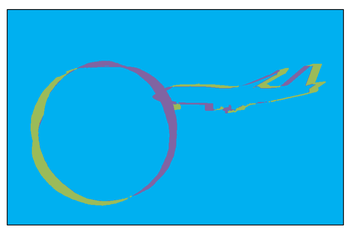
Inferred Motion Field $M_{4\to 2}$



$M_{4\to 2}$

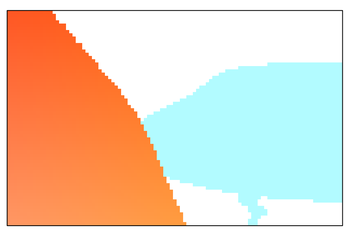


$\widehat{M}_{4\to 2}$

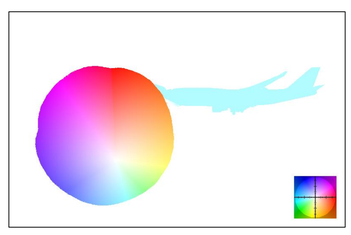


Disocclusion and Folding

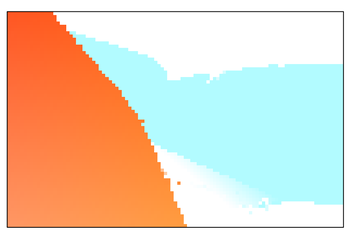
Inferred Motion Field $M_{2\to 3}$



Crop of $M_{2\to 3}$

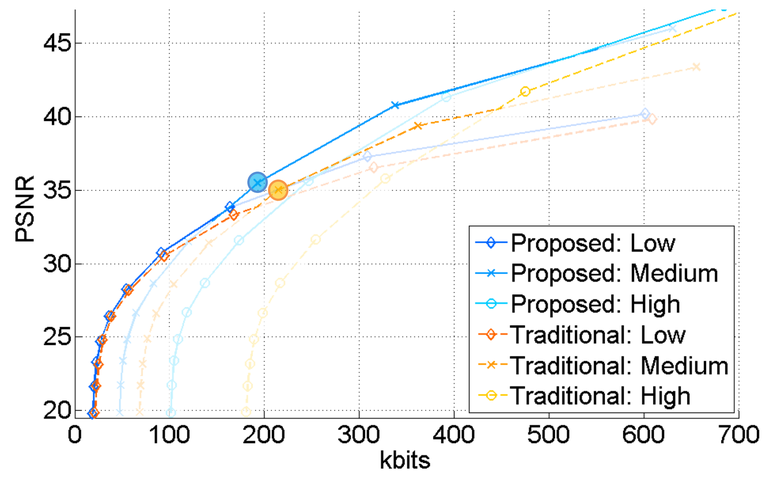


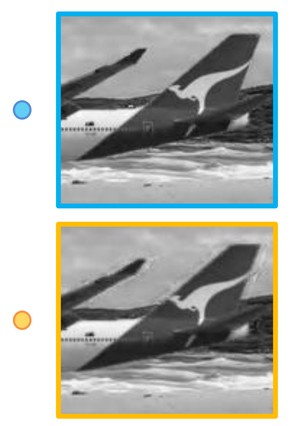
$\widehat{M}_{2\to 3}$



Crop of $\widehat{M}_{2\to 3}$

Rate-Distortion Curves for different MF Qualities





Conclusions and Future Work

- **Hierarchical Anchoring** requires motion fields to be **warped**
  - **Disocclusion and folding map** → guide bidirectional prediction
  - Robust method to **resolve double mappings**
  - **Extrapolate background motion** in disoccluded regions
- **Warped fields** are **consistent**
  - **Credible** reconstructed **frames** and **better coding efficiency**

Hierarchical breakpoint warping scheme will enable **temporal oversampling**