Blind Deconvolution

**Task:** Estimate a sharp image \( u \) and the point spread function (PSF) \( k \) from a single blurry image \( f \).

**Clearing the fog: Several approaches, which one is right?**

Method 1: Deconvolution

Method 2: Energy reweighting.

Method 3: Total Variation Blind Deconvolution: The Devil is in the Details

Method 4: Edge enhancement.

**We address the following question:** Why do these algorithms work despite theoretical results showing that they cannot?

**Summary of our findings**

1) The findings of Levin et. al. [1] are correct: the exact minimization of a large class of energies with texture priors leads to a no-blur solution.

2) Many algorithms still work because they do not minimize the claimed cost.

3) Delayed normalization (scaling) of the blur is key.

**Total Variation Blind Deconvolution**

Blind deconvolution is typically solved by minimizing a variation of the following cost function.

\[
\text{arg min}_{u, k \geq 0 \mid k \in K} \frac{1}{2} \| k \ast u - f \|^2_2 + \lambda \| u \|_{TV}
\]

**Theorem 1:** A large class of regularization terms, such as the total variation, favor the blurry image and not the sharp one (extension of the results in Levin et. al. [1]).

\[
\| A v \|_1 \leq \| B v \|_1
\]

**Projected Alternating Minimization**

A common approach to minimize (1) is to alternate between the following steps.

\[
u^t \leftarrow \text{min} \frac{1}{2} \| u^{t-1} \ast k - f \|^2_2 + \lambda \| u \|_{TV}
\]

**Proposition:** The energy in (1) is not minimized by the Projected Alternating Minimization (PAM) algorithm.

\[
k^t \leftarrow \text{max} \{k^{t-1}, 0\} / \| k^{t-1} \|_1
\]

**Theorem 2:** for a 1D step function blurred with a blur of support equal to 3 pixels and for \( \lambda > \lambda_p \), the PAM algorithm estimates the true blur in two steps.

**Experimental Validation**

The PAM algorithm without any additional heuristics achieves state-of-the-art results.

**References:**


**Code available at:**

http://www.cvg.unibe.ch/Perrone/Tvdb/