Advanced 3D Point Cloud Processing with Point Cloud Library (PCL)

ICRA 2012

PCL People - Koen Buys (University of Leuven)

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1. What
2. How
3. Learning
4. Runtime
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What is this all about

- Human pose detection and tracking
- Human recognition
- Applications in:
  - Human robot interaction
  - Medical field
  - Entertainment
  - ...

Koen Buys / Point Cloud Library
Why

- Triggered by work of J. Shotton MSR
- OpenNI NITE library
Why

OpenNI

- BG-subtraction based
- Model-based
- Segfaults
- Fixed camera
Not model-based
Assumes BG-subtraction
Classifies each pixel
Runs mean-shift
Why

Motivation

- Moving platform
  - No BG subtraction
  - Separate segmentation and pose estimation?
- Cluttered scenes
- SDK gives only skeleton
- Processing power
- Open Source, modular
How

Workflow

- Build 'human' database
- Synthesize training data
- Train RDF trees on this data
- Run labeling based on RDF
- Search within kinematic constraints
- Evaluation global consistency
- Temporal tracking
- Build 'human' database
- **Synthesize training data**
- Train trees on this data
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Workflow

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MapReduce problem
Solved in Hadoop
3 Trees, 20 levels
2000 features/pixel
2000 pixels/image
290GB features for single person in 80k poses
7 day training
Training Problems

Training

- 1 Person is limited
- 80k poses is not enough
- > more data
Runtime

Workflow

- Label PointCloud
- Search feasible blobs
- Build local consistency map
- Find local consistency tree
- 3D Grabcut
- Iterate again
Label PointCloud
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First Iteration
- Noisy skeletons
- Clusters
- Pixel labelling

Second Iteration
- Final skeleton
- Clusters
- 3D Segmentation
- Refined label

Time:
- t-1
- t
- t+1

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Overview

Body Pose + Parameter Estimation
\[ p(X_C \mid \{c, l, x\}) \rightarrow p(X_R \mid \{X_C\}) \]

Body Part Evaluation and Pose Estimation
\[ p(c \mid \{l, x\}) \rightarrow p(X_C \mid \{c, l, x\}) \]

Pixel-Body Part Labeling
\[ \{l, x\} \rightarrow p(c \mid \{l, x\}) \]

RGBD Sensor
Organized PointCloud XYZRGB

Time t

Time t+1

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Examples

Positive
Examples

Clutter
Clutter
Requirements

- Fermi, Kepler GPU
- CUDA Toolkit 4.x
- RGBD camera, organised and projectable
Input:
- (RGB)-D

Output:
- BG/FG Segmentation
- Skeleton
- Pixel labeling
Code is in trunk in gpu/people:

```
people_app -numTrees 3 -Tree0 treefile.txt -Tree1 treefile.txt
-Tree2 treefile.txt -Tree3 treefile.txt
```

Contained in single object:

```
PCL::PeopleDetector peopledetector;
peopledetector.process(cloudhost);
or:
peopledetector.processProb(cloudhost);
```
Demo
What next?

- Early tests
- Thesis student work
Who

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- ...

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Questions?