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Performance comparison of four 3D tracking systems for in-factory applications

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Loughborough University, Intelligent Automation

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Overview

- Workspace digitalization
- Tracking technologies -- focus: cameras
- Comparing tracking systems
- Monitoring workspace components: humans

- **Workspace digitalization**
  - Tracking technologies -- focus: cameras
  - Comparing tracking systems
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Workspace digitalization

What?

- **workspace awareness**
  - In real-time
  - Human + robots + parts

https://robohub.org

Workspace digitalization

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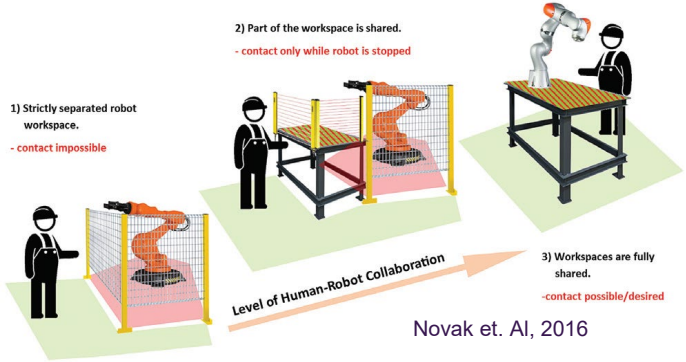

Novak et. Al, 2016

© Pilz

Why?

- **Security & safety**
  - Human + robot in same space
  - Worker health: postures, collisions
- **Productivity & efficiency**
  - Human-robot collaboration
  - Process design and monitoring
  - Error/failure detection (e.g. assembly)

Siemens

Assemblymag.com

- Workspace digitalization
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Tracking technologies

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Existing technology

Camera: Good for digitalization

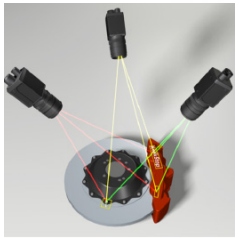
Active marker	Passive marker	Marker-less	Other
Optical CMM (Nikon K-CMM)	Camera based (Vicon) Laser tracker	Camera based Pattern projection (Ensenso, Kinect, David scanner)	Safety dedicated (Pilz SafetyEye)
Fast, good accuracy, robust Expensive, markers + wire	Fast, good accuracy, robust Expensive, needs markers	**No markers, universal** Slower (data+), resolution	Fast, proven Dedicated role

Nikon

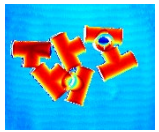
Faro

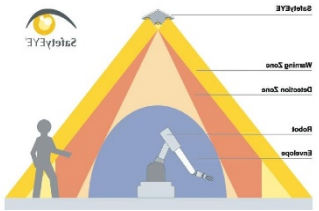
Vicon

Ensensno



Cognex





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Tracking technologies: camera-based

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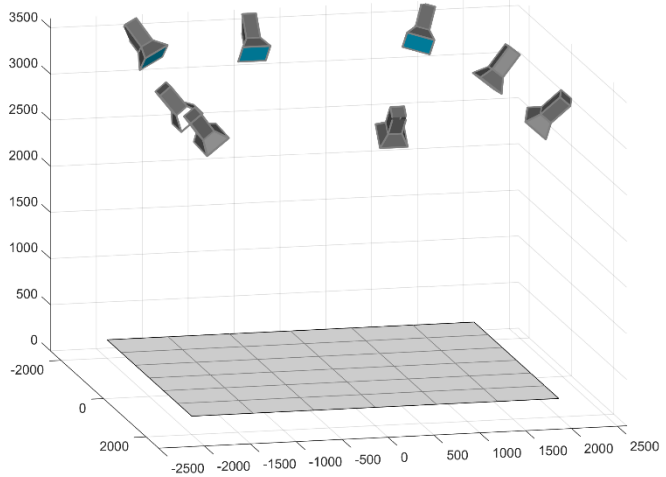
Proposed approach

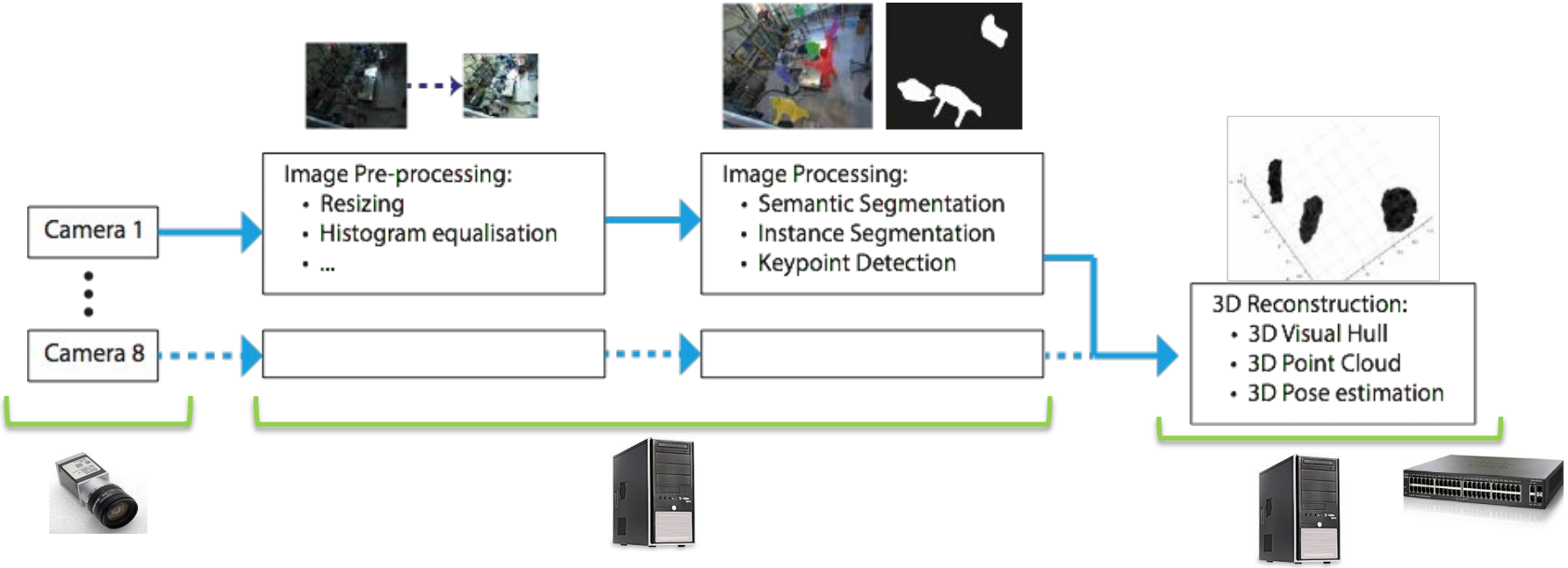
Use cameras

- Decent speed
- Large volume
- Extendable
- Generic
- AI needed



Tracking technologies: camera-based

Proposed architecture



- Workspace digitalization
- Tracking technologies -- focus: cameras
- **Comparing tracking systems**
- Monitoring workspace components: humans

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Camera system benchmark

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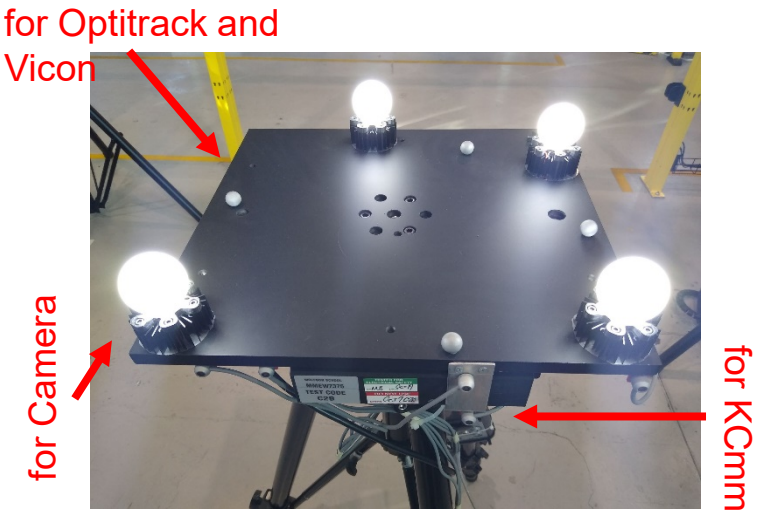
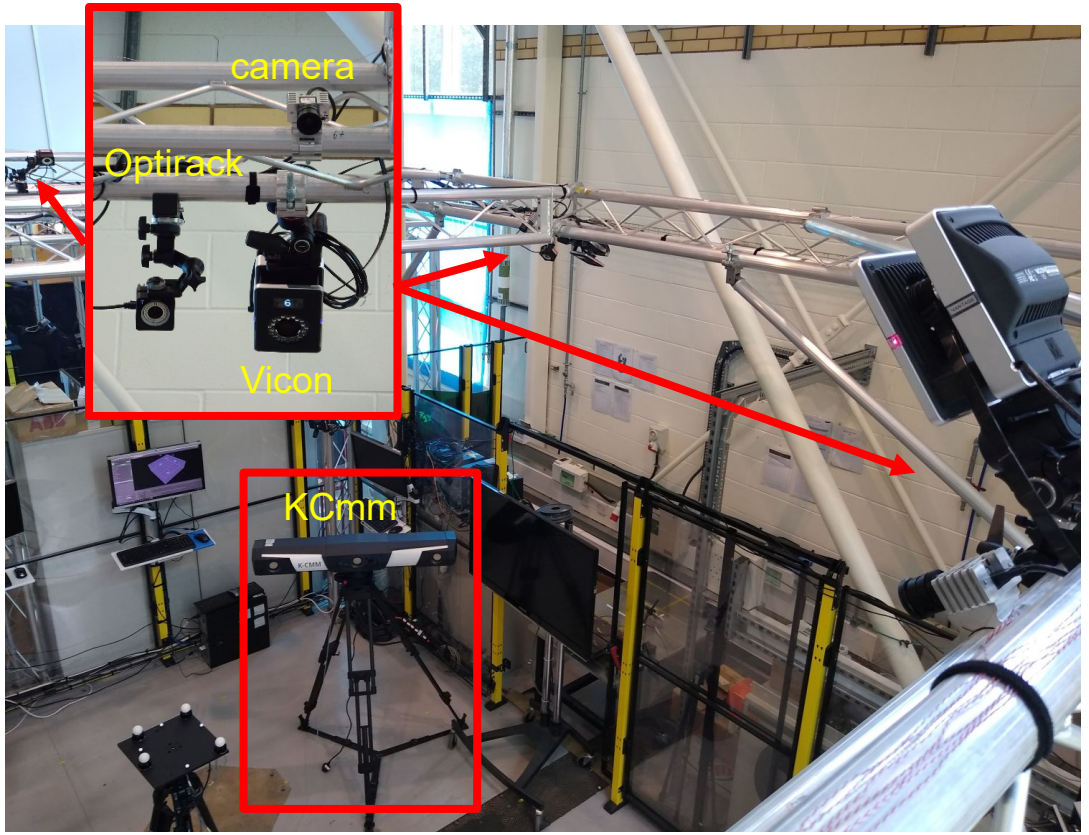
How to compare systems?

- Similar arrangement
- Common artefact





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Camera system benchmark

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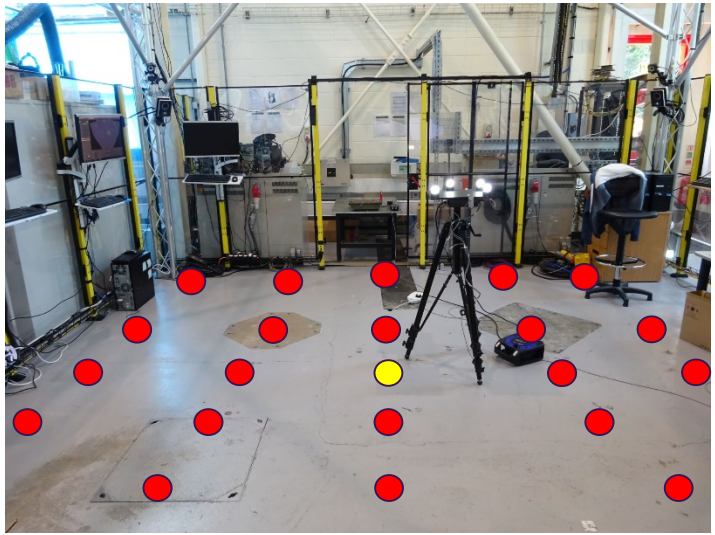
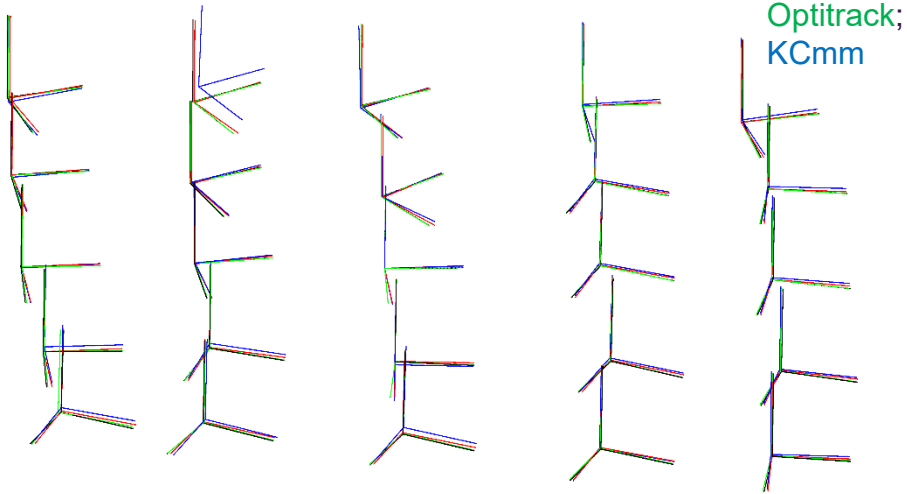
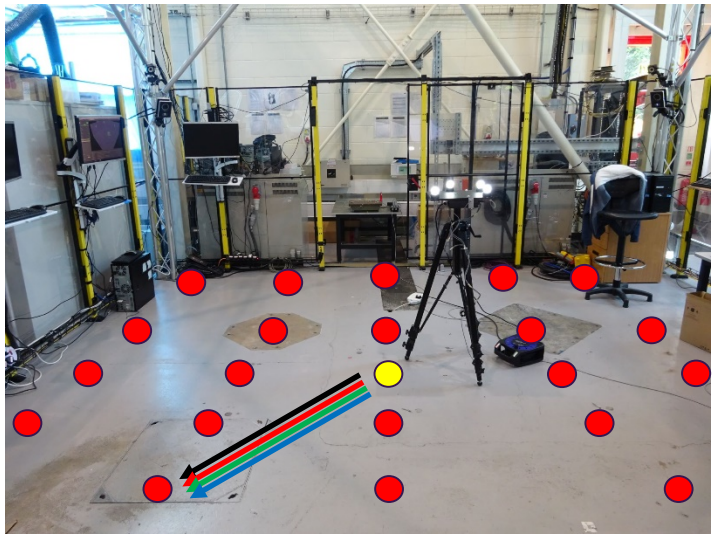
- **Direct comparison throughout cell: pose measurements**

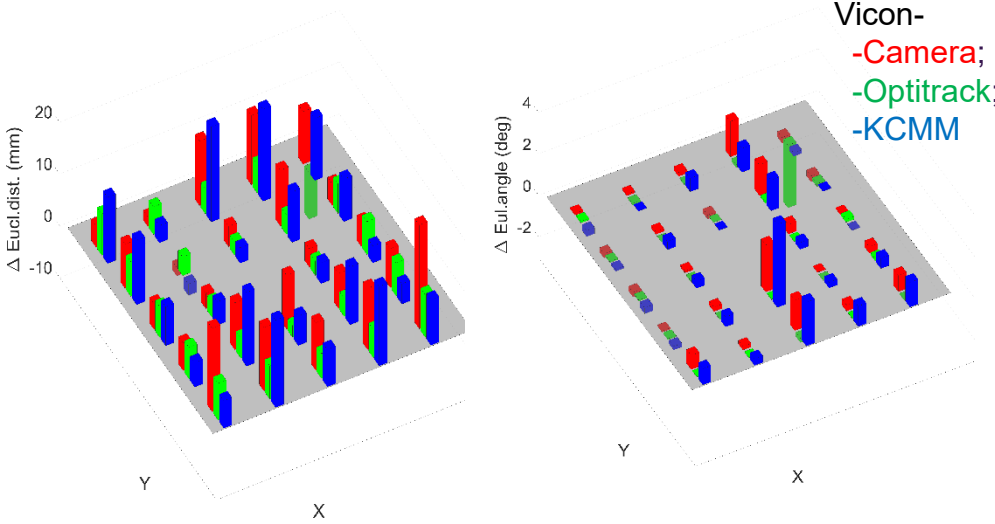




Camera system benchmark

- **Direct comparison throughout cell: pose measurements**

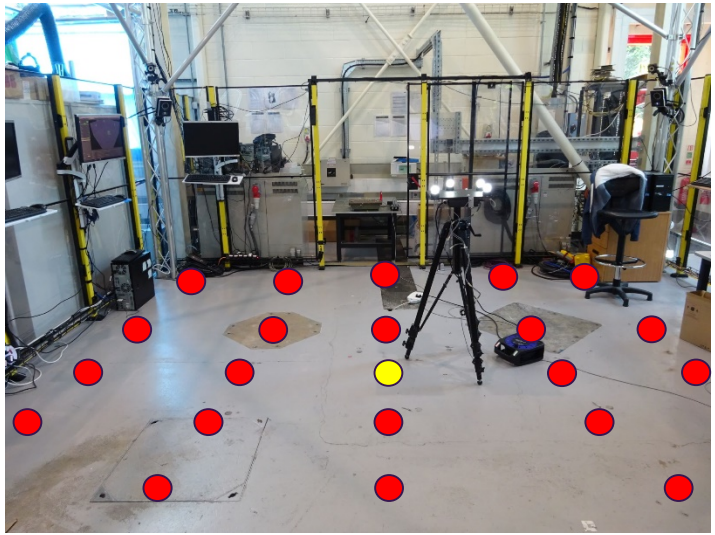


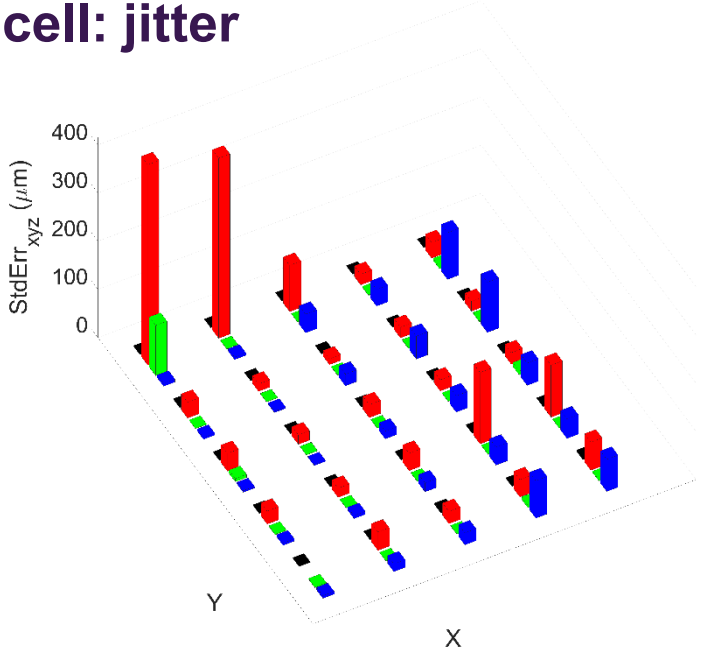


- within 30mm and 5deg … not absolute truth
- Camera and KCMM match better
- good enough for monitoring/tracking

Camera system benchmark

- **Direct comparison throughout cell: jitter**





Vicon
Camera;
Optitrack;
KCMM

- Mostly low jitter, except:
  - Low coverage edge
  - Moved KCMM

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Camera system benchmark

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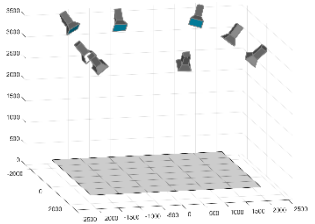
- **Speed**
  - Vicon: 2kHz (interp.)
  - KCMM: 1kHz
  - Optitrack: 240Hz
  - Camera: 40Hz
    - hardware / detection limited
    - can be enhanced (cam+ or GPU+)



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Workspace digitalization: cameras

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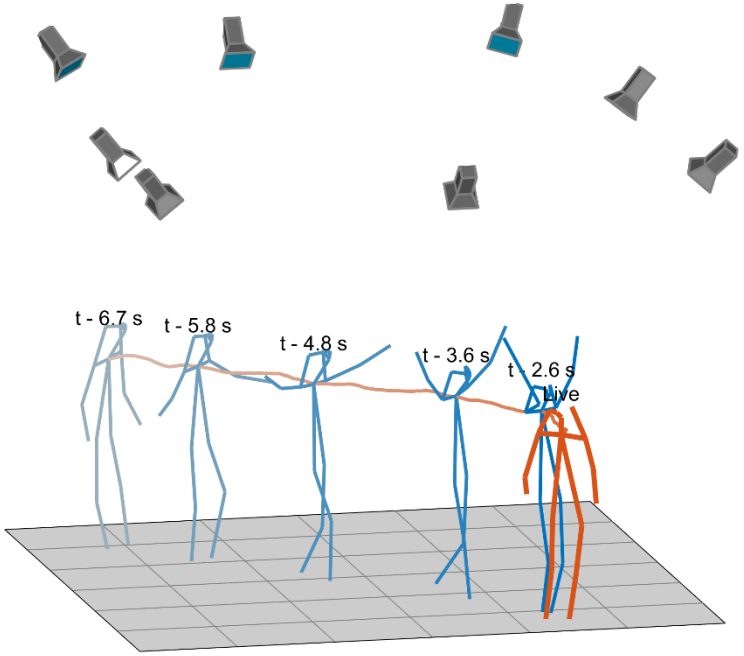
- **Object identification and tracking**

  → Humans

  → Other: AI training



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Human tracking

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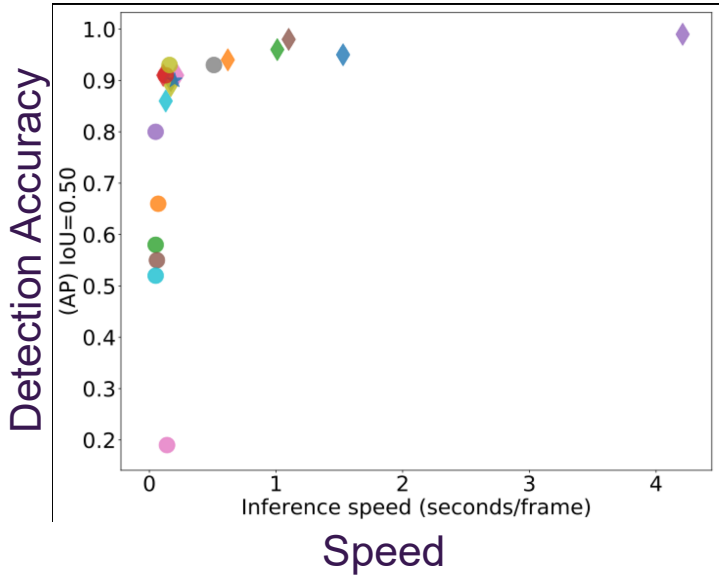
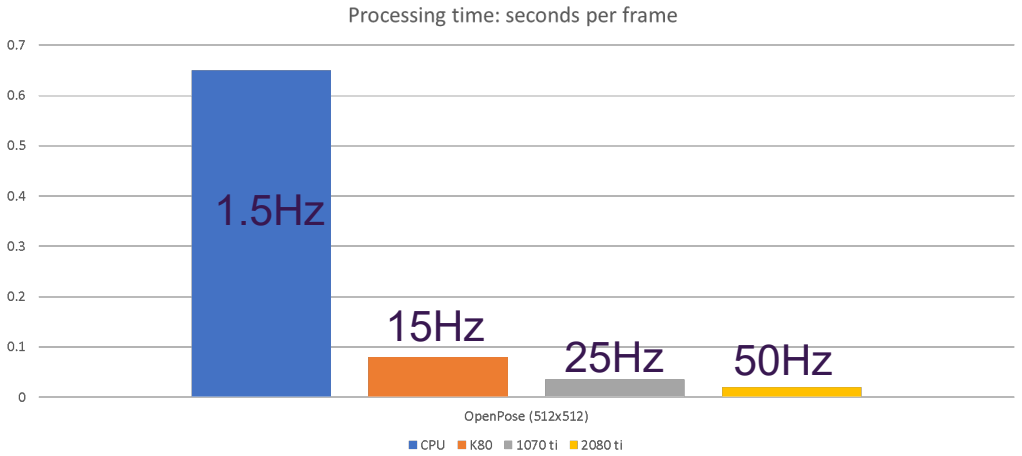
How fast?

- Camera limit (40Hz)
- Processing (variable, 50Hz+)



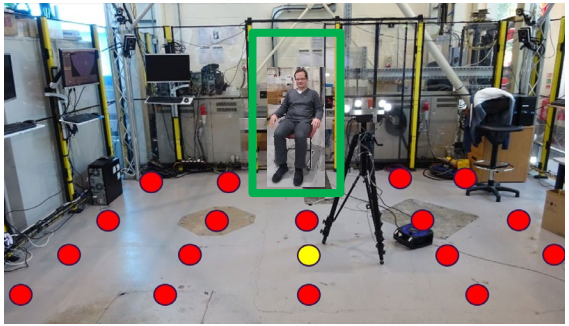
Segmentation Speed

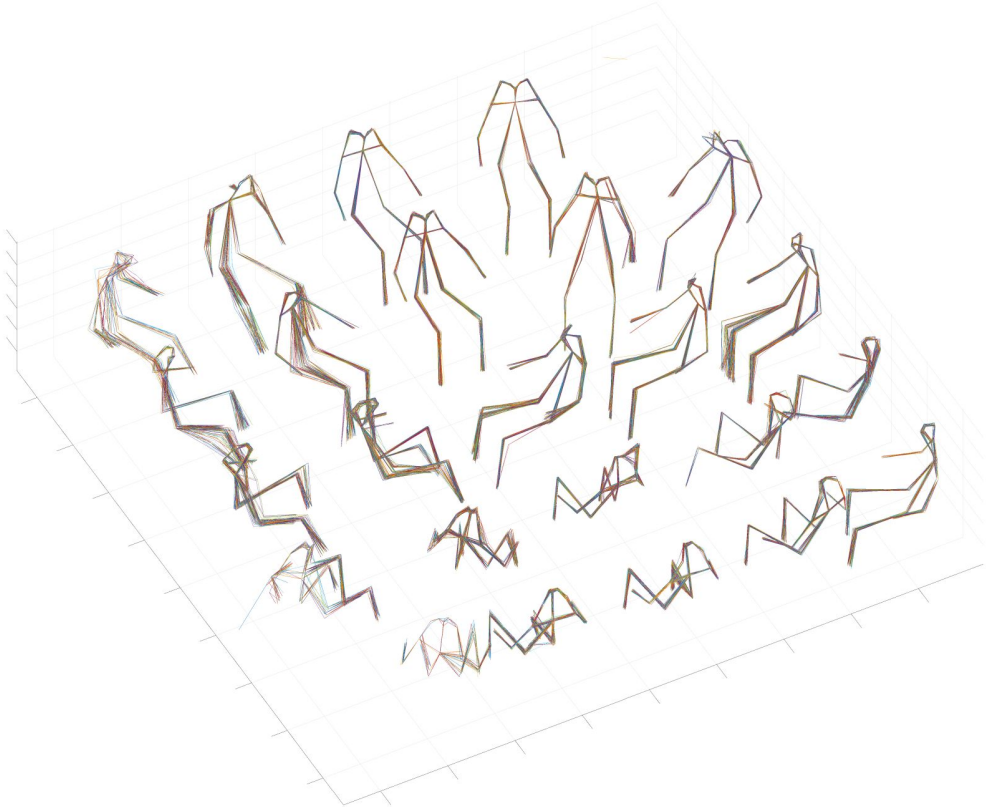


Human tracking

How well?

- System inaccuracy (object)
- Detection jitter

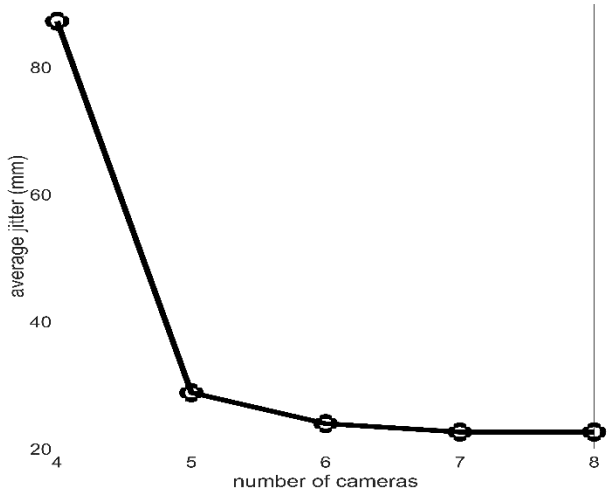


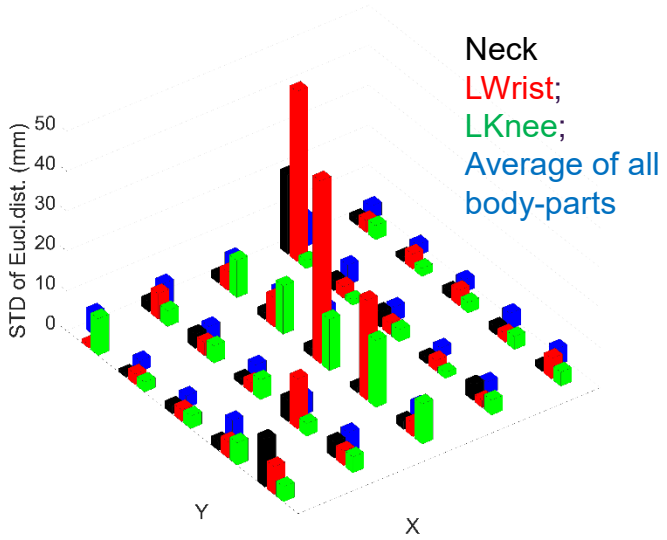


Human tracking

How well?

- Detection jitter
  - Higher then system inaccuracy
  - Body-part specific
  - Pose / Visibility specific





Conclusions

- Marker-less tracking applicability proven
- Comparable spatial accuracy with commercial systems, slower
- Human tracking trials promising
- Need AI for more industrial objects

Thank you!

- questions?

- posters

- demo