Detecting Fine-grained Affordances with an Anthropomorphic Agent Model

Viktor Seib, Nicolai Wojke, Malte Knauf, Dietrich Paulus

{vseib, nwojke, mknauf, paulus}@uni-koblenz.de

Active Vision Group, http://agas.uni-koblenz.de

University of Koblenz-Landau, Germany

Motivation

- ➤ distinguish affordances on a fine-grained scale
- ➤ allows for detailed scene analysis
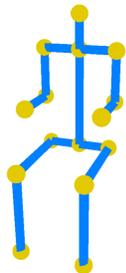
- ➤ example: sitting affordance

sitting ...

... w/o backrest   ... with backrest   ... with armrest   ... with headrest

Models

Anthropomorphic Agent

- ➤ models typical human body proportions
- ➤ directed acyclic graph
- ➤ (non-leaf) nodes: joints, movement restrictions
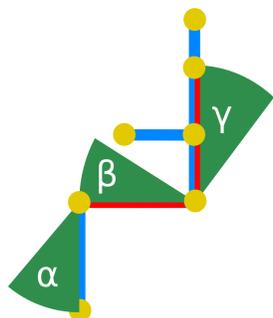- ➤ edges: parameterized spatial relations between joints

Affordances

- ➤ α, β determine valid heights, γ determines valid plane inclination
- ➤ supporting plane size must be in $[D_{min}, D_{max}]$ percent of agent width
- ➤ support has to be present in contact area (red)
- ➤ feet must touch the ground
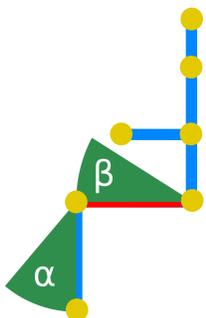
sitting without backrest   sitting with backrest

Algorithm

- ➤ feature-centered algorithm for fine-grained Affordance Detection for sitting affordances

Require: Point cloud P, Affordance models f_1, f_2, Agent model H
Ensure: Point cloud with segmented affordances P_1 and P_2

```
    E ← segmentPlanes(P)
    S ← ∅
    for all horizontal planes p ∈ E do
        if supportsModels(p, H, f₁) then
5:          S ← S ∪ p
        end if
    end for
    for all s ∈ S do
        V ← vertical planes ∈ E close to s
10:     if supportsModels(v, H, f₂) and v is biggest plane ∈ V that supports the models
        then
            P₂ ← P₂ ∪ v
            P₂ ← P₂ ∪ s
        else
            P₁ ← P₁ ∪ s
15:     end if
    end for
```

Experiments and Results

- ➤ dataset: RGBD point clouds
- ➤ positive samples: 294 views of 3 stools, 17 chairs
- ➤ negative samples: 109 views of 9 objects (bed, desks, tables, etc.)
- ➤ 59 parameter combinations tested in 2 rounds
- ➤ evaluation using the F-measure: $\text{F-measure} = \frac{2 \cdot precision \cdot recall}{precision + recall}$

Sitting Without Backrest
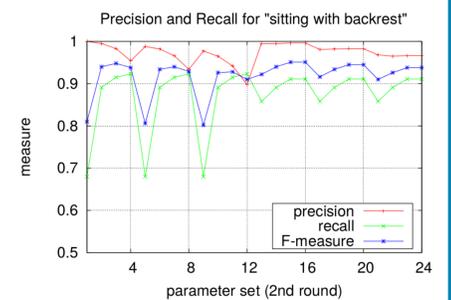
- ➤ "plateaus": α, β between 20° and 40°
- ➤ low values for decreasing D_{min}
- ➤ almost stable for increasing D_{max}
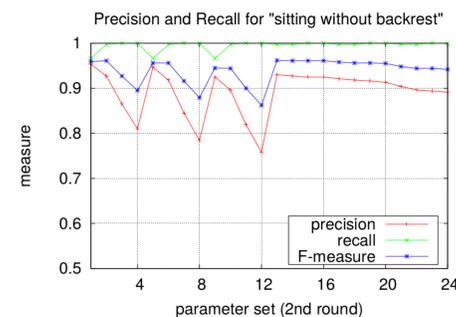
Sitting With Backrest

- ➤ very sensitive to D_{min} and D_{max}
- ➤ little influence by γ
- ➤ lower values for high D_{min}

- ➤ best F-measure values

	sit. w/o backrest	sit. with backrest
best w/o backr.	0.962	0.922
best with backr.	0.961	0.951

- ➤ best parameters

| α, β	γ	D_{min}	D_{max}
30°	35°-40°	0.5	1.4-1.6

Conclusion and Outlook

- ➤ promising results on distinguishing two closely related affordances
- ➤ fine-grained affordances allow for implicitly classifying stool and chair

Future Work

- ➤ use fuzzy logic for parameter tests
- ➤ include more fine grained affordances
- ➤ extension to an agent-centered algorithm
- ➤ evaluation on a bigger dataset
- ➤ reduce number of parameters (e.g. get rid of D_{min} and D_{max})
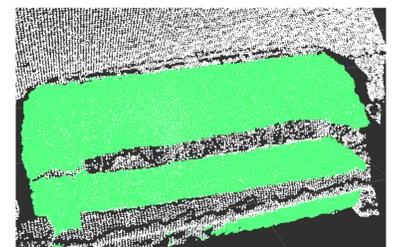
(detection of the sitting with backrest affordance on a sofa with modified D_{max} parameter)

UNIVERSITÄT KOBLENZ · LANDAU

COMPUTERVISUALISTIK

AGAS