Deblurring Face Images with Exemplars
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https://eng.ucmerced.edu/people/zhu/ECCV14_facedeblur.html

Introduction
Goal: recover clear face images from blurry ones
Challenges:
• Not much texture in the blurry face image
• Ambiguous edges caused by blur
• Implicit or explicit restoration of salient edges are difficult
• Relying on local salient-edge restoration

Algorithm Overview
Approach:
• Extract global exemplar structure
• Find the best matched exemplar edges for input image
• Guide kernel estimation with exemplar edges

What Structure Is Useful?
Input & kernel
Extracted salient edges from clear image

Exemplar Structure
• Collect 2,435 face images (with landmarks) from the CMU PIE dataset of different identities, facial expressions and poses
• Manually extract informative structures (lower contour, eyes, and mouth)
• Refine contours using guided filter

Extract Salient Edges
• Find the best matched exemplar
\[ v_i = \max_{t} \sum_{x} \nabla x_i \cdot \nabla T_i(x + t) \]
where \( i \) is the index of the exemplar, \( \nabla T_i(x) \) is the \( i \)-th exemplar, and \( t \) is the possible shift between image gradients \( \nabla B(x) \) and \( \nabla T_i(x) \).
• Salient edges computation
\[ \nabla S = \begin{cases} \nabla T_i(x), & \text{if } x \in \{ x \mid M_i(x) = 1 \} \\ 0, & \text{otherwise} \end{cases} \]
where \( i^* = \arg \min_i v_i \) and \( M_i(x) \) is the contour mask for \( i^* \)-th exemplar.

Kernel Estimation Process
• Alternatively solving
\[
\begin{align*}
\min_k & \| \nabla S^* k - \nabla B \|_2^2 + \gamma \| k \|_2^2 \\
\min_I & \| I^* k - B \|_2^2 + \lambda \| \nabla I \|_0
\end{align*}
\]

Experimental Results
• Robustness to Exemplar Set Size

• Comparisons with State-of-the-Art Methods

References

* indicates equal contribution