Detecting Vanishing Points using Global Image Context in a Non-Manhattan World

Menghua Zhai, Scott Workman, Nathan Jacobs
{ted, scott, jacobs}@cs.uky.edu
http://cs.uky.edu/~ted

Goal

Given a single image, detect the horizon line and vanishing points without making a Manhattan-world assumption.

Algorithm Overview

1. Extract global image context (horizon-line prior) using a CNN.
2. Detect line segments using LSD [R. G. Von Gioi et al. 2010].
3. Localize zenith, using RANSAC to fuse prior and segments.
4. Sample horizon-line candidates using prior and the zenith direction.
5. Estimate vanishing points with many consistent line segments for each horizon-line candidate.
6. Extract global image context (horizon-line prior) using a CNN.

Definition of Global Image Context: A probability distribution over all possible horizon-line locations on the image.

Annotated training examples.

Inhomogeneous coordinates, lines and points are represented as three dimensional vectors. We define our consistency measurement between a line, \( l \), and a vanishing point, \( p \), as follows:

\[
\ell(p) = \max(0, -\Theta(p) \cdot \ell)
\]

where \( \Theta(p) = \cos(\psi(p)) \), and \( \ell \) is some threshold.

Horizon-Line Parameterization:
We use the slope/offset representation and uniformly discretize slope and offset (in homogeneous space) into 500 bins. We assume slope and offset are independent, which results in two 500-class classification problems.

CNN Training:
Replace the last layer of AlexNet with two fully-connected layers, one for slope and one for offset. We initialize our network with weights pre-trained for image classification on the ImageNet dataset.

Results

Main innovations:
• Use of global image context to sample possible horizon lines.
• A novel horizon-first framework for vanishing point detection.
• A novel discrete-continuous procedure to score each horizon line by choosing the optimal vanishing points for the line.

Our method is both more accurate and more efficient than the previous state-of-the-art algorithms.

Conclusion

Acknowledgement:
We gratefully acknowledge the support of DARPA (contract CSSG D11AP00255). The U.S. Government is authorized to reproduce and distribute reproductions for Governmental purposes notwithstanding any copyright annotation thereon.

IEEE 2016 Conference on Computer Vision and Pattern Recognition
CVPR2016