PanoContext: A Whole-room 3D Context Model for Panoramic Scene Understanding

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http://panocontext.cs.princeton.edu

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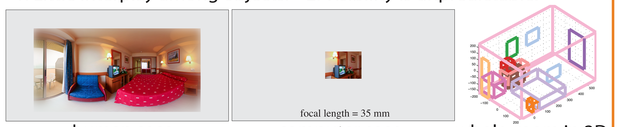
Motivation

Narrow feld of view:

1. Little interplay among objects. 2. Visibility is unpredictable.



human sees computer sees whole-room in 3D

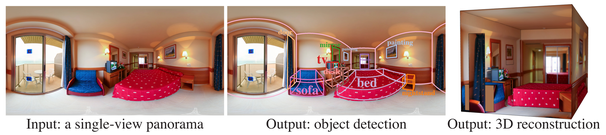
We desire a context model:

1. Whole-room: number of objects make sense; high-order statistics.
2. Non-parametric: model complicated distribution realistically.

context whole-room non-parametric

3. Built in 3D: more invariance in relative size and position.

Our Task



Input: a single-view panorama Output: object detection Output: 3D reconstruction

PanoContext:

Input: Single full-view panorama with 360 degrees FOV.
Output: Room layout and objects represented by cuboids.

2D/3D Panorama Dataset

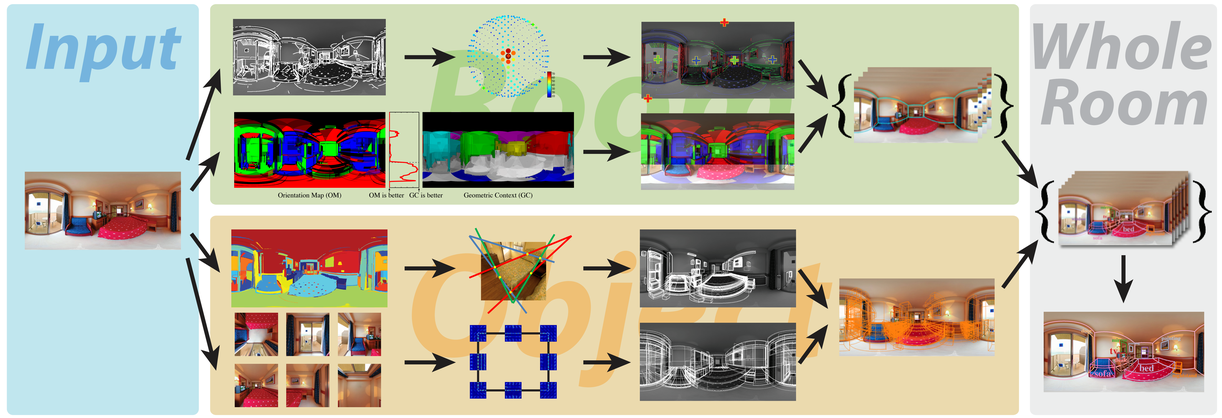
Annotation tool User annotation Initial Refined

Minimize reprojection error under constraints:

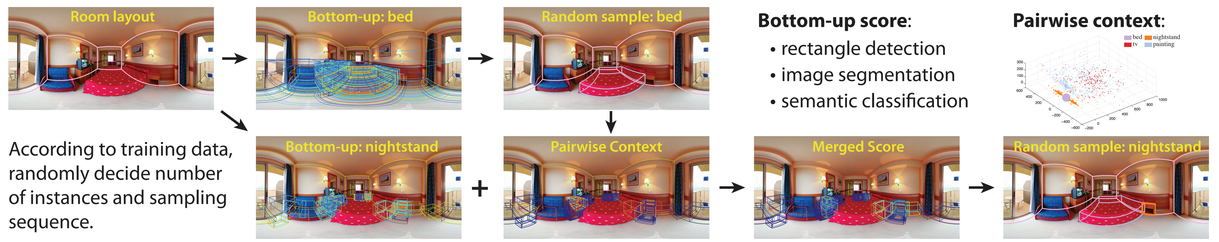
1. Must be perfect cuboids & rectangles. 2. Axis-aligned if possible.
3. All objects must be inside the room. 4. No small gap to walls.

bedroom: 539 living room: 448 bathroom: 317 counter: 140

Method



Data-driven Sampling



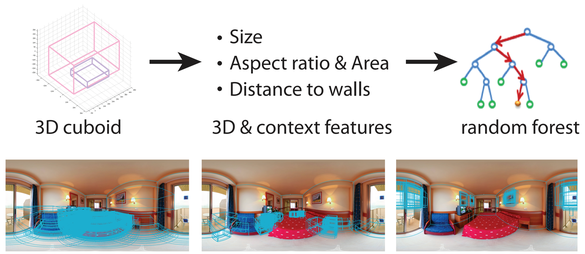
According to training data, randomly decide number of instances and sampling sequence.

Bottom-up score:

- rectangle detection
- image segmentation
- semantic classification

Pairwise context:

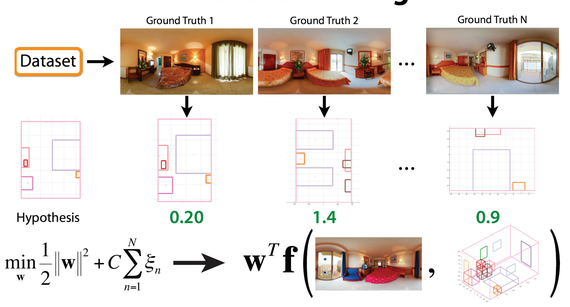
Semantic Classification



3D cuboid 3D & context features random forest

bed nightstand painting

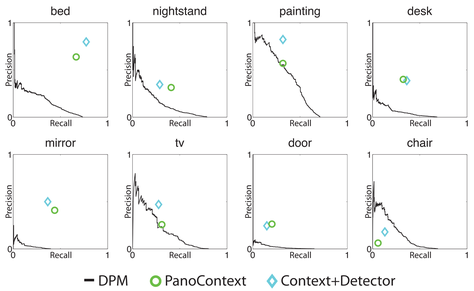
Holistic Ranking



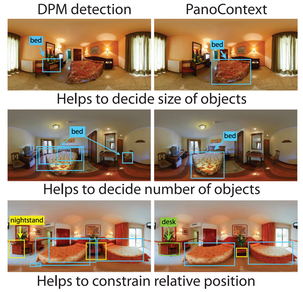
$$\min_{\mathbf{w}} \frac{1}{2}\|\mathbf{w}\|^2 + C\sum_{n=1}^{N}\xi_n \rightarrow \mathbf{w}^T\mathbf{f}\left(\quad,\quad\right)$$

Evaluation

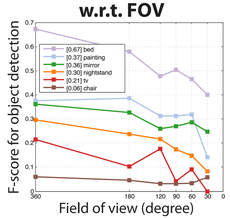
Object detection comparison



Advantage of 3D context

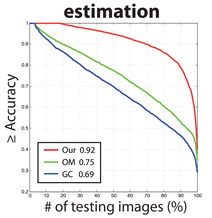


Object detection w.r.t. FOV



FOV must be smaller than the limit to get pairwise context during sampling.

Room layout estimation



We do this on 360°FOV; the other two work on images with 54.4°FOV.

More Results

bedroom

living room

room bed window door nightstand desk sofa chair coffee table
painting mirror cabinet wardrobe dining table tv stand end table tv