A Perceptual Measure for Deep Single Image Camera Calibration

Yannick Hold-Geoffroy*, Kalyan Sunkavalli†, Jonathan Eisenmann†, Matt Fisher†, Emiliano Gambaretto†, Sunil Hadap†, Jean-François Lalonde*

Université Laval*, Adobe†

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Motivation

Goals: 1) Estimate camera calibration from a single image;
2) Understand human sensitivity to those errors.

Approach

Method: Train DenseNet-169 on images extracted randomly from the SUN360 panorama dataset to estimate camera field of view and horizon.

Study: Show 10,638 pairs of images with un/distorted objects to 376 Turkers and ask their preference.

Human Sensitivity Performance

Using our user study, we can create a performance measure based on human perception to evaluate calibration errors.
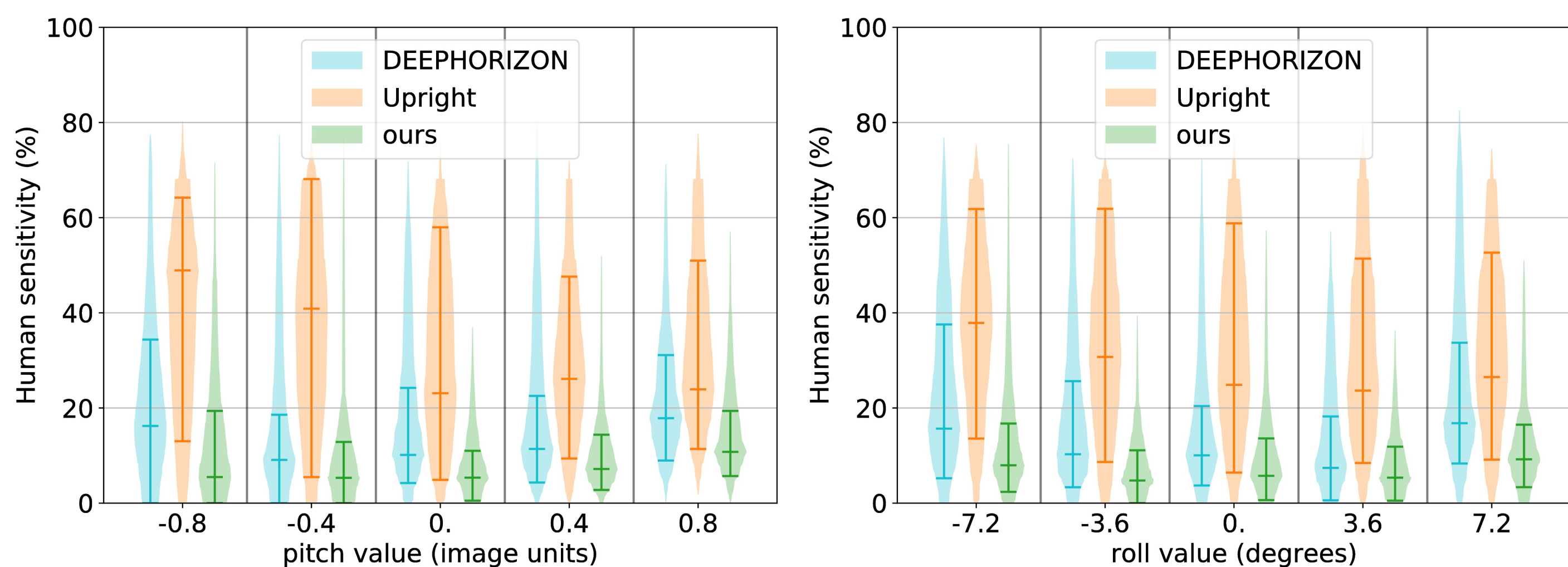
Horizon Estimation Results


ground truth   DEEPHORIZON   Upright   ours
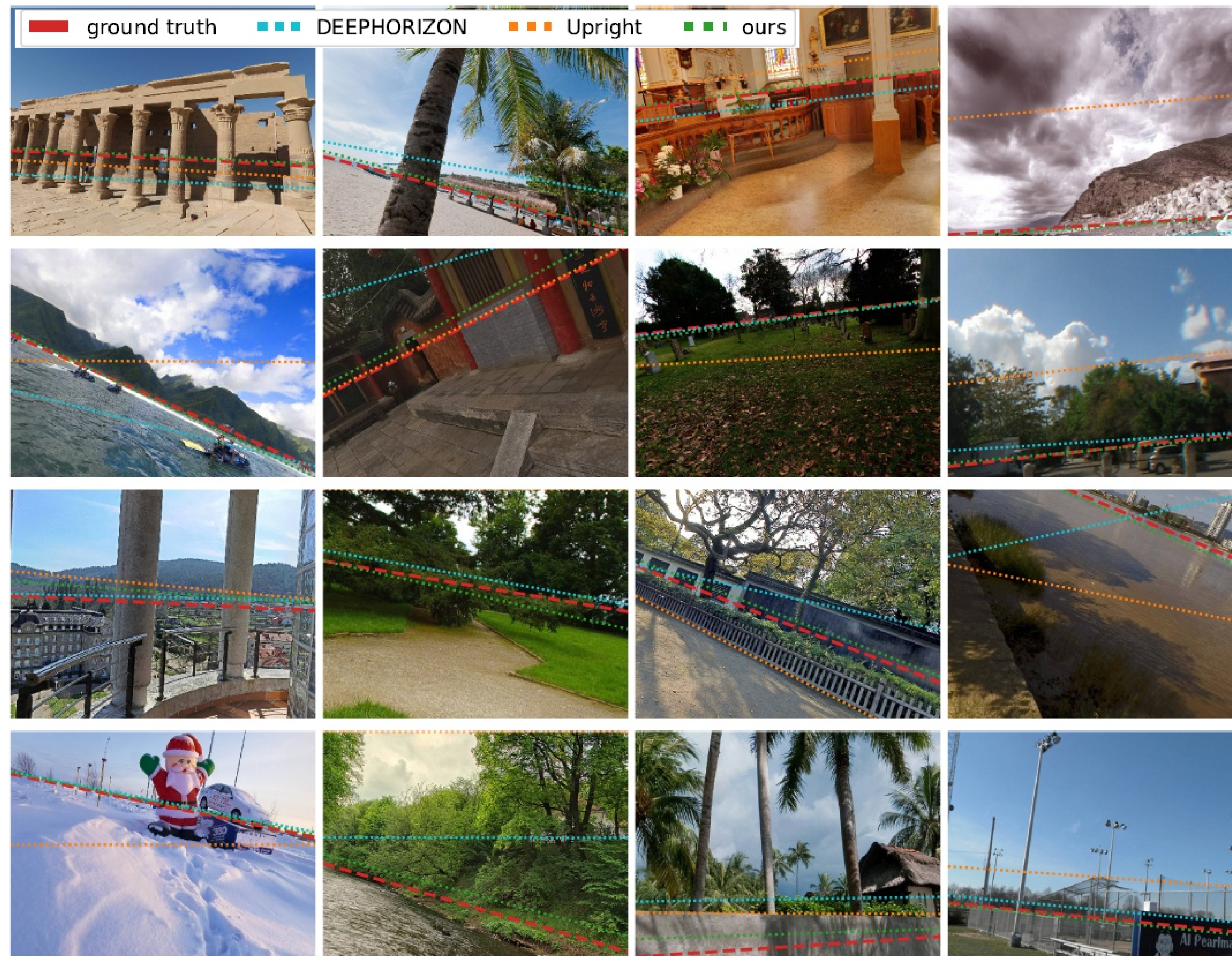
CNN Focus Analysis

We used smoothed guided backpropagation (jet overlay) to show the focus of our CNN. Note how important features (vanishing lines, sky/ground texture) are highlighted while the rest is ignored.

User Study

Examples of images and results from our user study. Note how humans are sensitive to roll, but only when the background image itself does not have roll. Furthermore, humans seem sensitive to images with high foreshortening effects and prefers less projection distortion.
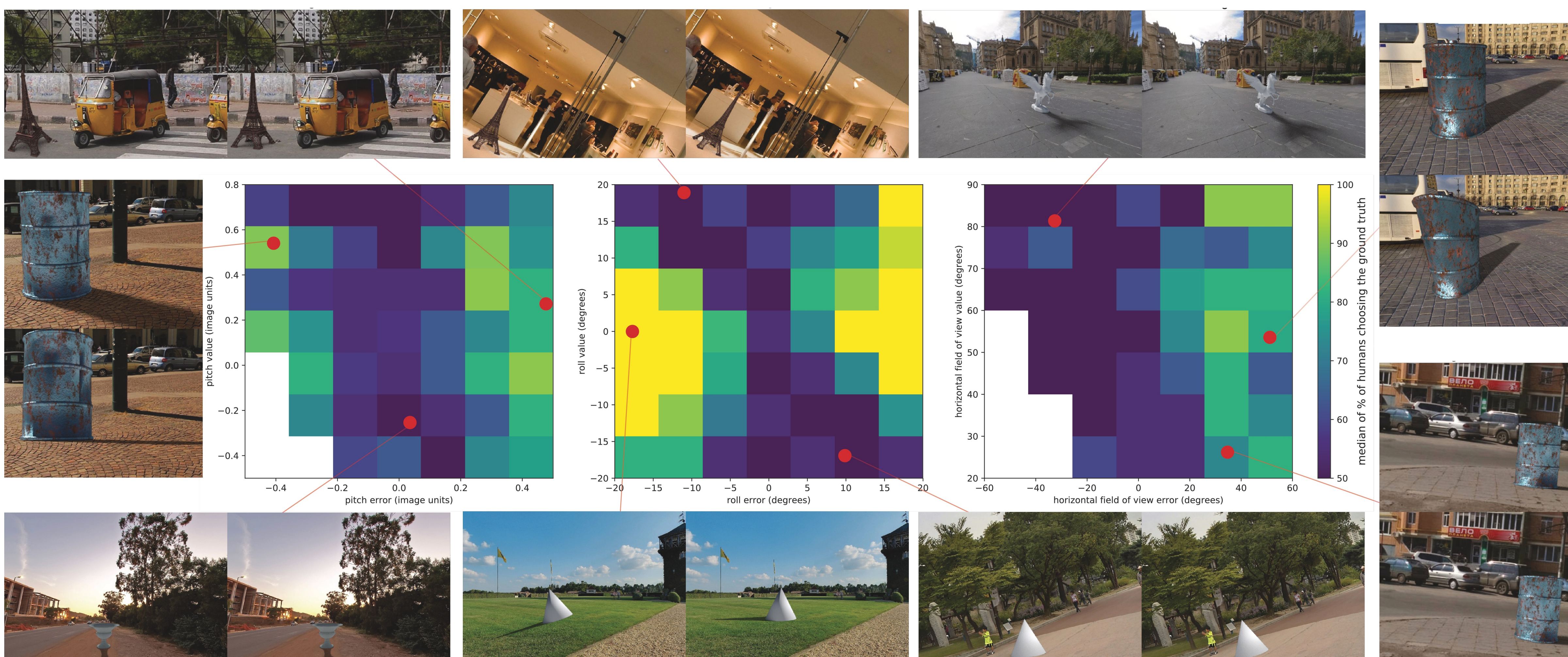
Virtual Object Insertion Results

Results on virtual object insertion using our camera calibration estimation. Outdoor lighting estimated by Hold-Geoffroy et al. (CVPR'17) and indoor lighting estimated by Gardner et al. (SIGASIA'17).

Method preference user study

We compared human preference between our method, DEEPHORIZON [Workman et al., 2016] and Upright [Lee et al., 2014] on virtual object insertion. Percentage represents each method's share of votes.

ours	DeepHorizon	Upright
46%	31%	23%

Image Retrieval Results

Given a query image, our approach can find images with similar horizon lines.

Query   NN1   NN2