Acquisition of 3D Indoor Environments with Variability and Repetition

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Motivation
We explore the possibility of quickly acquiring indoor environments in large scale based on three observations:

• Most of indoor environments exhibit repeating elements (tables, chairs, monitors, etc)
• Man-made objects are generally formed of simple rigid parts and low-dimensional variability
• Mutual relationships among basic elements (floor, desk) provide a strong prior

Contributions
• Acquire proxy models of common indoor objects consisting of rigid parts, and their variability modes
• Detect occurrence of such models from single-view, low-quality scans
• Speed up large-scale indoor acquisition towards high-level scene understanding

Approach
**Learning phase** starts from registered scans, builds low-complexity models with their variability modes.

1. Primitive fitting (box or cylinder) for each scan.
2. Initial matching and alignment. We matched 2 primitives and 1 hinge joint.
3. Test remaining points with all configurations and replace by best configuration.

Use relationship with parts that are already discovered

- Match back and seat
- Mirror symmetry
- Rotational symmetry

**Recognition phase** starts from a single view scan, clusters points and quickly populates learned objects along with deformation parameters

- **MRF formulation** compares segments in clusters \((s_i)\) against parts in learned model \((m_j)\) by unary term \(D\) and pair-wise term \(V\)

\[
E = \sum_i D(s_i = m_j) + \eta \sum_{i,j \neq i} V(s_i = m_j, s_j = m_j)
\]

where \(E\) is the energy to be minimized, \(D\) is the data term, \(V\) is the pair-wise term, \(\eta\) is a positive constant, \(s_i\) and \(m_j\) are the variables taking values in the space of the possible configurations of parts and models, respectively.

geometry, distance from ground consider joint parameters

Results

**office**

- monitor
- chair
- trash bin

**auditorium**

- open tables
- change detection
- open seat

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