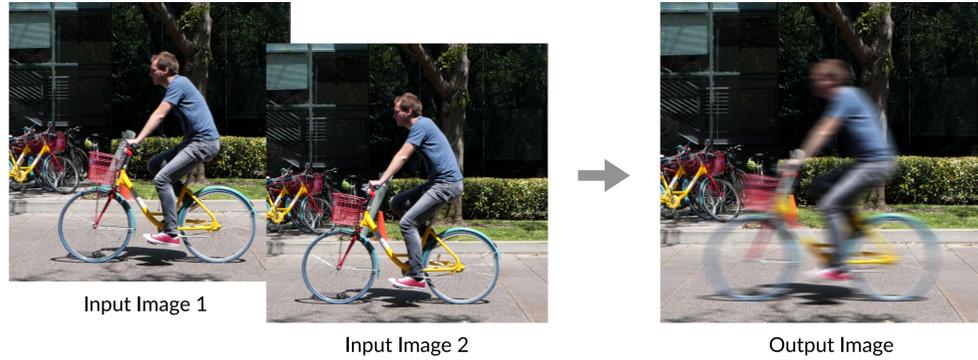


Learning to Synthesize Motion Blur

Tim Brooks & Jon Barron

Problem

Synthesize a motion blurred image from two sharp images.



Applications

Photography, timelapse, rendering, cinematography, synthesizing deblur training data.



While motion blur is unwanted in some cases, skilled photographers, animators and filmmakers use purposeful motion blur to convey motion.

Contributions

1) Novel line prediction network with state-of-the-art motion blur performance:

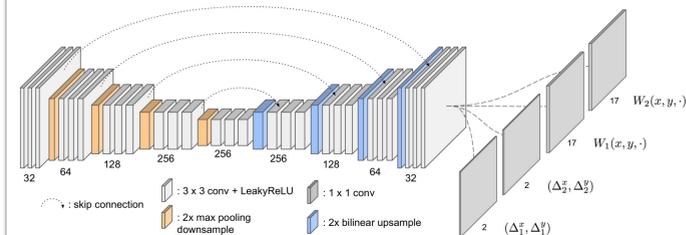
- ◇ 4dB higher quality than optical flow.
- ◇ 2,500x faster than frame interpolation.

2) Procedure for generating massive amounts of motion blur training data.

3) Small ground-truth motion blur dataset for evaluation.

Line Prediction Network

We learn lines with varying weights along which to blur each pixel.



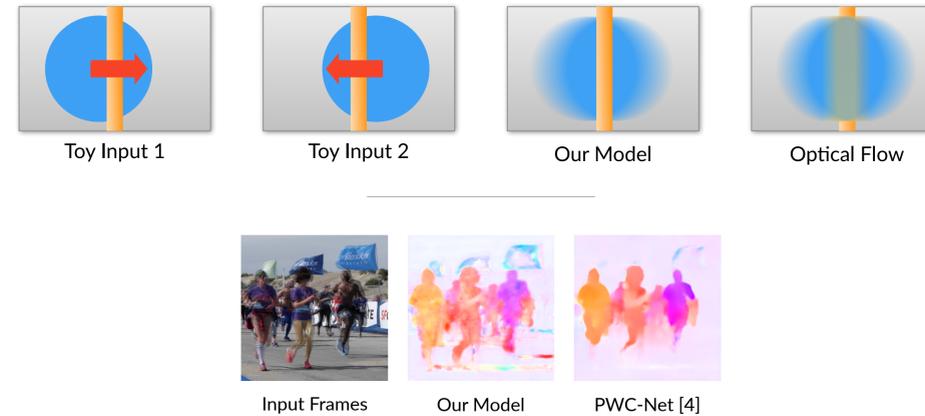
Network architecture predicting line endpoints and weights.

$$I_{1 \rightarrow 2}(x, y) = \sum_{i \in \{1, 2\}} \sum_{n=0}^{N-1} W_i(x, y, n) \times I_i \left(x + \left(\frac{n}{N-1} \right) \Delta_i^x(x, y), y + \left(\frac{n}{N-1} \right) \Delta_i^y(x, y) \right)$$

Calculation of motion blurred image from line endpoints and weights.

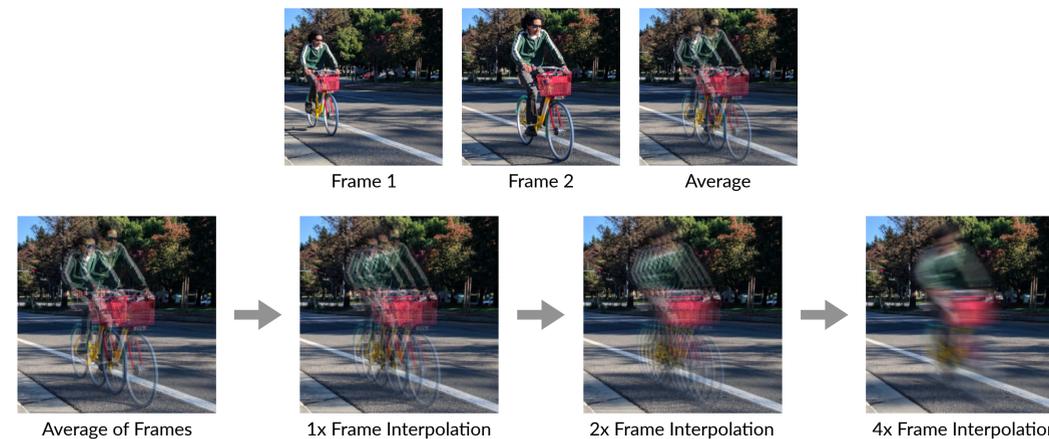
Handling Complex Motions

Our line prediction network is better able to handle complex motions than previous methods.



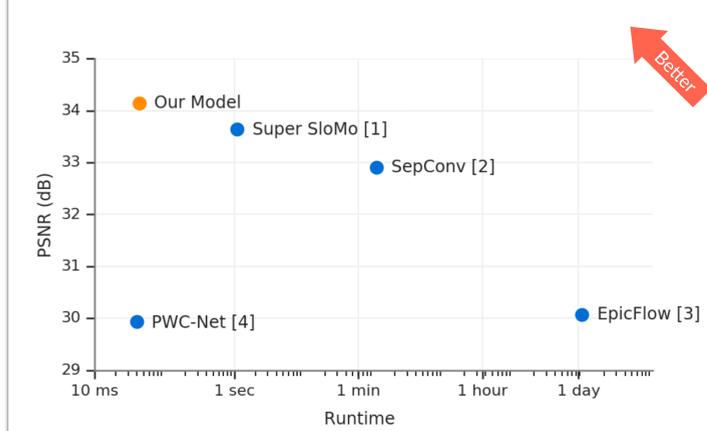
Training Data Generation

We recursively interpolate video frames and average to produce motion blur pseudo-ground truth.



Results

Performance on our evaluation dataset captured using real slow motion videos.



Algorithm	PSNR (dB)	Runtime (ms)
PWC-Net [4]	29.93	39.5
EpicFlow [3]	30.07	96.3 × 10 ⁶
SepConv [2]	32.91	10.9 × 10 ⁴
Super SloMo [1]	33.64	13.7 × 10 ²
Our Model	34.14	43.7
Ablations		
Our Model (Direct)	33.97	34.7
Our Model (Uniform)	33.88	42.8



Supplemental material and more information available:

timothybrooks.com/tech/motion-blur

Bibliography

- [1] Jiang et al., Super SloMo: High Quality Estimation of Multiple Intermediate Frames for Video Interpolation, *CVPR 2018*
- [2] Niklaus et al., Video Frame Interpolation via Adaptive Separable Convolution, *ICCV 2017*
- [3] Revaud et al., EpicFlow: Edge-Preserving Interpolation of Correspondences for Optical Flow, *CVPR 2015*
- [4] Sun et al., PWC-Net: CNNs for Optical Flow Using Pyramid, Warping, and Cost Volume, *CVPR 2018*