AR (Augmented Reality) in robotics

Steffen Haesler - 2014 / 11 / 03

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    - Overview
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    - Conclusion
- Discussion

[1]Mario Gianni, Federico Ferri, and Fiora Pirri
ALCOR Laboratory, DIIAG, Sapienza University of Rome, Rome, Italy

Augmented Reality

What is Augmented Reality?
What is the difference to Virtual Reality?

Augmented Reality (AR)

Definition: Augmented reality is a system that enhances the real world by superimposing computer-generated information on top of it.

Borko Furht (Ed.), Encyclopedia of Multimedia, Springer 2008, p. 35

Augmented Reality (AR)

Augmented Reality:

- Combines real and virtual
- Interactive in real time
- Registered in 3D

Ronald T. Azuma, A survey of augmented reality. In: Teleoperators and Virtual Environments 6, 1997, pp-355-385

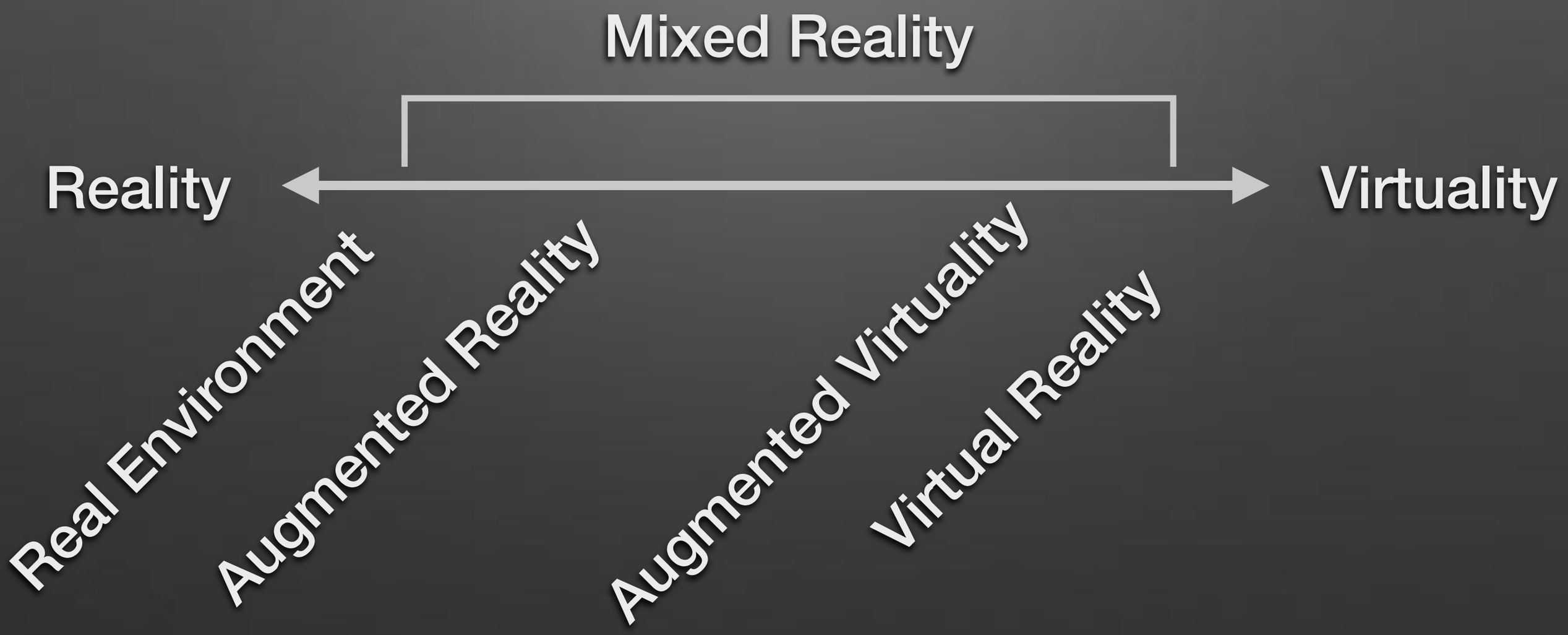
Augmented Reality (AR)

Definition: Augmented reality is a medium in which digital information is overlaid on the physical world that is in both spatial and temporal registration with the physical world and that is interactive in real time.

Aland B- Craig, Understanding Augmented Reality, Elsevier 2013, p. 20


DINER
SHERIFF

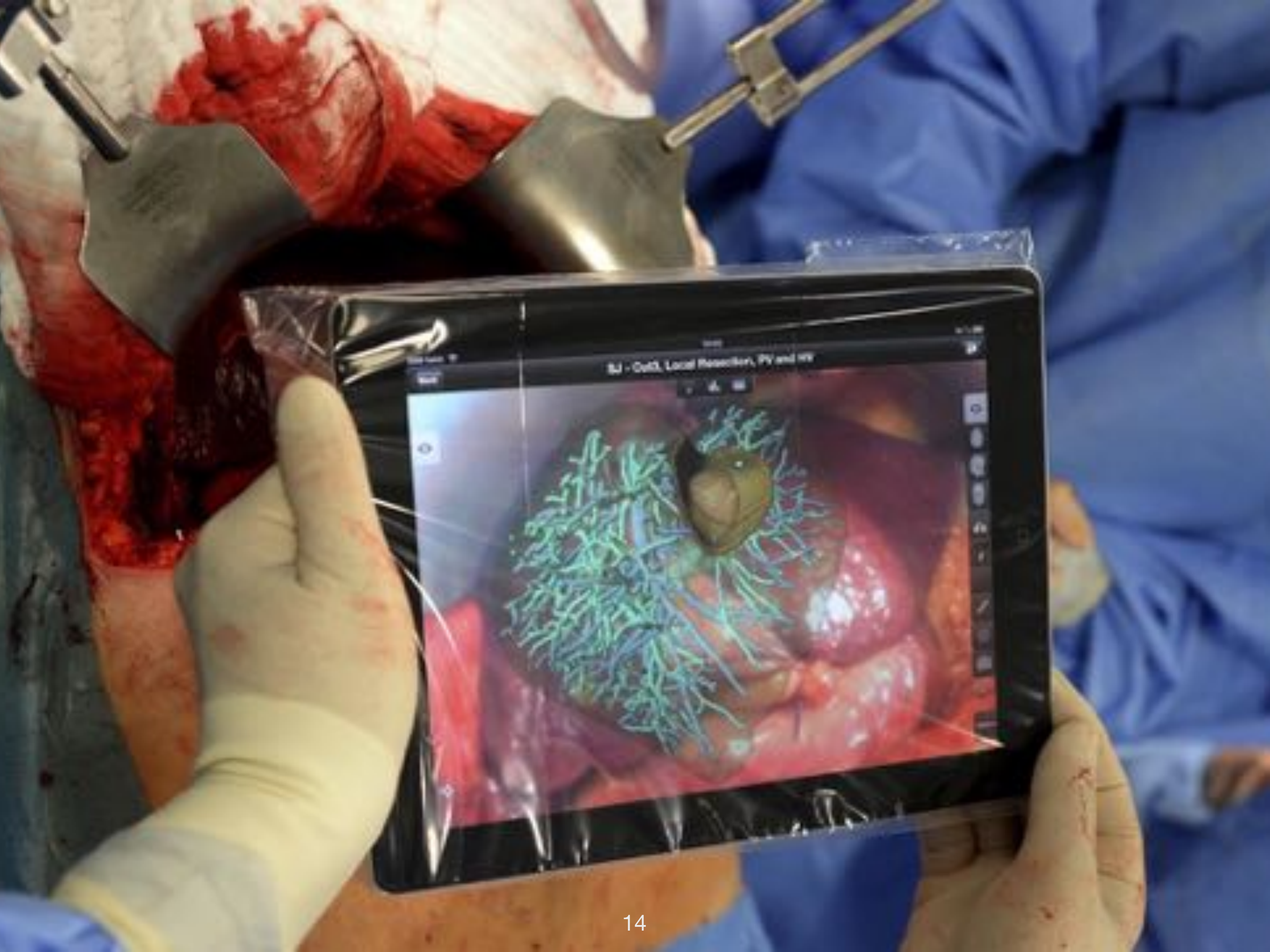
Virtual Continuum



Aland B- Craig, Understanding Augmented Reality, Elsevier 2013

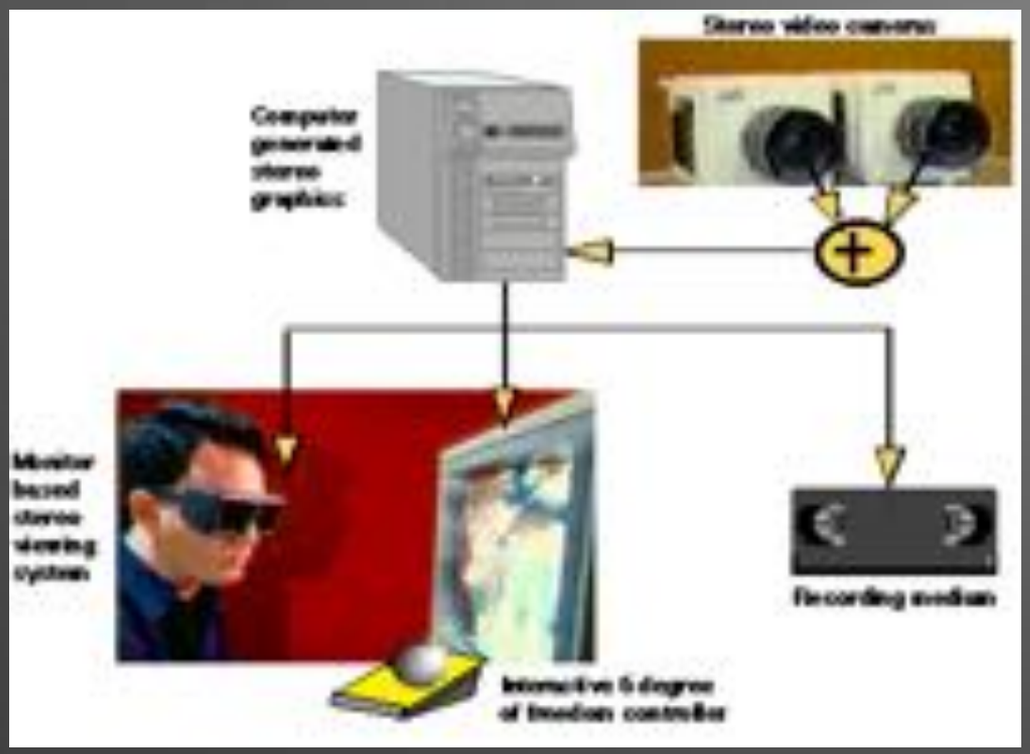
Typical usage of AR

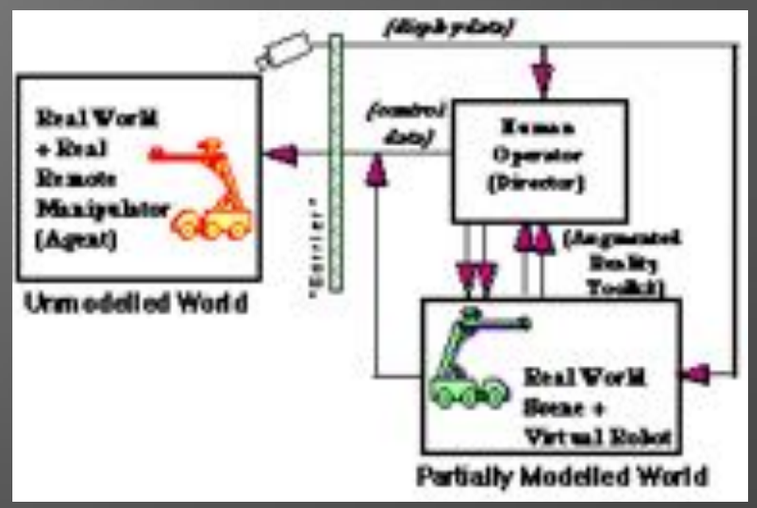
Next slide contains blood…


SJ - Cutch, Local Resection, PV and HV

AR in robot development, control and interaction

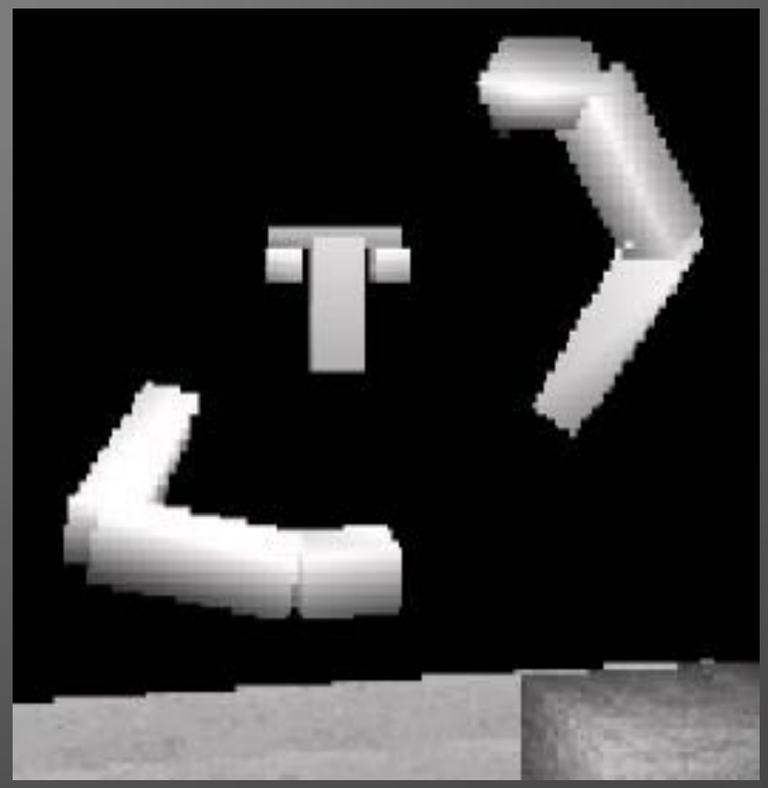
Examples





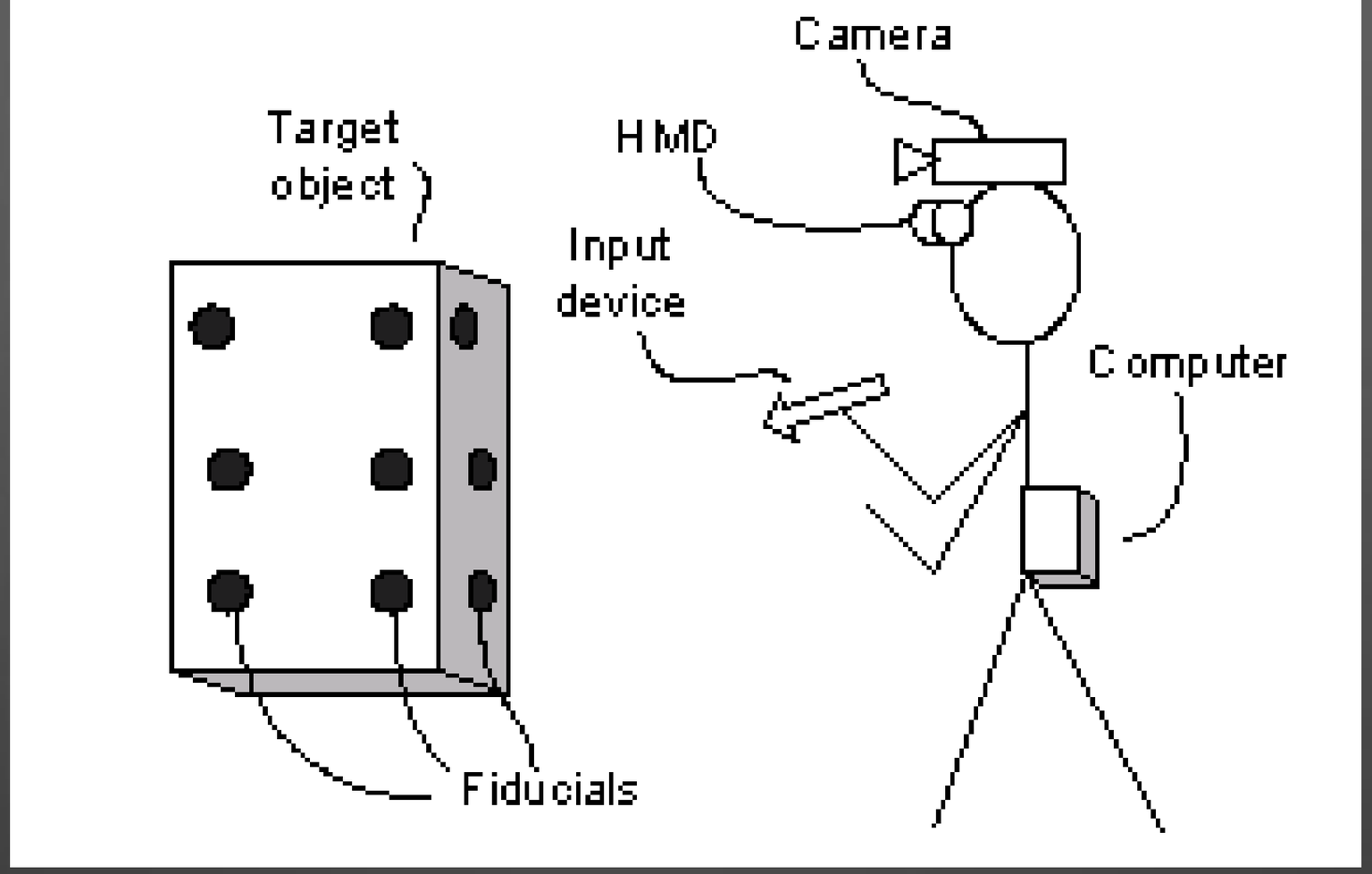
Telerobotic Control Using Augmented Reality

Paul Milgram, Anu Rastogi, Julius J. Grodski*, 1995



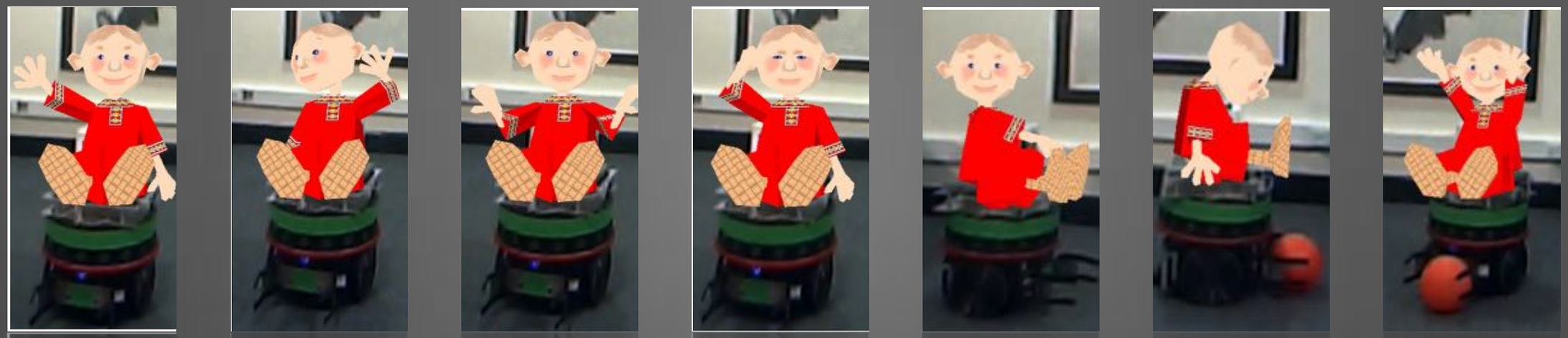
Real Time Visualization of Robot State with Mobile Virtual Reality

Peter Amstutz and Andrew H. Fagg, 2002



Augmented Reality for Programming Industrial Robots

T. Pettersen, J. Pretlove, C. Skourup, T. Engedal and T. Løkstad, 2003



(1) Saluting the user
(2) Listening and waiting for instructions
(3) User's utterance not understood
(4) Instruction acknowledged
(5) Found ball, pointing at it
(6) Looking at the ball while grabbing it
(7) Celebrating a successful grabbing manoeuvre.

Using mixed reality agents as social interfaces for robots

Dragone, Mauro; Holz, Thomas; O'Hare, 2007

ARE: Augmented Reality Environment for Mobile Robots

Mario Gianni, Federico Ferri, and Fiora Pirri
ALCOR Laboratory, DIIAG, Sapienza University of Rome, Rome, Italy

Towards Autonomous Robotic Systems pp. 470-483, Springer 2014
14th Annual Conference, TAROS 2013, Oxford, UK, August 28--30, 2013

ARE

- Introduction
- [AR State of the Art]
- Overview
- Experiments
- Conclusion

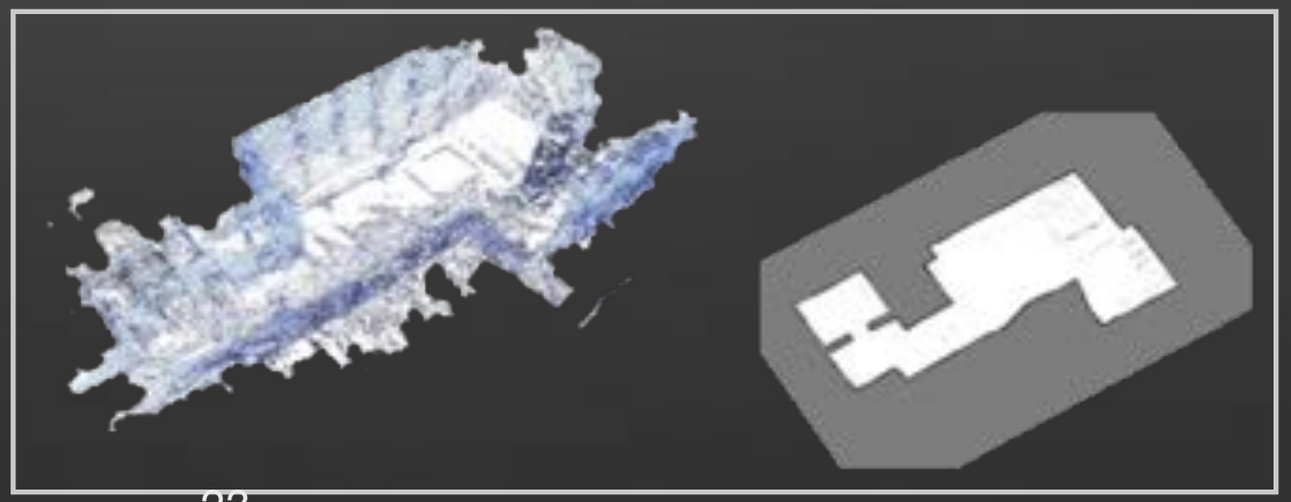
Introduction

- Robots are more complex
- Testing in Labs
- Field tests
- AR simulates real-world problems

ARE

- ROS integration
- 3D Objects with behavior
- 2D/3D Scene of environment
- Stochastic model
- Goal: Path planing

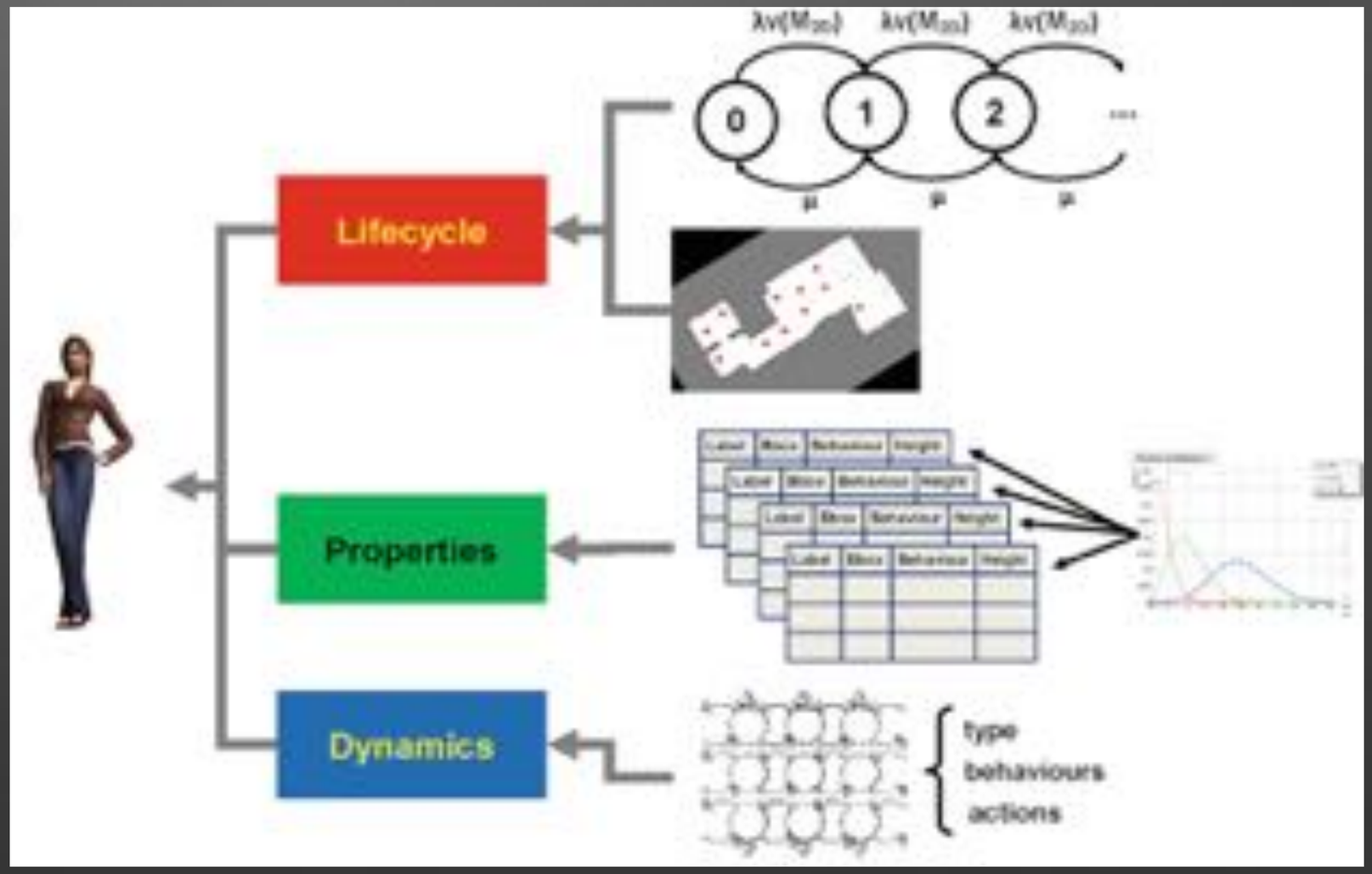
```
Header header
int32 id
int8 label
geometry_msgs/Pose pose
geometry_msgs/Vector3 bounding_box
sensor_msgs/PointCloud2 mesh
Features features
```



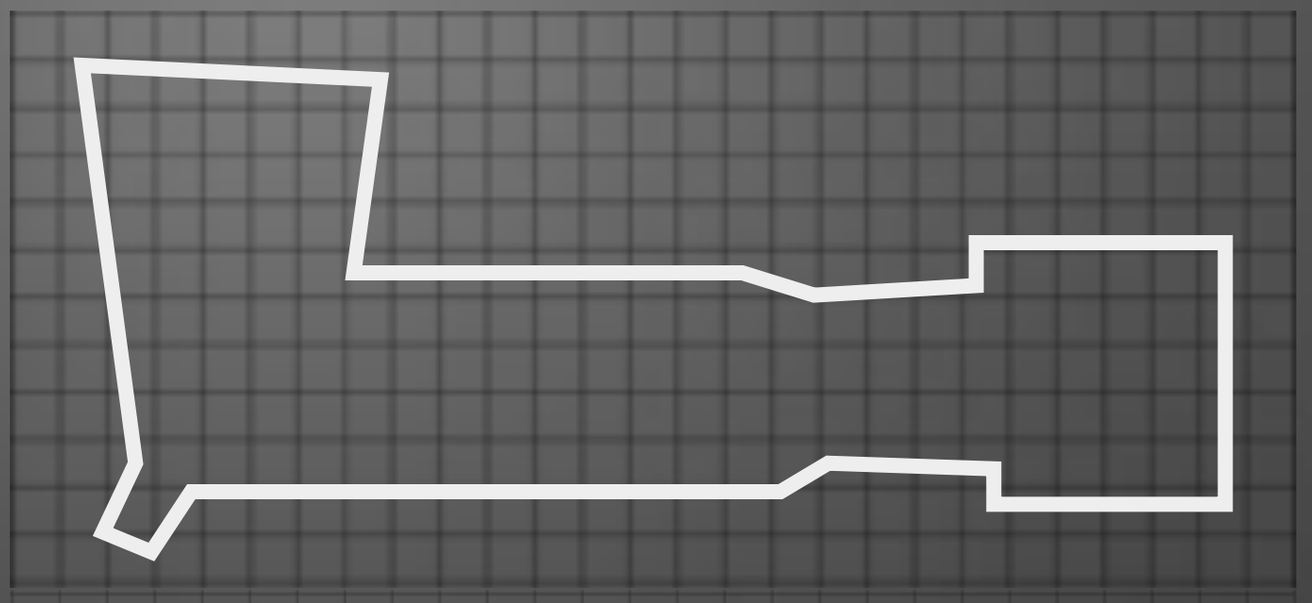
Artificial Objects

Robots, Cars, People, Pallets, other barricades

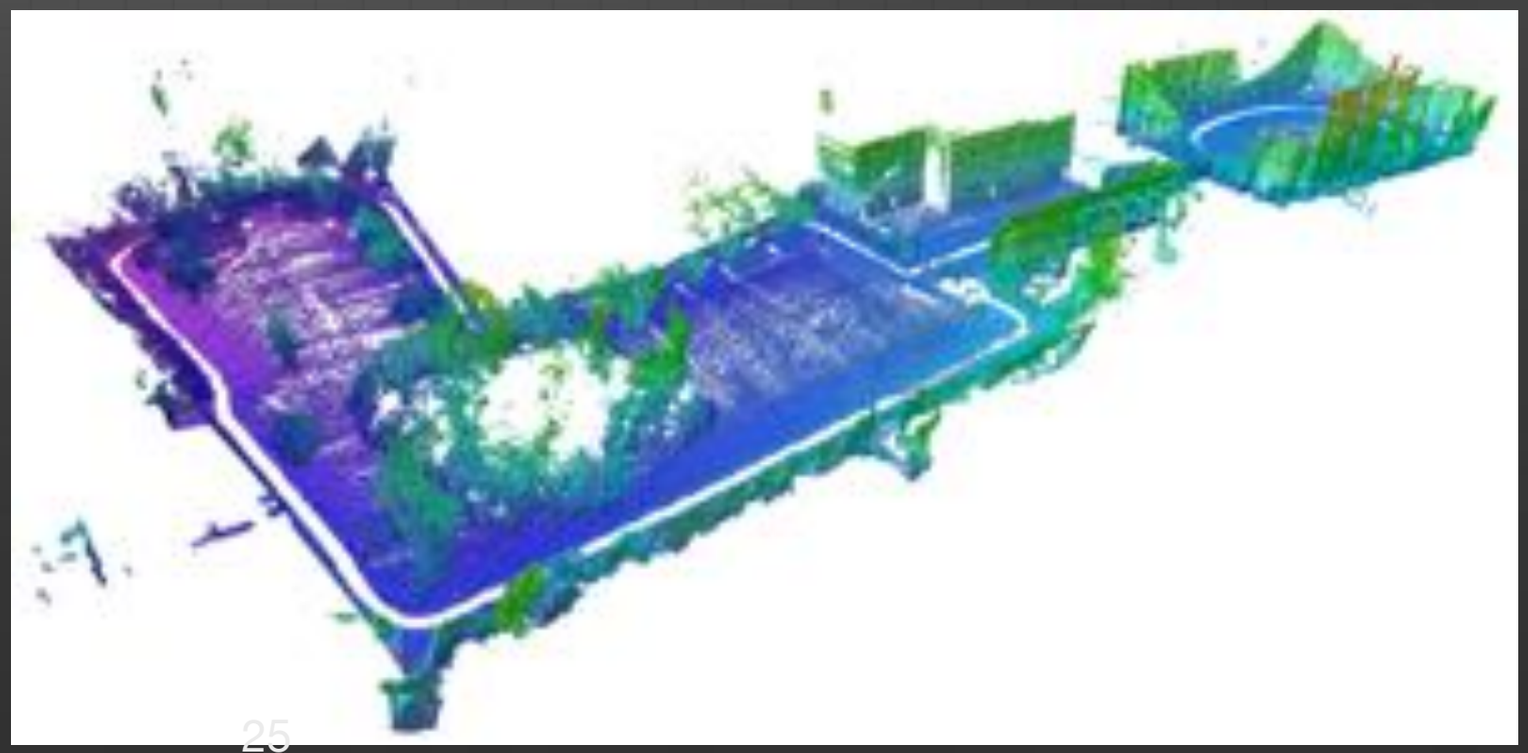
- Behavior
- Stochastic model
- Probability of existence
- Collision avoidance



Real World representation



- 2D occupancy grid map
- Octree-based 3D map



UGV - unmanned ground vehicle

Bogie

360° Camera

Rotating Laser

IMU

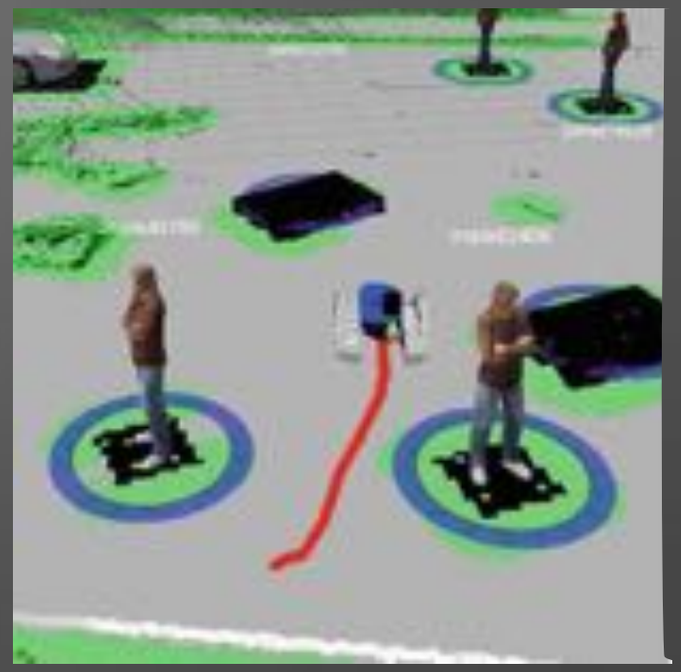
GPS

Flipper

Central unit:

- High-Level planer
- Path planing algorithm

Putting all together



Experiments

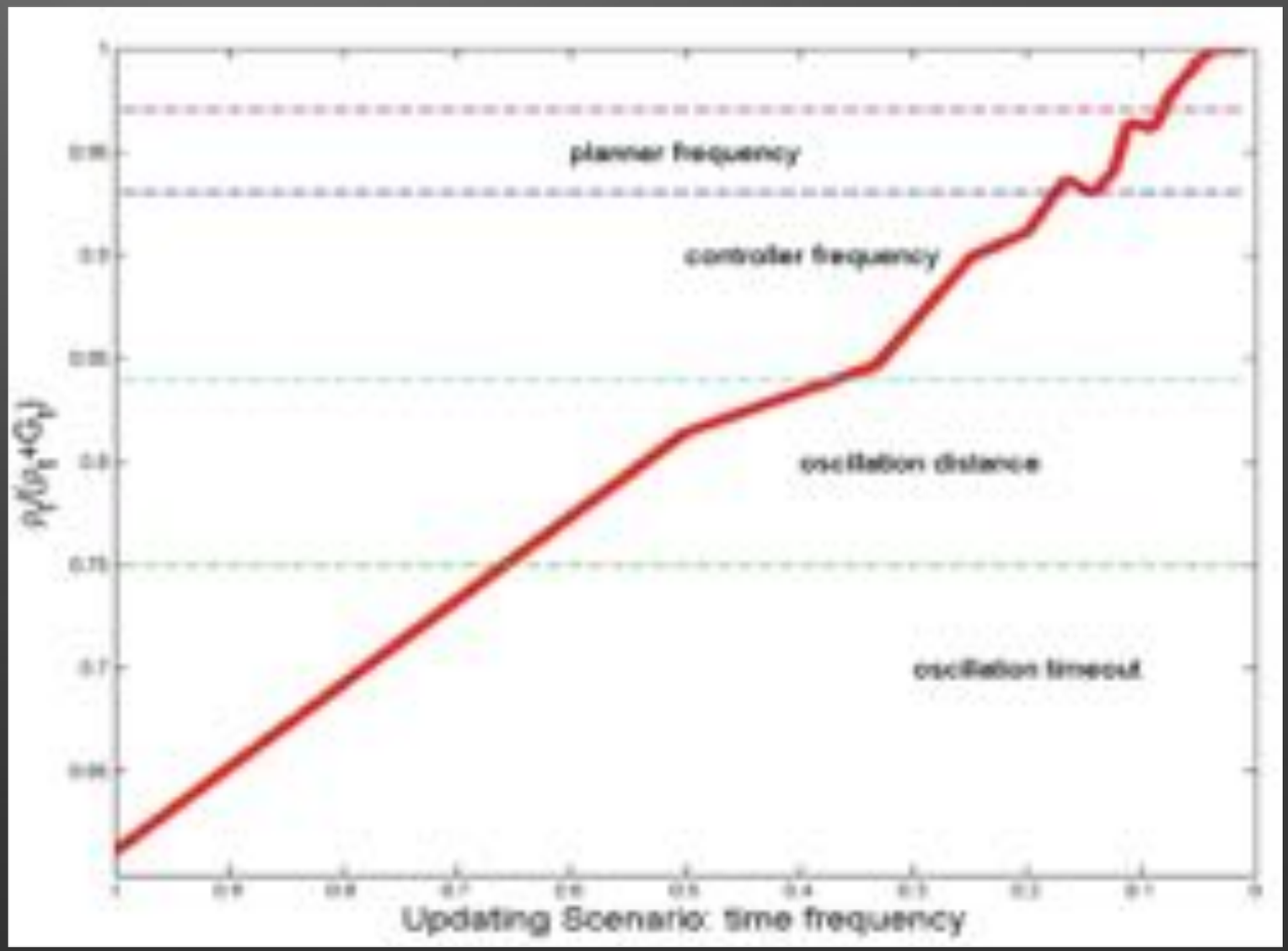
Robot platform in a wide outdoor area. ARE used to populate this area with artifacts.

Experiment 1: Replaning path towards goal with moving objects.

Ability to replan:

$$p = \frac{p_t}{p_t + G_t}$$

p_t = Time needed to replan
G_t = Esitmated time to reach goal



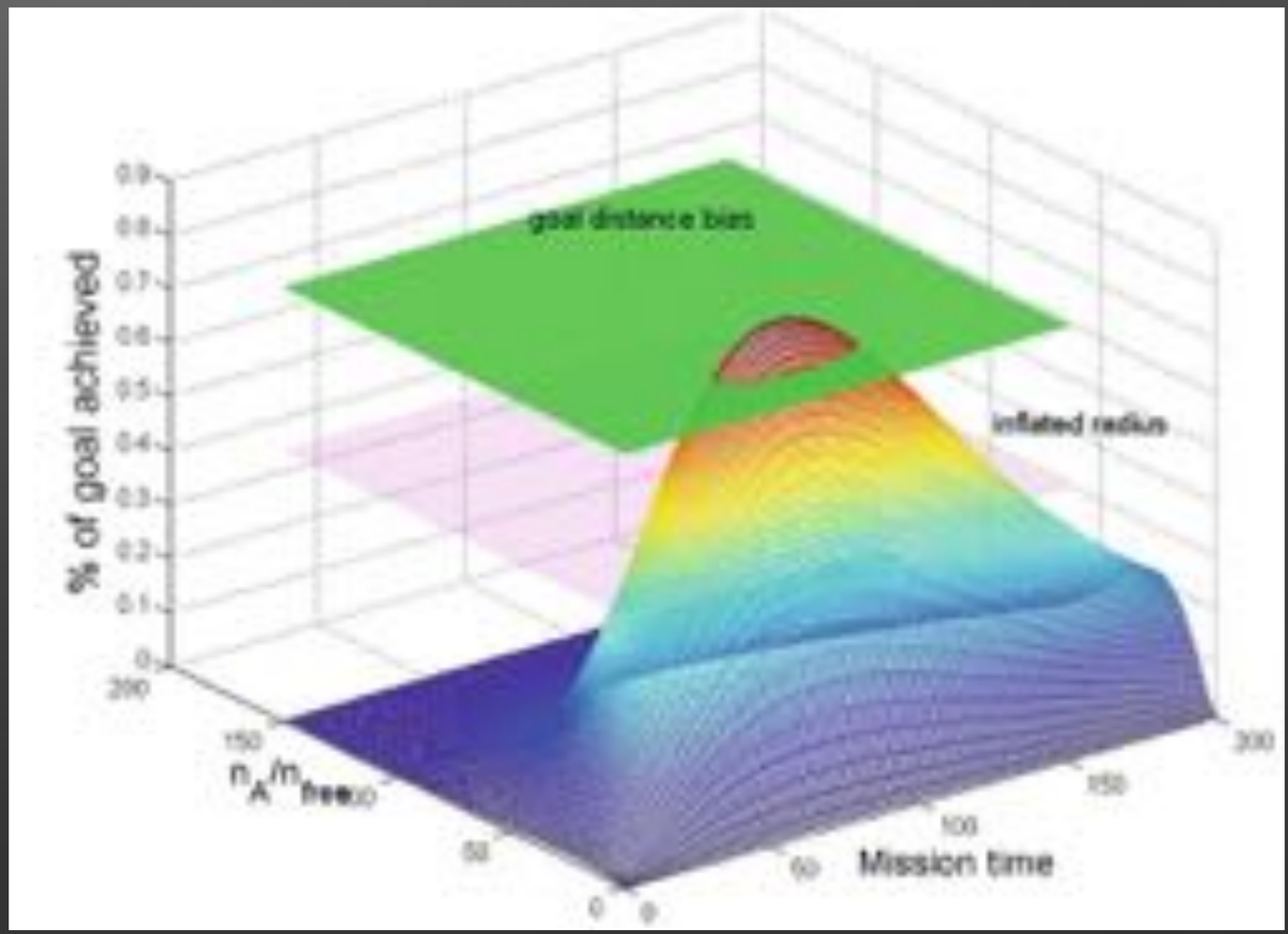
Experiments

Experiment 2: Long-term capability in cluttered environment.
Robot should reach multiple goal locations.

Space complexity:

$$v = \frac{n_A}{n_{free}}$$

n_A = number of free cells of the 2D occupancy grid
n_{free} = number of the cells occupied by the set A of artifacts



Conclusion

- ARE not for low-level programming (basic functions or actions, e.g. painting gun robot)

- ARE for parameter tuning of robots
  - E.g. experiments have shown how increasing complexity can affect robot abilities.

  - Measuring the limits of a robot

➡ **ARE is a promising experimental tool**

Questions?

Discussion

Can this experiment give trustworthy results?
What do you think are limits?
For which robots does it make sense, for which not?

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Mercedes
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Surgery
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Intro
http://www.thecoolector.com/wp-content/uploads/2013/07/robot_1024_B.jpg
http://www.thecoolector.com/wp-content/uploads/2013/07/robot_1136_C.jpg
Octo:
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