Region-of-Interest Based Adaptation of Video to Mobile Devices

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- We focus on news broadcasting and interview scenes.
- Developing an editor guided algorithm for ROI detection and tracking.

Proposed Tracking Method

- Estimating the global motion of the whole frame and estimating the local motion inside the ROI.
- The method is based only on the horizontal and vertical projections.
- Estimating motion parameters in the transform domain.
- We use only 1D transforms, and thus reduce complexity.
- We limit ourselves to a rectangular ROI.

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Scale Estimation using Cross-Correlation of Slices

- Transforming the model equation to the frequency domain.

$$\begin{aligned} f_2(x,y) &= f_1(\alpha x + d_x, \alpha y + d_y) \\ F_2(f_x, f_y) &= \frac{1}{\alpha^2} e^{j2\pi(f_x d_x + f_y d_y)} F_1\left(\frac{f_x}{\alpha}, \frac{f_y}{\alpha}\right) \end{aligned}$$

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- The relation between slices:

$$|S_2(f_x)| = |F_2(f_x, 0)| = \frac{1}{\alpha^2}\left|F_1\left(\frac{f_x}{\alpha}, 0\right)\right| = \frac{1}{\alpha^2}\left|S_1\left(\frac{f_x}{\alpha}\right)\right|$$

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$$\left|S_2\left(f_x\right)\right| = \left|F_2\left(f_x, 0\right)\right| = \frac{1}{\alpha^2}\left|F_1\left(\frac{f_x}{\alpha}, 0\right)\right| = \frac{1}{\alpha^2}\left|S_1\left(\frac{f_x}{\alpha}\right)\right|$$

- Scale is estimated by using cross-correlation of slices in the frequency domain.

$$\left|S_2\left(log(f_x)\right)\right| = \frac{1}{\alpha^2}\left|S_1(log(f_x) - log(\alpha))\right|$$

Projection-Slice theorem

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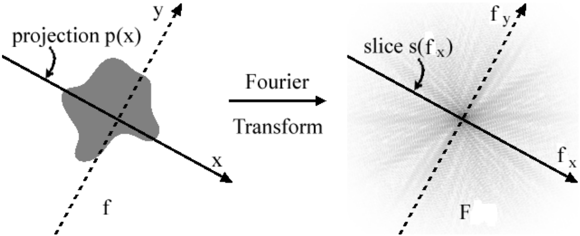
- Instead, project on the perpendicular axis and take the Fourier transform.

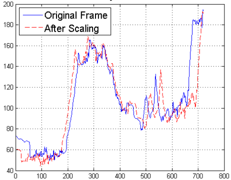


Scale Estimation Example

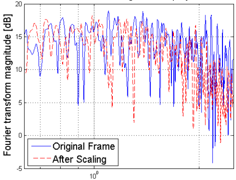
Original Frame

Frame after scale change of 0.9

Projections

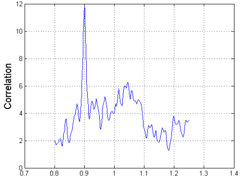


Fourier transform magnitude of projections



Normalized frequency [radians] - logarithmic (base 10) scale

Cross-Correlation Result



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$$M_2(s) = \int |S_2(x)| x^{s-1} dx = \frac{1}{\alpha^2} \int \left| S_1\left(\frac{x}{\alpha}\right) \right| x^{s-1} dx = \alpha^{s-2} M_1(s)$$

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- Estimate the scale using a specific value of s ($s \neq 2$):

$$\alpha = \left[\frac{M_1(s)}{M_2(s)}\right]^{\frac{1}{2-s}}$$

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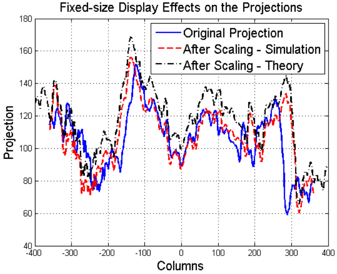
- Example for zoom in. The projection without the display limitation is different than the projection with the limitation.



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a

b

c

d

- Image (a) is the previous frame.
- Image (b) is the current frame, which is a scaled and shifted version of the previous frame.
- Image (c) is the previous frame after zeroing out the parts that do not appear in the current frame.
- Image (d) is the current frame after zeroing out the parts that do not appear in the previous frame.

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- Shift values for current frame will be estimated after the scale estimation.

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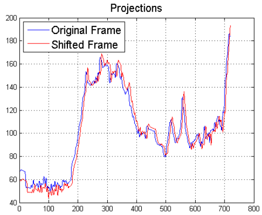
- The global motion estimation can be done iteratively, but we didn't find it necessary.



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- We assume that there is no local scale change.
- Calculate horizontal and vertical projections only for the ROI.
- Scale the projection from the previous ROI and then perform cross-correlation in the spatial-domain.

Example - TV scenes

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- We reduced complexity by using the slice-projection theorem and the Mellin transform.
- We further reduced complexity by using Mellin transform in the spatial domain.

Thank You!