An Adaptive Model for Face Distortion Correction

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Motivation

Handheld devices such as smartphones with wide-angle cameras have shown the current trend in mobile photography. Although one can take great delight in a wide field of view through modern cameras, nearby objects or faces may be distorted significantly.

Fig. 1: Face distortion in a wide-angle image [1].

This work introduces an adaptive polynomial model that automatically selects faces and performs image distortion correction. Since the photos are processed locally, faces are undistorted, and the background is close to the original state.

Contributions

- We propose an adaptive polynomial model to recover faces and make them look natural on wide-angle images.
- Our model minimizes the chance that the background is distorted.
- Our experimental results show promising results on public wide-angle images captured in the wild. Beyond the image quality, our model is simple.

Model

- Given a wide-angle image $I_d = \{(x_d, y_d)\}$, image centroid (x_o, y_o), and face coordinates $f_{n,c} = (x_f^{n,c}, y_f^{n,c})$ where $n = \overline{1, n_f}$ and $c = 1, 2, 3, 4$
- **Global mapping** $\kappa_{r_d,g} = \log^{p_g} \|(x_d, y_d) - (x_o, y_o)\|_2$
- Local mapping anchors $c_n = \underset{c\in\{1,2,3,4\}}{\arg\max} \left\|f_{n,c} - (x_o, y_o)\right\|_2$
- **Local mapping** $\kappa_{r_d,l} = \underset{n\in\{1,2,\ldots,n_f\}}{\max} \{\log^{p_l} \|(x_d, y_d) - c_n\|_2\}$
- **Combining local and global mappings** $\kappa_{r_d} = \kappa_{r_d,g} \times \left(1 - \kappa_{r_d,l}\right)$. Note that p_g and p_l are adjusted according to image resolution
- **The adaptive model for face distortion correction**

$$(r_d, \phi) = \left(\sqrt{x_d^2 + y_d^2}, \arctan\left(\frac{y_d}{x_d}\right)\right)$$
$$r_u = r_d + \kappa_{r_d} r_d^2$$
$$(x_d, y_d) = (r_u \cos(\phi), r_u \sin(\phi))$$

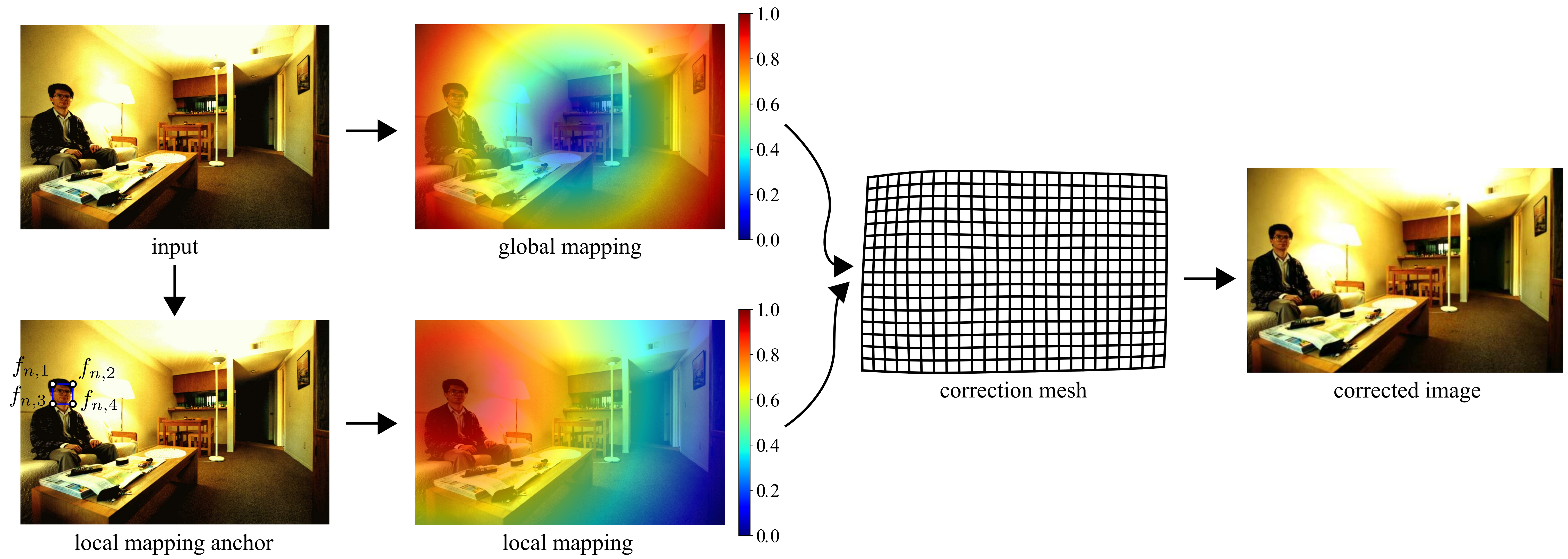

Fig. 2: Flowchart.

Results

- Our method outperformed Zorin and Barr [1] and Shih et al. [2] in correcting low-resolution images as shown in Fig. 3.1.0-3.
- It is no doubt that our result was better than what Adobe Photoshop Perspective Warp (APPW) [3] obtained in Fig. 3.2.1 and Fig. 3.2.3. Comparing to Shih et al. (Fig. 3.2.2), their result and ours are nearly identical, except the top-left corner where their method generated a small amount of artifacts.
- Our model was better than Samsung Galaxy S9+ Shape Correction (SSSC) [4] in maintaining straight lines in the background (Fig. 3.3.1 and Fig. 3.3.3).
- However, as the complexity of the region around the faces increases, our model may have difficulty in recovering the original structure of the background. Another term in the polynomial function that takes this issue into account is our future consideration for improvement.

Fig. 3: Results.

References

[1] Denis Zorin and Alan H. Barr. "Correction of Geometric Perceptual Distortions in Pictures". In: *Conference on Computer Graphics and Interactive Techniques*. 1995, pp. 257–264.

[2] YiChang Shih, Wei-Sheng Lai, and Chia-Kai Liang. "Distortion-Free Wide-Angle Portraits on Camera Phones". In: *ACM Transactions on Graphics* 38.4 (2019).

[3] Chintan Intwala and Aseem Agarwala. *Perspective Warp*. US Patent 9,117,253, 2015.

[4] Samsung. *About Shape Correction*. https://www.samsung.com/nz/support/mobile-devices/galaxy-s7-about-shape-correction/. 2017.