# Supplemental Document for Distortion-Free Wide-Angle Portraits on Camera Phones

YICHANG SHIH, WEI-SHENG LAI, and CHIA-KAI LIANG, Google

(a) Applying lens correction warp (b) Combing our method and (a)

(c) Rectangular crop of (a) (d) Rectangular crop of (b)

Fig. 1. We correct lens distortion (a) before applying our method to the input. When the mesh optimization finishes, we combine our method and lens correction into a single warp (b) for speed optimization. After rectangular crop, the perspective projection (c) and our result (d) may have slightly different FOVs.

In the title of each section, we put the section number referenced in the main paper.

## 1 INCOPORATING LENS CORRECTION (SECTION 4.3)

Geometric lens distortion is typically very strong in a wide-angle lens due to design limitation and trade-off to other optical requirements. When an input photograph contains lens distortions, we first compute a lens correction warp from the lens distortion coefficients. Instead of directly warping the input to correct lens distortion, we hold-off the warping until the mesh optimization described in Section 4 of the main paper is finished. We combine the lens distortion correction warp and our optimal mesh warp into a single warp field for image resampling. This order reduces the computationally expensive image warping step from twice to once, as illustrated in Fig. 1.

Authors' address: YiChang Shih, yichang@google.com; Wei-Sheng Lai, wlai24@ucmerced.edu; Chia-Kai Liang, ckliang@google.com, 1600 Amphitheatre Parkway, Mountain View, CA, Google.

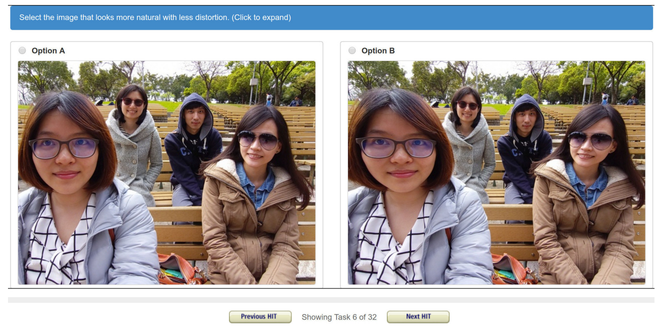


Fig. 2. Our interface for user study on Amazon Mechanical Turk. The left-right orders are randomized. In this case, Option A (**left**) is the result of our method, and option B (**right**) is the perspective projection.

| Compared to input (perspective projection). | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 | 0 | Total |
| Percentage (%) | 25.0 | 39.2 | 28.2 | 6.6 | 0.9 | 0.0 | 100 |
| Cumulative percentage | 25.0 | 64.2 | **92.4** | 99.1 | 100 | 100 | N/A |

Table 1. Distribution of votes favoring our method from user study on 1047 results.

## 2 ACCOMPANYING WEB PAGES (SECTION 5)

We generate massive results with an accompanying web page under the directory of this document: `webpage/index.html` for browsing. We show inputs collected by us and downloaded from Flickr, the results of our method, and comparisons with other parametric projections. The data set contains 167 inputs with various facial contents, expressions, and under arbitrary lighting conditions.

## 3 USER STUDY (SECTION 5.3)

We show the interface for our user study on Amazon Mechanical Turk in Fig. 2. In the title of each assignment, we ask testers to select the image that looks more natural with less distortion between the perspective projection and the result of our method. Testers are given unlimited time to finish the task. For each assignment, we ask the opinions from 5 different testers unaffiliated with us. Our study consists of 1047 testing image pairs and therefore 5235 questions in total. On average, each question takes 9.5 seconds for a tester to finish. Assuming that each worker ID corresponds to a unique person, our study is completed by 117 individual persons. Table 1 shows the distribution of the user study results. By majority voting, 92.4% of our results are classified as more natural. We conduct the

| Compared to the stereographic projection. | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 5 | 4 | 3 | 2 | 1 | 0 | Total |
| Percentage (%) | 21.6 | 36.5 | 26.3 | 12.0 | 2.4 | 1.2 | 100 |
| Cumulative percentage | 21.6 | 58.1 | **84.4** | 96.4 | 98.8 | 100 | N/A |
| Compared to Mercator projection. | | | | | | | |
| | 5 | 4 | 3 | 2 | 1 | 0 | Total |
| Percentage (%) | 24.0 | 29.3 | 27.5 | 16.2 | 2.4 | 0.6 | 100 |
| Cumulative percentage | 24.0 | 53.3 | **80.8** | 97.0 | 99.4 | 100 | N/A |
| Compared to Pannini projection [Sharpless et al. 2010]. | | | | | | | |
| | 5 | 4 | 3 | 2 | 1 | 0 | Total |
| Percentage (%) | 22.2 | 31.7 | 31.1 | 12.6 | 2.4 | 0 | 100 |
| Cumulative percentage | 22.2 | 53.9 | **85.0** | 97.6 | 100 | 100 | N/A |

Table 2. User study in comparisons to other methods on 167 results. The table shows the distribution of votes favoring our method.

comparisons to other methods using the same approach on the 167 inputs mentioned in Sec. 2, and report the results in Table 2. When compared to the stereographic projection, Mercator projection, and Pannini projection [Sharpless et al. 2010], the percentages favoring our method are 84.4%, 80.8%, and 85.0%.

## REFERENCES

Thomas K Sharpless, Bruno Postle, and Daniel M German. 2010. Pannini: a new projection for rendering wide angle perspective images. In *Proc. 6th international conference on Computational Aesthetics in Graphics, Visualization and Imaging*. 9–16.