Anti-Glare: Tightly Constrained Optimization for Eyeglass Reflection Removal

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Introduction

Absence of a clear eye visibility not only degrades the aesthetic value of an entire face image but also creates difficulties in many computer vision tasks. So we try to increase the eye visibility from a single image in the presence of eyeglass reflections.

Contributions

1. Inspected the salient properties of eyeglass materials.
2. Derived the priors using following cues:
   - Single side illumination on eyeglasses ⇒ reflections with sharp & sparse gradients.
   - Residual reflections: eyeglass attenuates each light λ differently ⇒ color tint & piecewise constancy
   - Bilateral symmetry: •
3. Prior (residual map) is used to gradually tighten the constraints in an optimization problem at each iteration.
4. Eyes with Eyeglasses (EwE): a synthetic dataset is created & evaluated for iris detection.

EyeGlass Reflections

Single side illumination gives rise to very sharp reflections. Eyeglasses always have single side illumination.

Facial Symmetry Prior

In case of eyeglasses, different wavelengths are attenuated differently (Fig. 2), so the reflection layer shows a specific color or a hue like green, blue, violet etc.

Optimization

Residual reflection property ⇒ look for distinctive hue regions. Constructing the hue map \( M_\gamma \) as

\[
M_\gamma = \exp \left( -\eta_\gamma |I_H - \mu(I_H)|^2 \right) .
\]

Filter it via guiding through hue & saturation to obtain,

\[
M_\gamma[k] = \frac{1}{\sum \exp \left( -\eta_\gamma |I_H[k] - k| \right)} M_\gamma[k].
\]

\[
W[k] = \exp \left( -\eta_\gamma |\|I_s[k] - I_H[k]\|_1| \right) .
\]

Tight the lower bound by spreading color tint (prior) over the residual map as,

\[
\Gamma_s = \mu(I_H)M_\gamma.
\]

Result

Iris detection is the precursor for iris recognition systems. On EwE dataset: ROC curve in Fig. 3 ⇒ the greater the eye visibility, the better the iris detection accuracy.

Conclusion

This method removes eyeglass reflections from a single frontal face image. What if reflections turn out to be perfectly symmetric? What about specular reflections? What if face is out-of-plane rotated?

References