Animation from Blur: Multi-modal Blur Decomposition with Motion Guidance

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GitHub: https://github.com/zzh-tech/Animation-from-Blur
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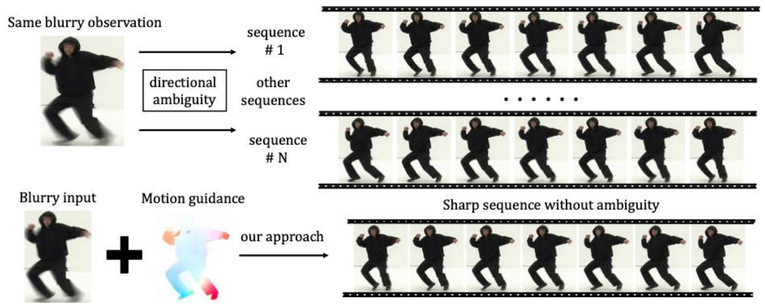
Directional ambiguity problem in blur decomposition

- Conventionally, the deblurring task is treated as a one-to-one mapping problem, taking a motion blurred image as input and producing a single output image corresponding to a single time instant during the exposure. Recently, attention has been drawn to a more challenging problem of extracting an image sequence instead, namely blur decomposition.



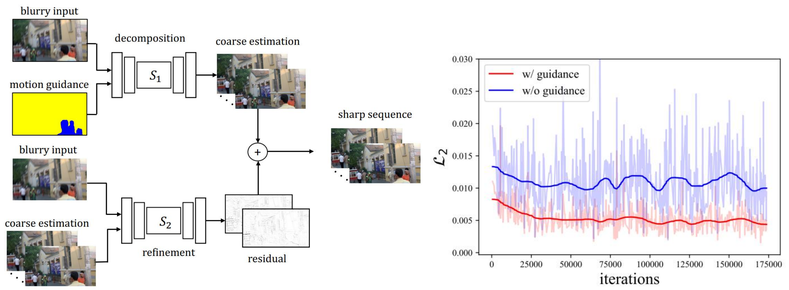
- Blur decomposition from a single blurry image faces the fundamental problem of directional ambiguity. Each independent and uniform motion blurred region can correspond to either a forward or a backward motion sequence, resulting in an exponential increase in the number of potential solutions for the image. However, existing methods for blur decomposition are designed to predict a single solution among them. This directional ambiguity brings instability to the training process and leads to poorly diversified and low-quality results.

Summarized contributions

- **We propose a novel motion guidance representation to address the directional ambiguity in blur decomposition.**
- **Due to the compactness of motion guidance representation, our unified framework only needs to be trained once, while supporting various decomposition scenarios under different modalities.**
- **Through extensive experiments, we demonstrate our method outperforms previous image- and video-based methods in terms of quality and diversity.**

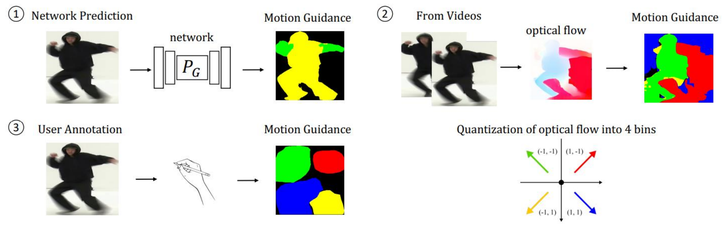
Motion guided blur decomposition

- The motion guidance is an optical flow representation quantized into four major quadrant directions, describing the motion field roughly. Given the input blurry image, conditioned on the compact motion guidance, the blur decomposition becomes a nearly deterministic one-to-one mapping problem without directional ambiguity.
- We propose a two-stage network to predict the image sequence. The first stage expands the blurry image into an image sequence based on the motion guidance, and the second stage refines the visual details in a residual fashion to generate high-quality images.
- The decomposition network shows significantly better training convergence with conditioning on an additional guidance input.

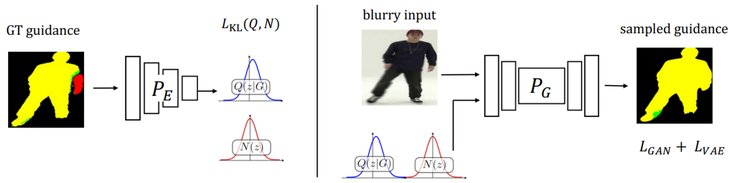


Flexible motion guidance interfaces

- We provide three interfaces to acquire the motion guidance: (1) a network to predict possible motion guidance, (2) motion from video, and (3) user annotation, illustrated in the following figure.

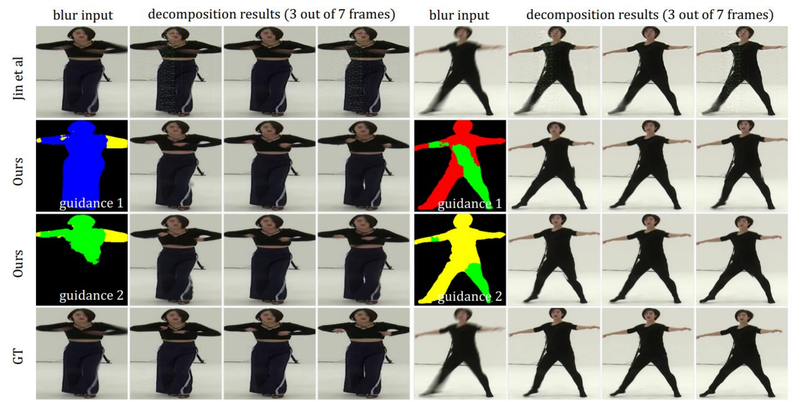


- We follow the cVAE-GAN to build a guidance prediction network.



Experimental results

- Given a blurry image, our method can generate multiple physically plausible motion guidance and recover distinct sharp image sequences based on each motion guidance.



- Given a blurry video, the deterministic decomposition results from our method still outperform the previous state of the art method.

Conclusions, limitations, and future works

We bring to light the issue of directional ambiguity in the blur decomposition and propose the first solution by introducing motion guidance to train networks. However, the current simple form of motion guidance may fail to handle the case with large and complex motion blur. Using a more elaborate guidance that considers different motion intensities may improve this problem.