Context-aware Intelligent Assistant
Assistance

Introduction

Servant

Valet

Secretary
Introduction

Siri

S Voice

Intelligent Assistant

[15]
Intelligent Assisting Devices

Amazon Echo

WIMM One

[16]
AR Intelligent Assisting Devices

Google Glass

CastAR

Moverio BT-200

[15], [16], [17]
AR Intelligent Assisting Devices
Privacy concerns

- What is recorded?
- Where does the data go?
- What is done with it?
- Who can see it?
Introduction

Context

Where you are

Who you are with

What resources are nearby

[4], [6]
Context-aware Intelligent Assistant

- Recognize current context of the situation
- Use context to help with a task
- Make predictions about the future
Road map

Introduction

Tracking of manual workflows
Guiding Block Assembly
Situation Awareness for In-Car Recommendations

enactive
proactive
Real-time Modeling and Tracking Manual Workflows from First-Person Vision

German Research Center for Artificial Intelligence (DFKI)
Goal

- Augmented Reality manuals
- Follow the progress of a user
- Show the next steps
- Indicate errors
Introduction

Real-time Modeling and Tracking
Manual Workflows from First-Person Vision

See furniture installed in your apartment
Ikea Manual

Introduction
Real-time
Modeling and
Tracking
Manual
Workflows from
First-Person
Vision
Show how it's done
Intelligent Augmented Reality Manuals
Approach

- Record with head-worn camera
- Analyze video sequences
- Record hands position during training
- Show the hand position for enactive feedback*
- Provide optical validation

*enactive feedback – there is an ongoing interaction between user action and the system
Process diagram

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Real-time Modeling and Tracking
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- Record Workflow
- Camera tracking
- Sequence into subtasks

- Project hand map on user view field
- Hand position map
- Estimate hand position
Camera tracking

- **Initialization:**
  - Select arbitrary corner features.
  - Find correspondences in the next frame with KLT.
  - Use RANSAC to find the largest subset \( P \) which can be described using a homography \( H \).
  - The subset \( P \) is used at a later step.
Camera tracking

- **Work step**
  - P as input from previous frame
  - Use KLT and RANSAC to find next $H$
  - Find new corner features across the entire image
  - Find correspondences in the next frame and reject points that cannot be described with $H$
Task segmentation

- **Image difference function:**
  \[ d(I_1, I_2) \to R \]

- **Strong camera movement:**
  - Translation
  - Rotation
Introduction

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Hand position
Application

Enactive feedback

![Image of enactive feedback]

Introduction
Real-time Modeling and Tracking
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Optical validation
### Conclusion

- Depth inferred from video sequences
- This approach works only in static environment
- Different lighting may be a problem
DuploTrack: A Real-time System for Authoring and Guiding Duplo Block Assembly

Introduction
Real-time Modeling and Tracking Manual Workflows from First-Person Vision

DuploTrack: A Real-time System for Authoring and Guiding Duplo Block Assembly
Goal

- Produce assembly manuals
- Track user actions
- Show next step
- Detect mistakes
Traditional manuals

Figure-based:
- Difficult to create
- No motion cues
Traditional manuals

Video based

+ Pause, repeat
+ Motion cues
- Possibly different view point
- Still no feedback
Augmented Reality

- Expensive equipment needed
- Static models
- Motion cues from head motion only
Overview

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Authoring

Guiding
DuploTrack Demonstration

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DuploTrack: A Real-time System for Authoring and Guiding Duplo Block Assembly
Processing pipeline

Introduction

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DuploTrack: A Real-time System for Authoring and Guiding Duplo Block Assembly
Tracking the model

- User may rotate and shift model in the Play area
- Lose of tracking if turned upside down
- The point cloud is aligned with virtual model
  - Iterative Closest Point (ICP)
Model tracking at the beginning

- Poor tracking for models with under 5 blocks
  - Noise from Kinect
  - Outliers overwhelm the points before an update

- Solution: Place the model on the table before reaching 5 blocks
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User study

Test guidance system

Baseline

Track
User study, Two Tasks

Single block and multiple blocks addition

(a) Model A  (b) Model B  (c) Model 1  (d) Model 2  (e) Model 3

(f) Model 4  (g) Model 5  (h) Model 6  (i) Model 7  (j) Model 8
Results, one block

- 21.8 seconds for Baseline
- 18.9 seconds for Track
- 14% of improvement
- 3 mistakes with Baseline
- 0 with Track
Results, one block

\[ \text{speedup} = 100 \times \left( \frac{\text{Time(Baseline)}}{\text{Time(Track)}} - 1 \right) \]

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Results, multiple blocks

Times to add blocks one after the other

(a) Model A.  (b) Model B.
Results, multiple blocks

- Model A
- 11.6s Track
- 17.3s Baseline
- 7 mistakes Baseline
- 0 mistakes Track
Results, multiple blocks
<table>
<thead>
<tr>
<th>Results, multiple blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Model B</td>
</tr>
<tr>
<td>• 10.03s for Track</td>
</tr>
<tr>
<td>• 10.22s for Baseline</td>
</tr>
<tr>
<td>• 0 mistakes for both interfaces</td>
</tr>
</tbody>
</table>
Results, multiple blocks

![Graph showing percentage speedup against mean time for a step using Baseline (seconds).]
Results, qualitative feedback

- 11 of 16 participants preferred Track
- 3 participants preferred Baseline
- All said Track was more enjoyable
Results summary

- Track increased on average the speed and accuracy
- For some participants negative speedup
- For more complicated models the results may be even better
Future work

- Extend system to handle smaller blocks
- Different shapes
- Furniture assembly
- Home repairs
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Situation Awareness for Proactive In-Car Recommendations of Points-Of-Interest (POI)

- Recommendation system for in-car context
- Fuel stations, restaurants, parking lots
Driver's attention

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Situation Awareness for Proactive In-Car Recommendations of Points-Of-Interest (POI)
Proactive system

User above the interaction loop

Resource: Driver's attention

Focus: Relevance of information - The right information at the right time to the right user
Three levels of situation awareness

- Level 1 context sensing
- Level 2 situation comprehension
- Level 3 projection into the future
Model for Situation Awareness in Proactive Systems

- Fuzzy logic values between 0..1
  - Certainty expression
  - No abrupt behavior

[7], [20]
Model for Situation Awareness in Proactive Systems

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Situation Awareness for Proactive In-Car Recommendations of Points-Of-Interest (POI)
IF fuel_level == empty THEN relevance_fueling = high
Model for Situation Awareness in Proactive Systems

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Situation Awareness for Proactive In-Car Recommendations of Points-Of-Interest (POI)
IF fuel_level == empty AND distance == close

THEN relevance_fueling = high
## Evaluation

- Fuel level and station reachability
- Connection fuzzy variable
- Low fuel stations coverage area
- 40 liters gas, 20 reachable stations
- 800km
Evaluation

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Future work

- More complex scenarios

- User study

- Comparison to other models
Summary

- **Assistant**
  
  Helps with some task, trust issues

- **Intelligent assistant**
  
  Privacy issues

- **Context**
  
  Characterize a situation
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Summary

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Guiding Block Assembly

Situation Awareness for In-Car Recommendations

Guiding systems

Recommender system
Papers:


References (2)

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Images:

- [17] CastAR: http://media.bestofmicro.com/N/M/433714/original/castar3.png (12.05.2015)
Images:
