Seminars in Artificial Intelligence and Robotics

Computer Vision for Intelligent Robotics

Introduction

DIPARTIMENTO DI INGEGNERIA INFORMATICA
AUTOMATICA E GESTIONALE ANTONIO RUBERTI

SAPIENZA
UNIVERSITÀ DI ROMA

Alberto Pretto

Contacts

Teacher:

- Alberto Pretto <pretto@diag.uniroma1.it>

Classes

- Tuesday h. 16-19 room A7
- ...

Meetings for advice

- Pretto: B115. Wednesday h. 14 or better **please book an appointment**.

  (Email subject should start with the [Seminars] suffix!)

Course web page:

- https://elearning2.uniroma1.it/course/view.php?id=5969
- Self enrolment, password: sair18

Overview

A main seminar series

- **Computer Vision for Intelligent Robotics** (Alberto Pretto)

A 3-days workshops

- **Social Robotics** (Dr. Mary Ellen Foster)

Other one-day events, e.g.:

- Picked by a robot: Behavior Trees for real world robotic applications in logistics (Guglielmo Gemignani)
  Room: Aula magna,
  Date: 19/03/2018 h. 16:00
- …

Have a look to the Lectures Schedule document in the course web-page!

Evaluation

To pass the exam you should:

- Attend all lectures, including the workshop and the advised talks (have a look to the Attendance Sheet in the course web-page)
- For the “Computer Vision for Intelligent Robotics” section:
  - Present 1 paper (the presentation slide should be sent in advance)
  - Prepare and present a poster about a paper
- For the “Social Robotics” workshop
  - Prepare a report about the presented topics (TBD)

For the main seminar series

Introductory lectures

- Introduction by the teacher about the research area, with a (non comprehensive) overview of the the state-of-the-art and the current trends.

Seminar lectures

- Four or five research papers for each lecture will be presented and discussed by the students.

Final poster session

- Each student will present a paper through a poster, interacting with the audience

Presentations

Prepare no more than 20 slides.

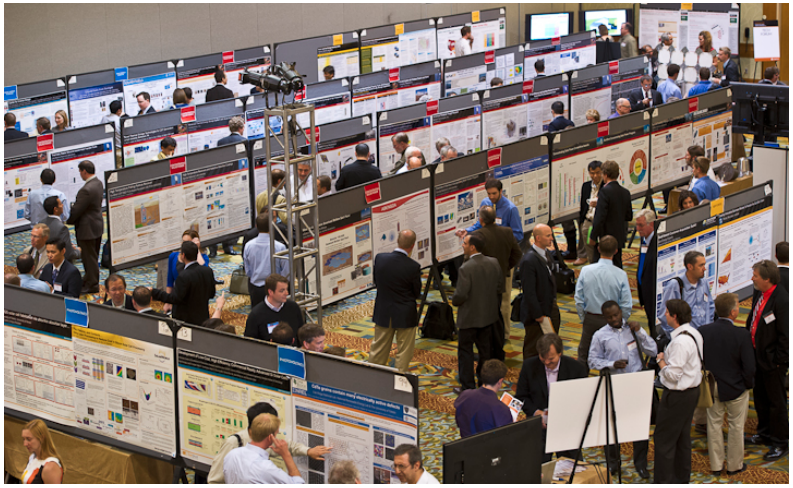
You should cover:

- Aims and objective of the paper
- Some related work
- The main contributions of the paper
- Methods
- Presented experiments
- ...

Poster session

Prepare a cool poster with:

- Aims and objective of the paper
- The main contributions of the paper
- Methods
- Presented experiments



Interact with the audience that will ask questions, etc..

Paper Selection

Papers are assigned on a first come first serve basis.

The papers list will be published in the course Moodle page after the first 1/2 lectures.

You can only pick one paper of the ones still remaining.

Section 1 presentation

Computer Vision for Intelligent Robotics

We will cover different sub-areas of robot vision.

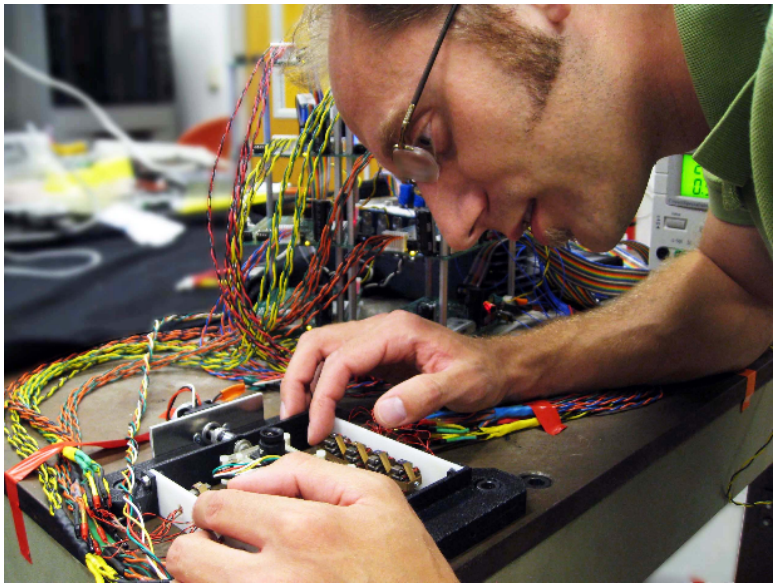
- “Low-level” vision
- Vision based ego-motion estimation and 3D reconstruction
- Visual servoing
- Semantic scene segmentation
- Object detection and localization

The objective of the seminars is to provide an overview of the recent trends in each covered topic.

The sense of vision

Is the main sense in humans and also plays a fundamental role in most living organisms.

Sensing information is processed to infer a **representation of the surrounding world.**



The human visual system measures the **intensity of light incident the retinas** and processes the measurements in the brain to produce an estimate of the 3D layout of the scene, to recognize objects, etc.

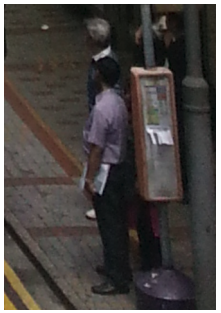
[Pictures: www.getholistichealth.com and gatech.edu]

Computer vision

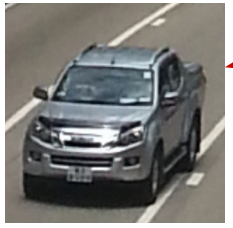
"Teach" a computer to understand an image or a video

- Place recognition
- Compute distances
- 3D reconstruction
- Navigation and localization
- People detection
- Object recognition
- Action recognition
- ...

Two people, they are waiting the bus, ...

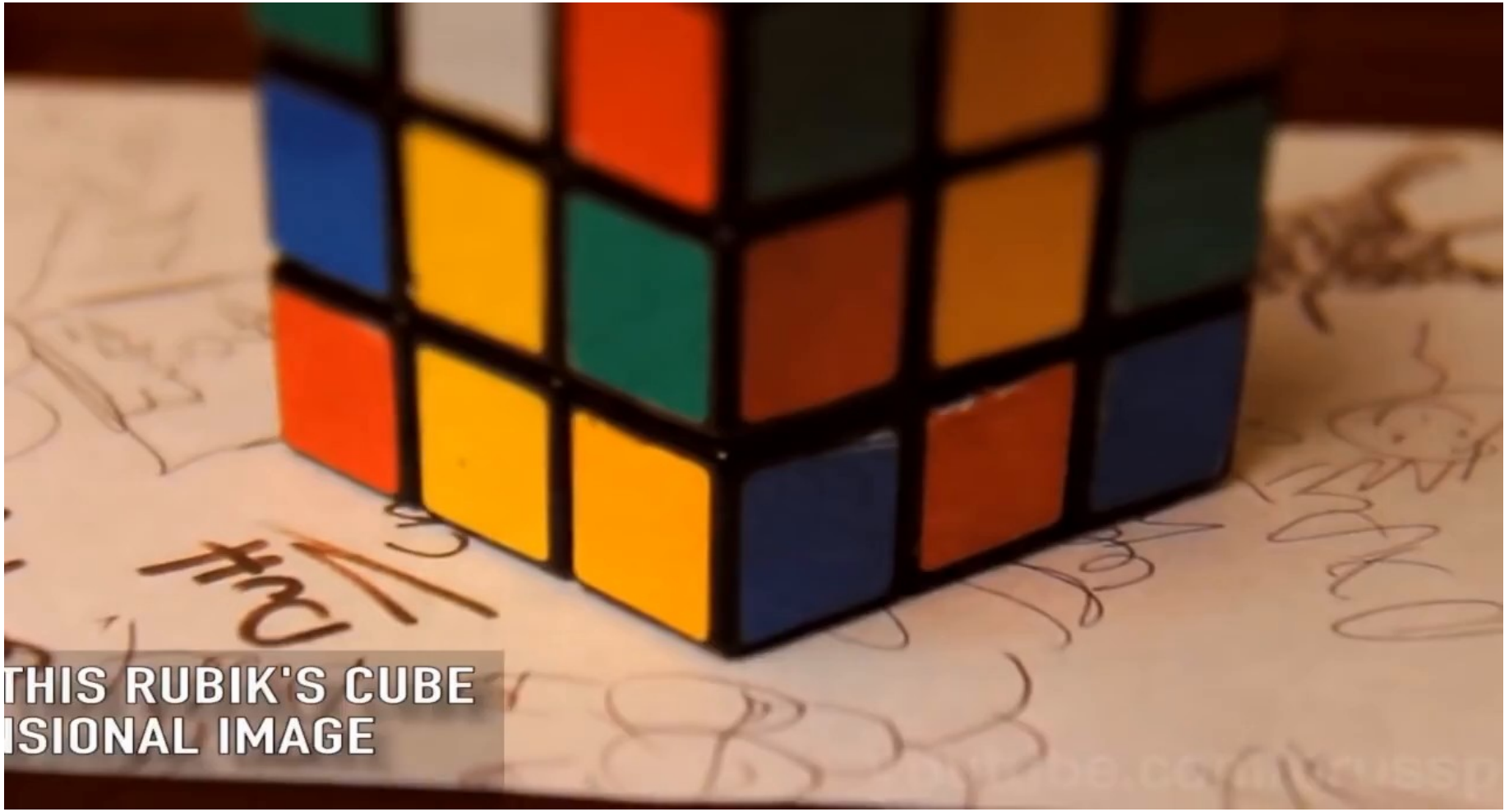


Car, model XXX, it is moving, ...



Car plate number YYY

Images can be tricky!



Computer Vision for Robots

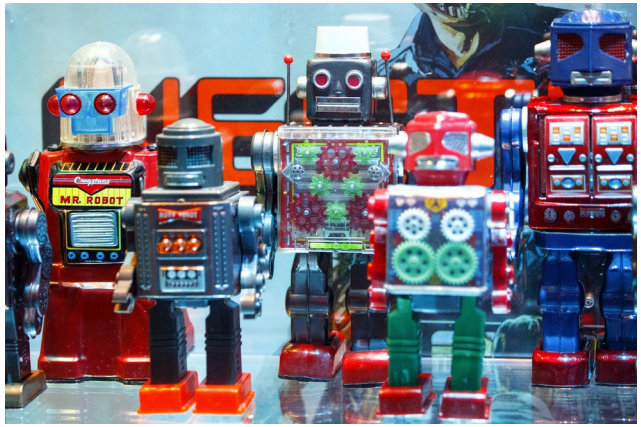
it is well known that **computer vision is hard**

- More human brain devoted to vision than anything else

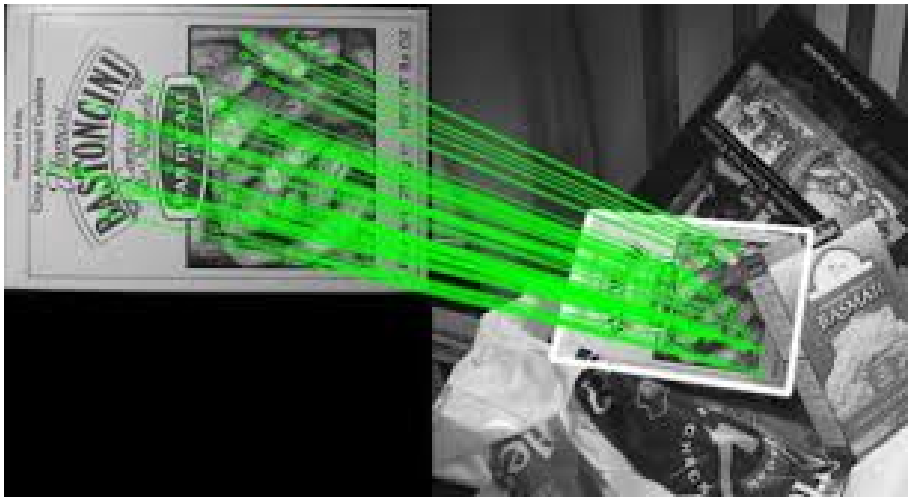
Computer vision for robots challenges:

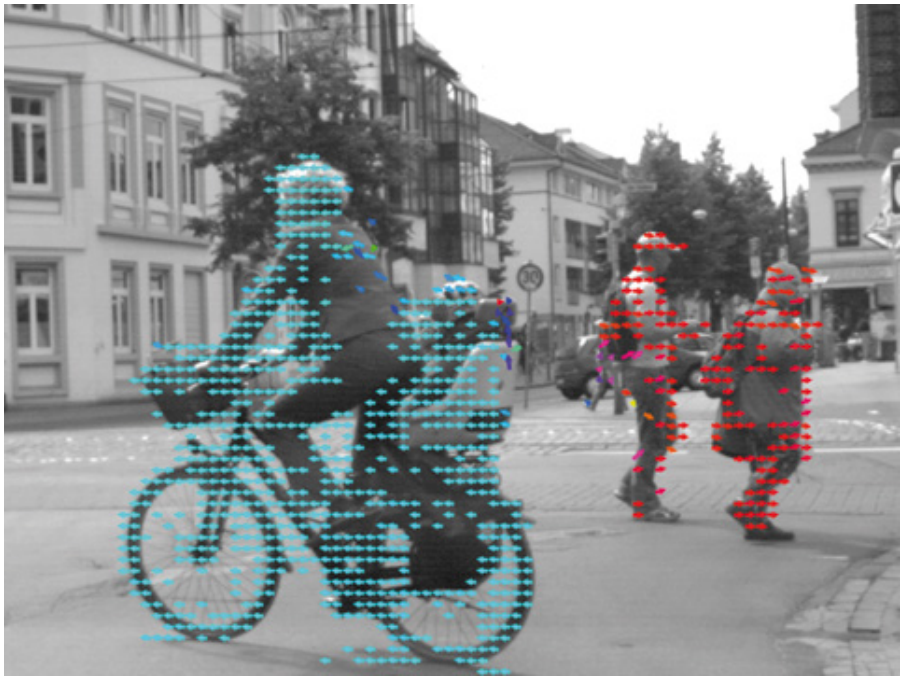
- Unstructured, dynamic world
- Changes in illumination
- Real time constraints
- Clutter
- Limited resources
- Quick motions
- ...

Computer vision for robots is *really* hard



Low level vision

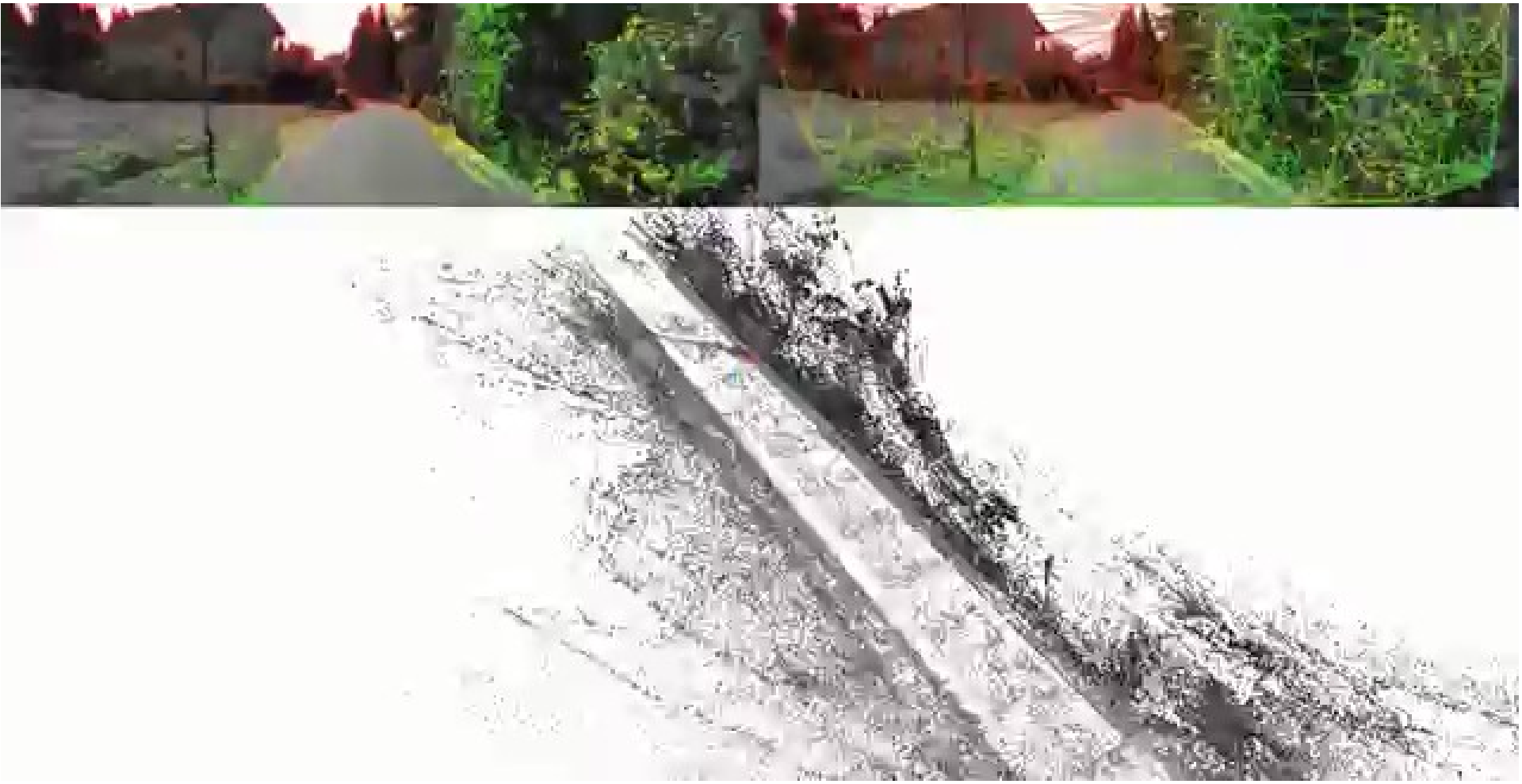




[Pictures: www.commonvisionblox.com, avisingh599.github.io]

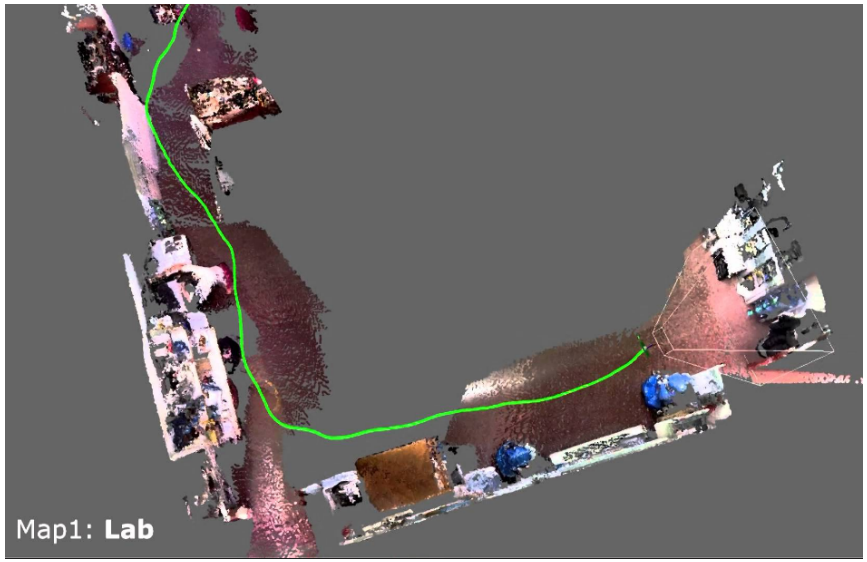
Target tracking

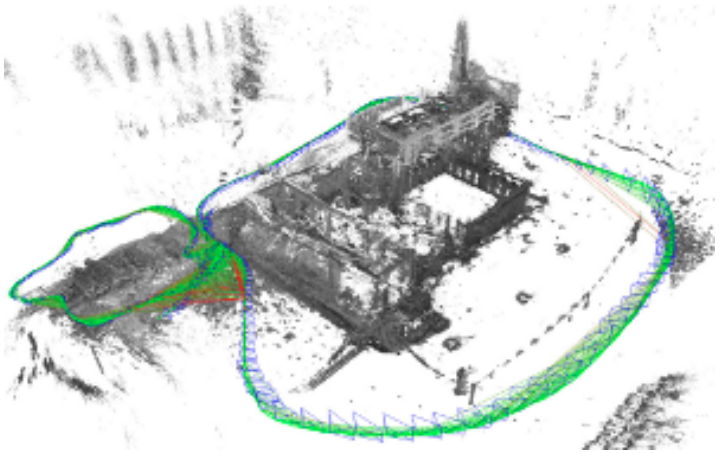
Stereo vision

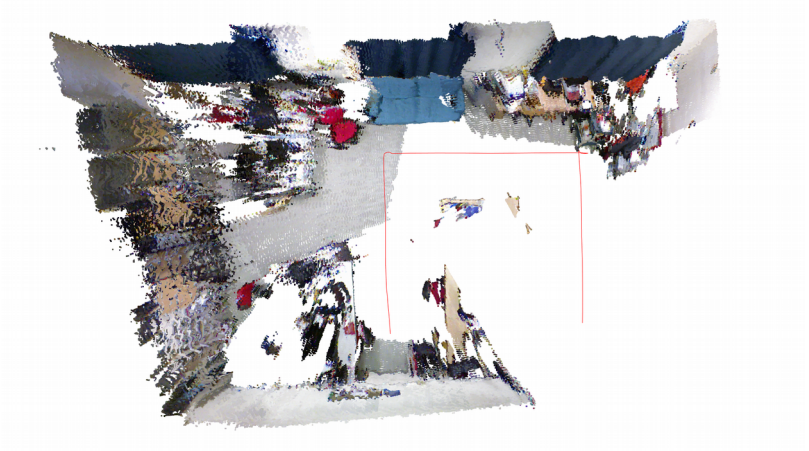


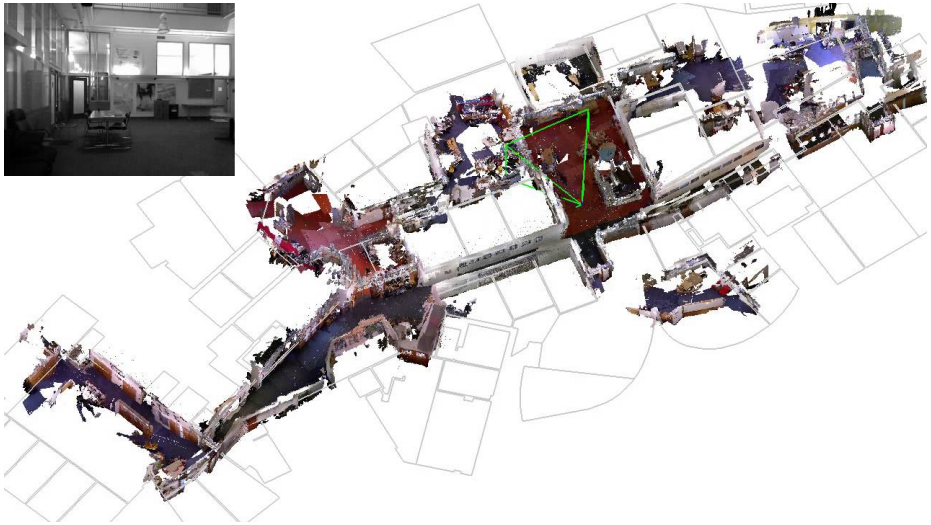
S. Pillai, S. Ramalingam and J. Leonard, “High-Performance and Tunable Stereo Reconstruction”, ICRA, 2016

Visual odometry and 3D mapping



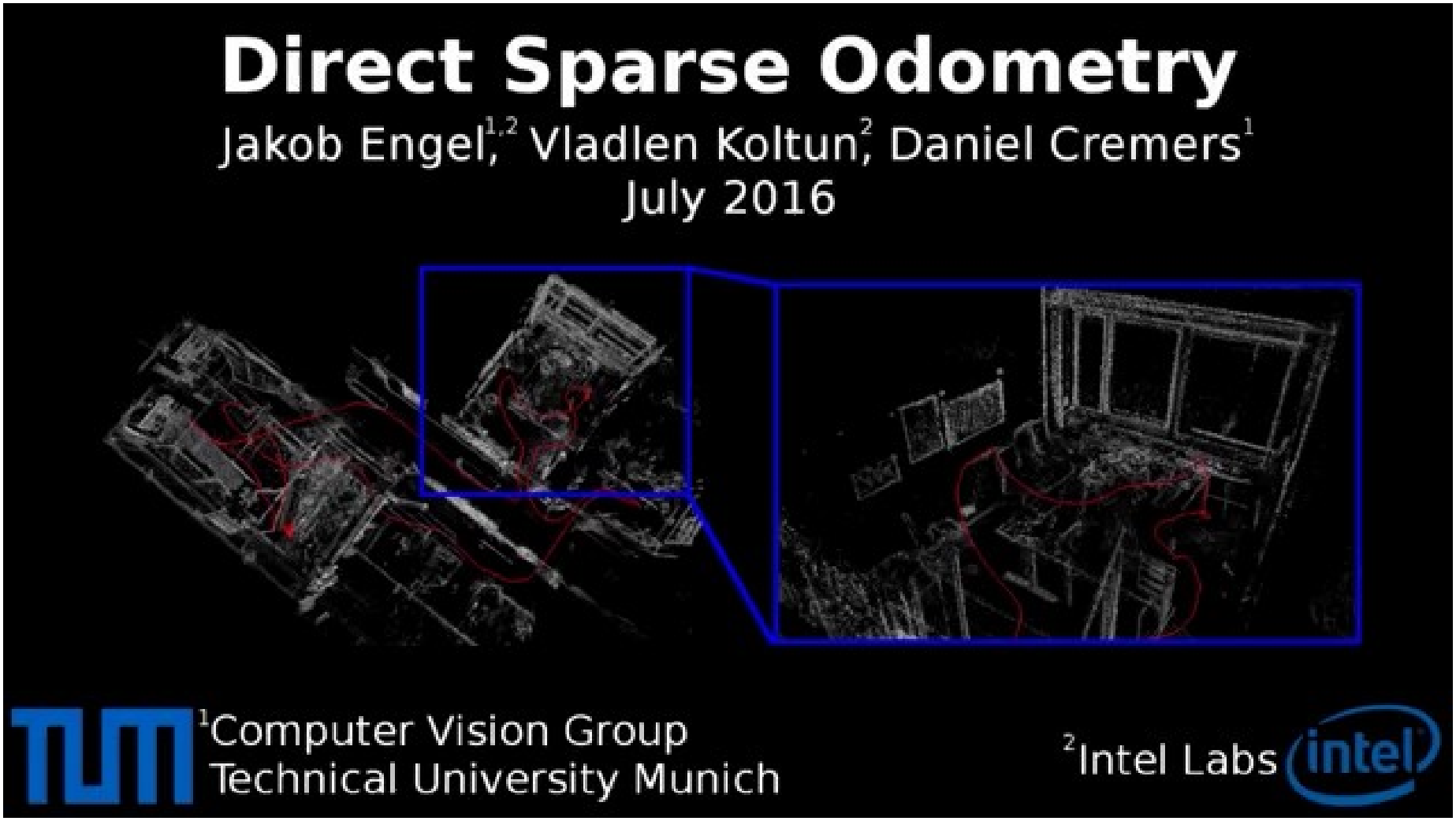






[Pictures: http://mapir.isa.uma.es, http://vision.in.tum.de

Visual odometry

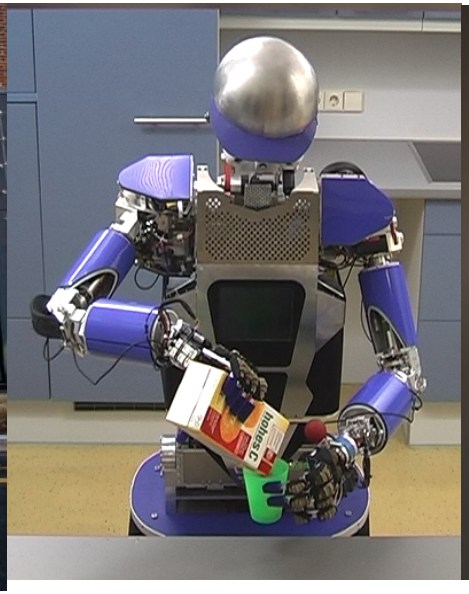


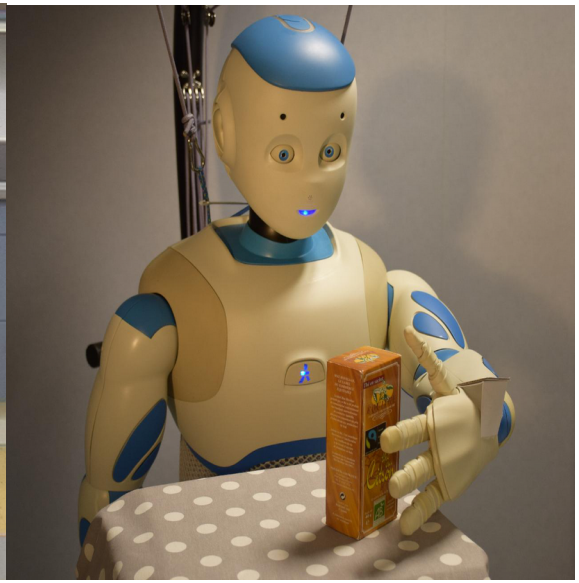
J. Engel, V. Koltun, D. Cremers, “Direct Sparse Odometry”, in arXiv:1607.02565, 2016.

3D reconstruction from images

Qi Shan, Riley Adams, Brian Curless, Yasutaka Furukawa, and Steven M. Seitz
“The Visual Turing Test for Scene Reconstruction”, Proc. Of 3DV13 (2013)

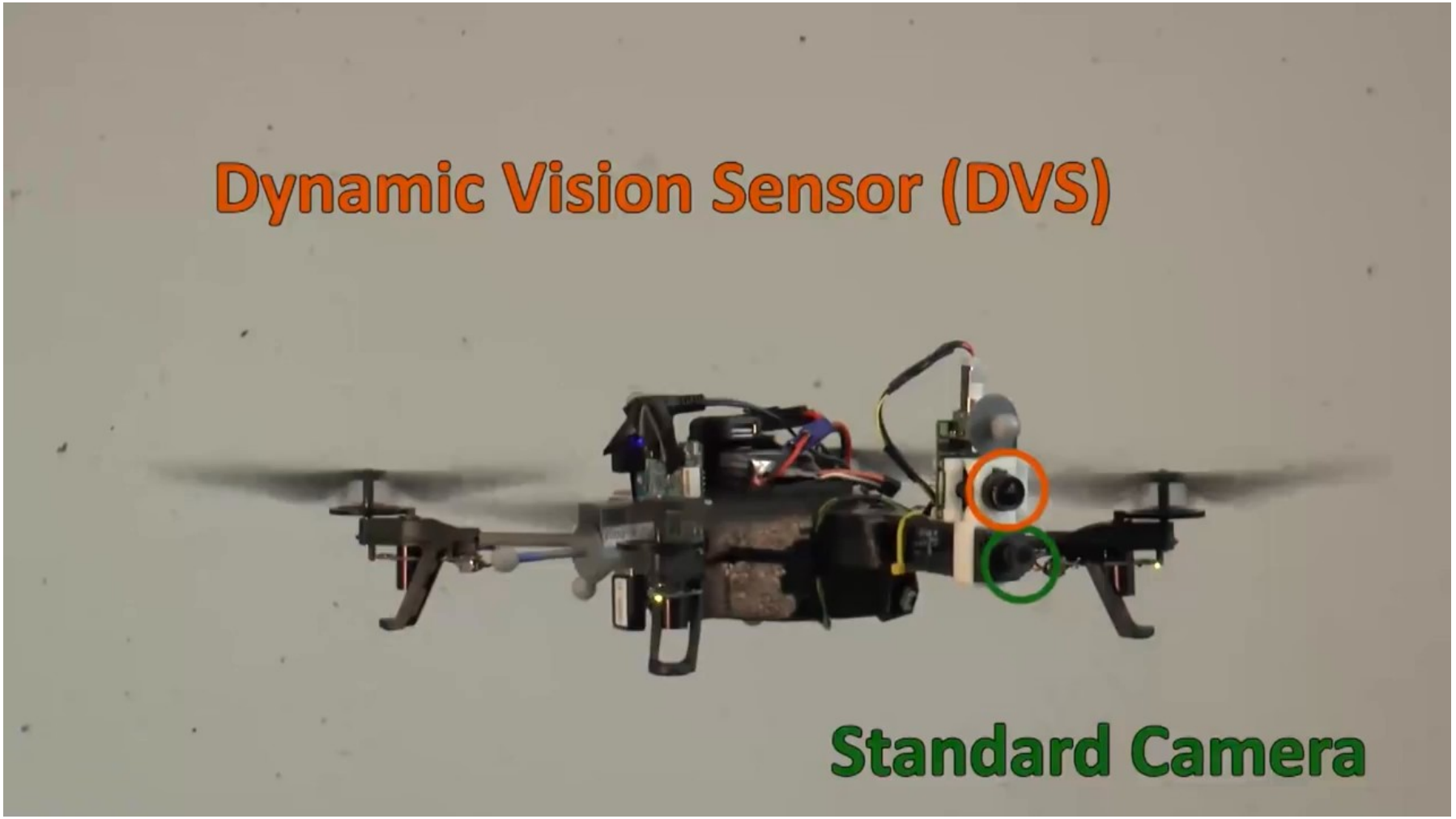
Visual servoing





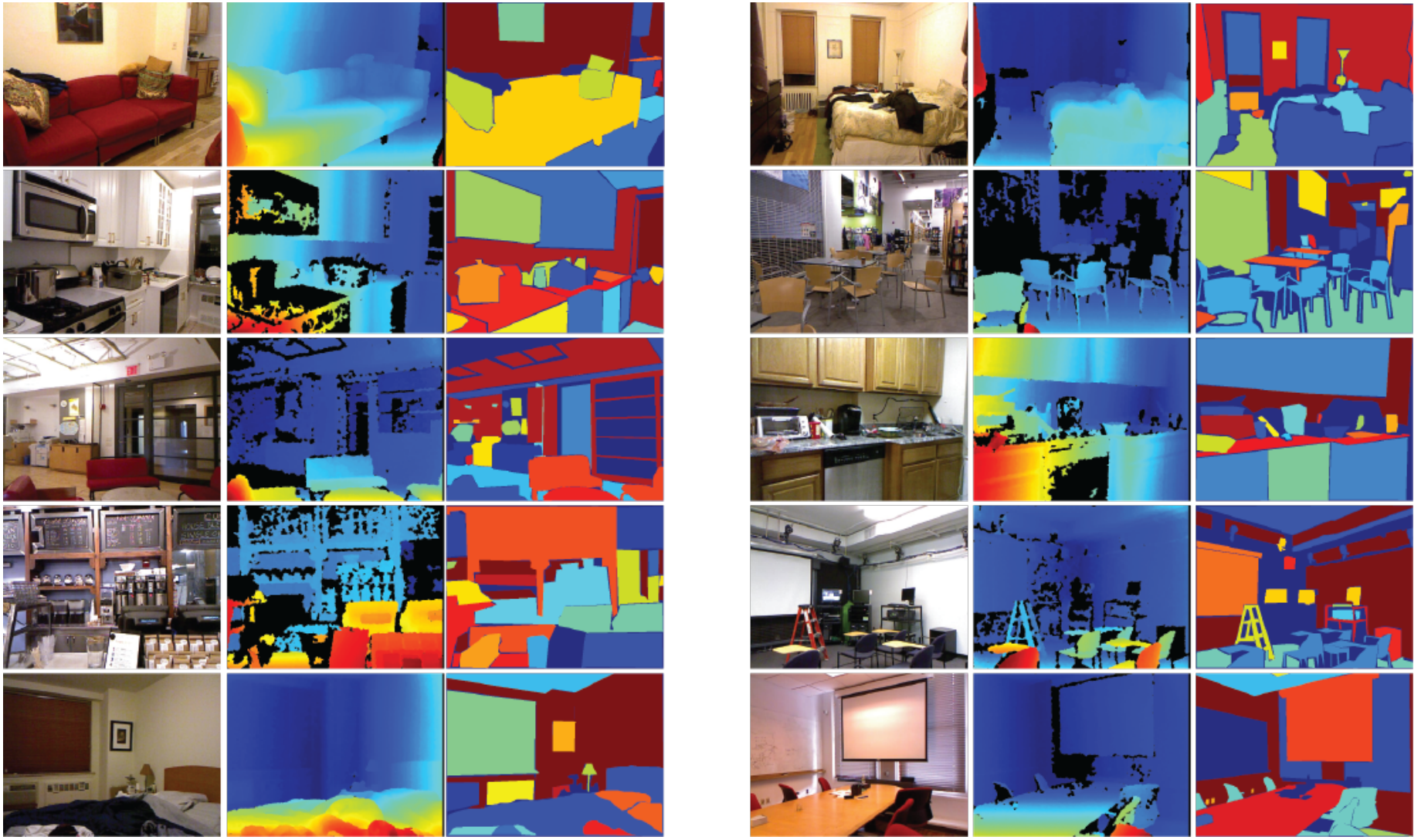
[Pictures: his.anthropomatik.kit.edu, raweb.inria.fr]

Visual aided control



E. Mueggler, B. Huber, D. Scaramuzza, “Event-based, 6-DOF Pose Tracking for High-Speed Maneuvers", IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Chicago, 2014.

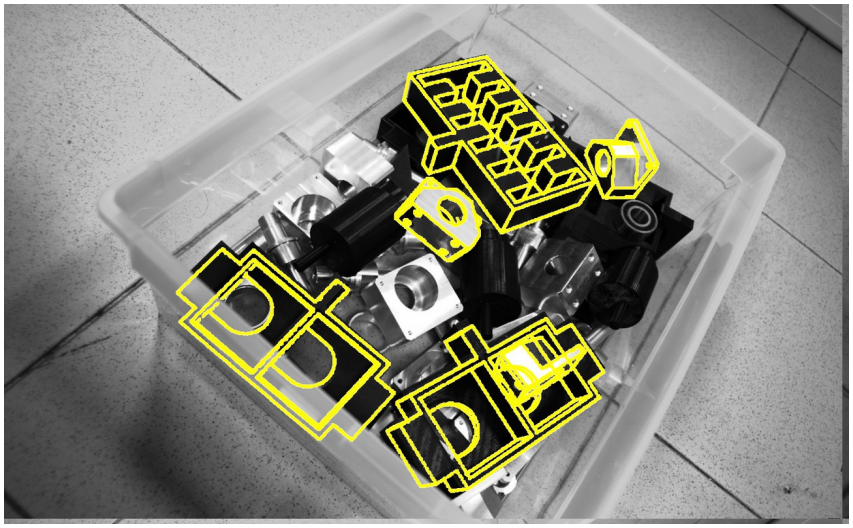
Semantic scene segmentation

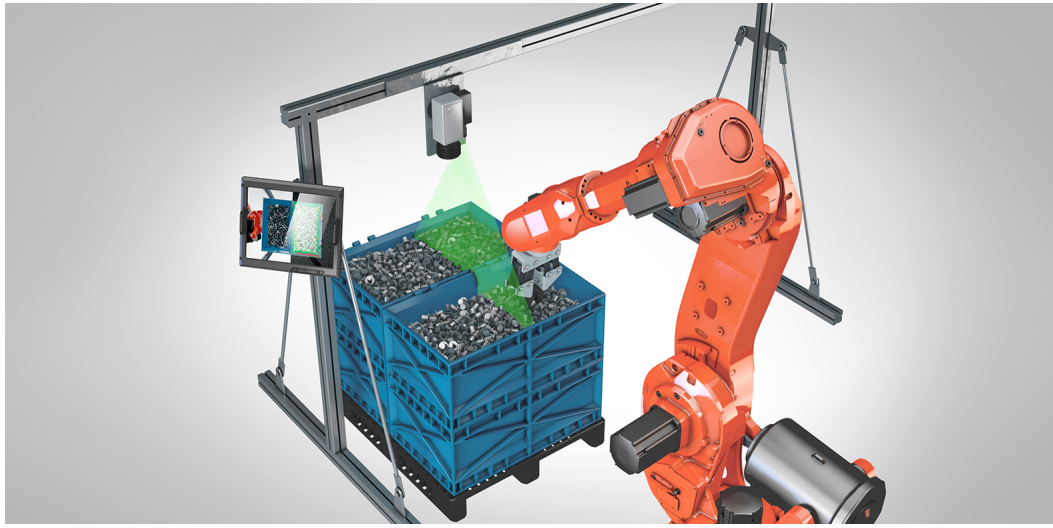


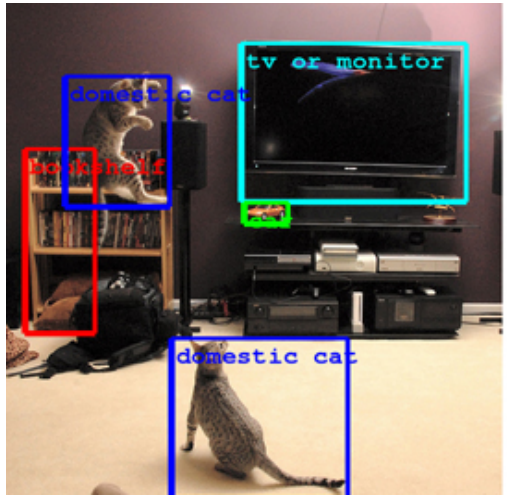
[Pictures: http://cs.nyu.edu/~silberman/

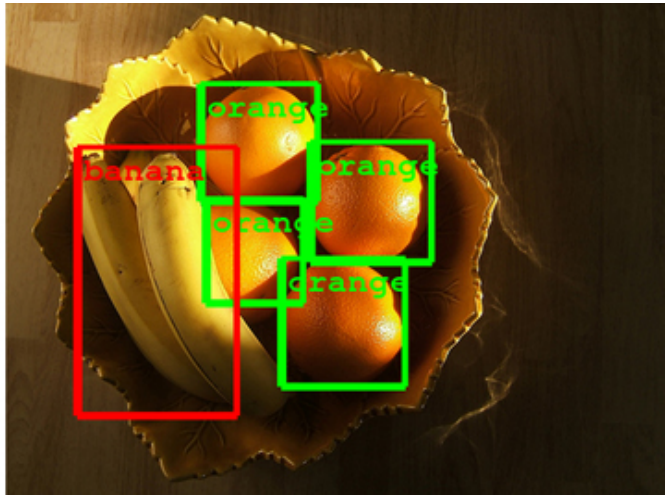
Road scene segmentation

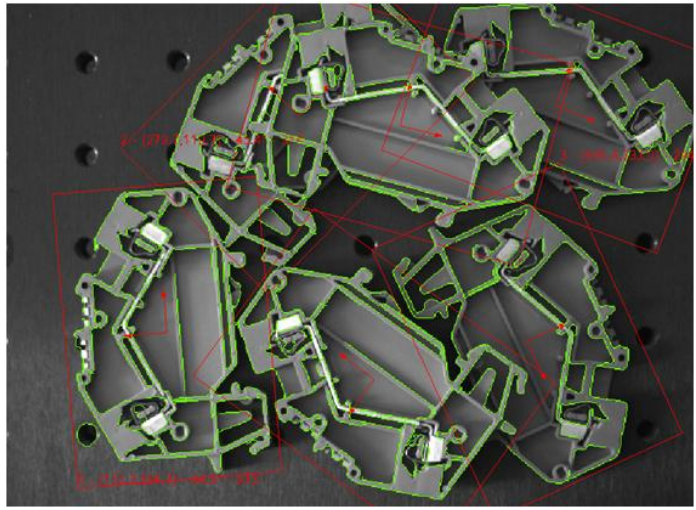
Object detection and localization











[Pictures: www.robotics.blumenbecker.com, www.engadget.com]

Bin picking

Factory in a Day

DELFTROBOTICS

TUDelft Robotics Institute

Team Delft

amazon picking challenge

Amazon Picking Challenge 2016

Use case 1: the Flourish project

Dipartimento di Ingegneria informatica automatica e gestionale Antonio Ruberti

Sapienza Università di Roma

Research and Innovation Action

Funded by the European Union

Horizon 2020

ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

universitätbonn Rheinische Friedrich-Wilhelms-Universität Bonn

BOSCH

cnrs

Sapienza Università di Roma

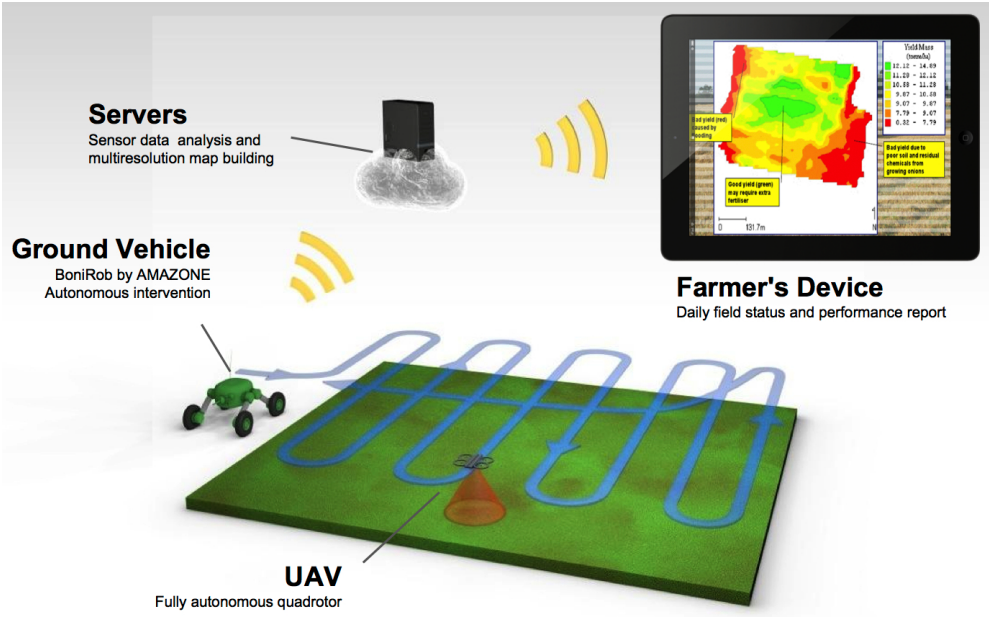
Assam

Goal: Build a robotic agricultural system that is able to achieve high yields while minimizing or eliminating the application of chemicals to the field.

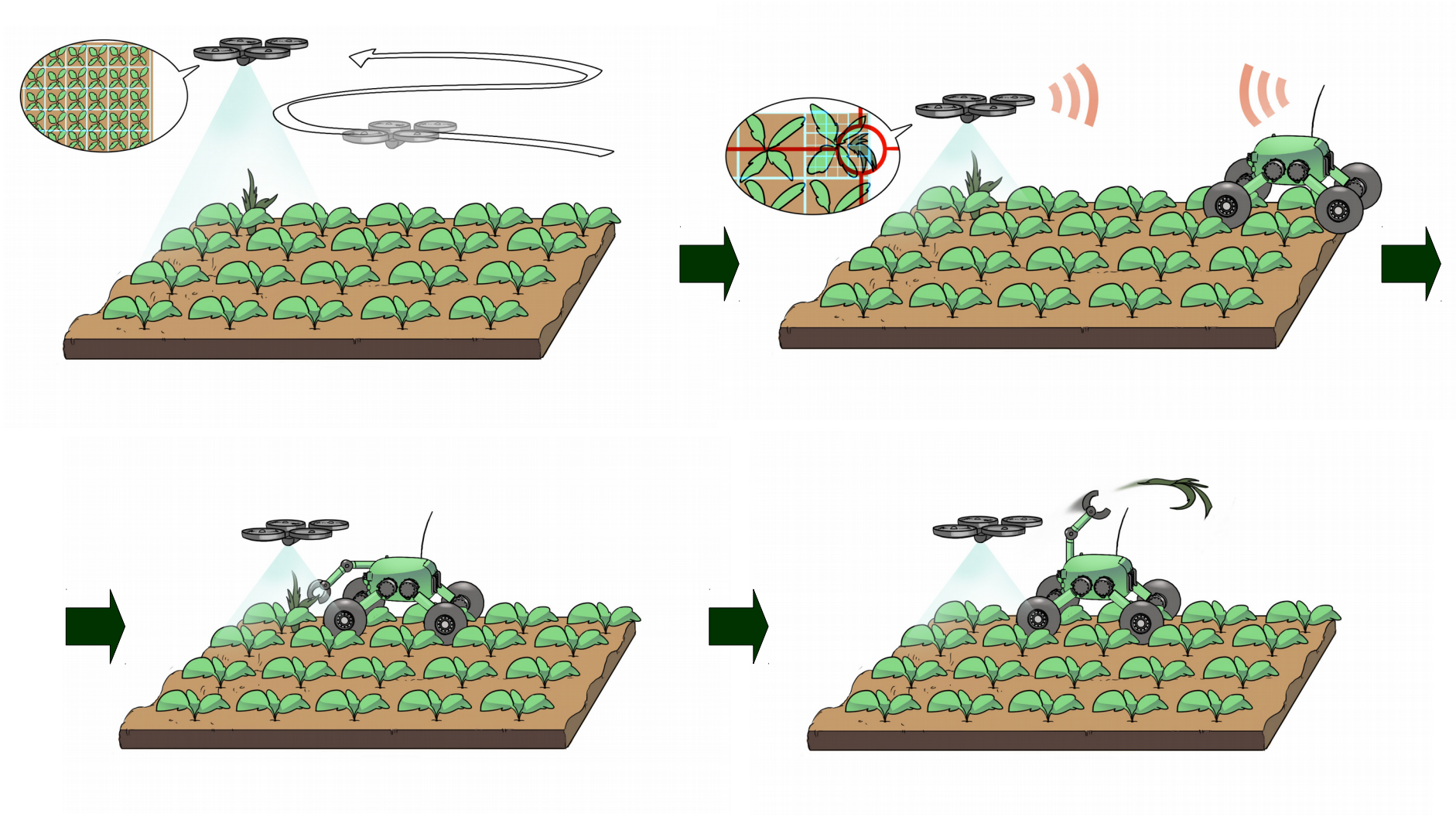
Project concept

A **UAV** continuously surveys a field over the growing season

A **UGV** is used for targeted intervention in the field, and data analysis is delivered to farm operators for high-level decision making.

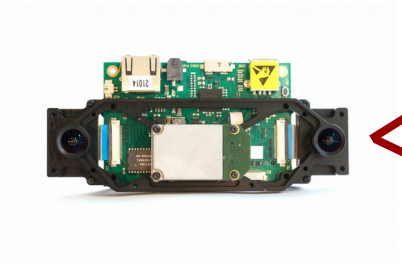


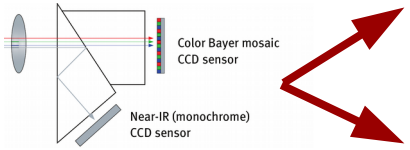
Project concept

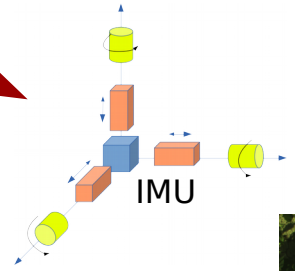


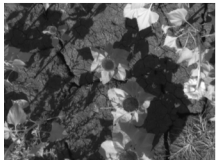
The UAV

ASCENDING TECHNOLOGIES NEO







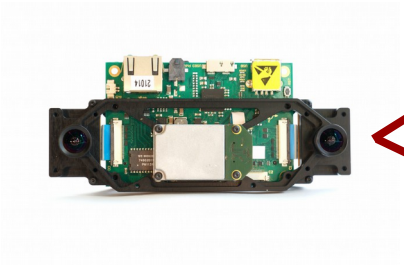


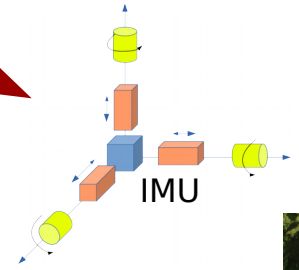
GPS

Depth sensor

The UGV

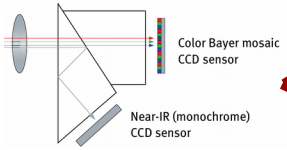
BOSCH BoniRob

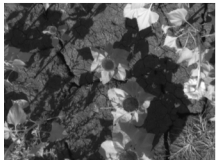




BoniRob

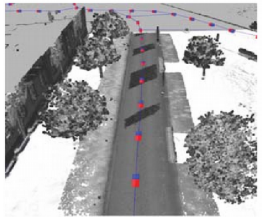
2 X





2 X GPS

2 X

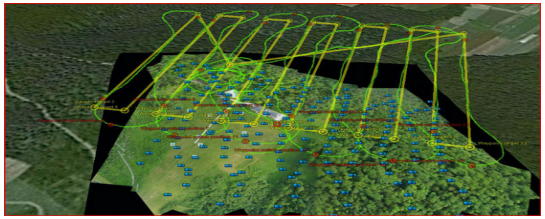


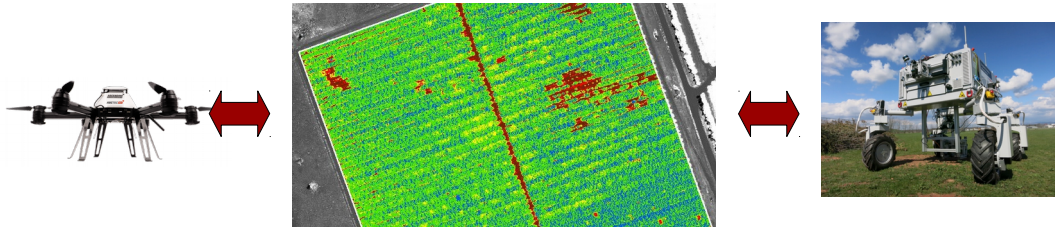
Challenges

State estimation

Robot ego-motion estimation

Sensor fusion

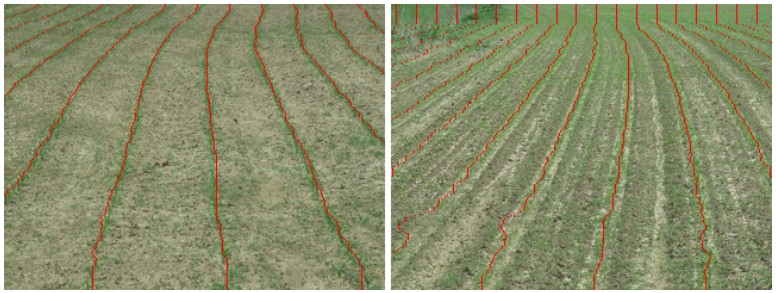




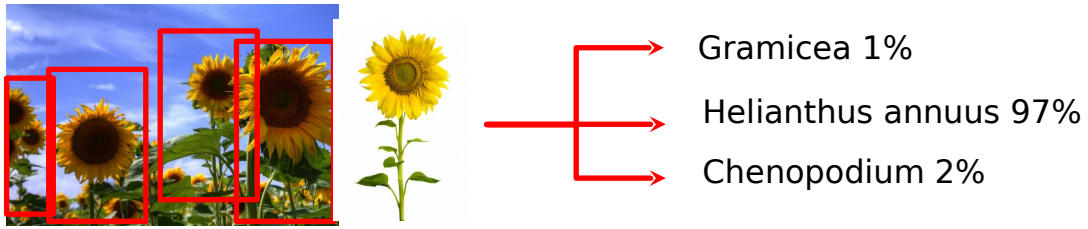
Cooperative Mapping

Pattern recognition

Vegetation detection



Plant classification



Crop/weed classification

Automatic Model Based Dataset Generation for Fast and Accurate Crop and Weeds Detection

Maurilio Di Cicco, Ciro Potena, Giorgio Grisetti and Alberto Pretto

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UGV field positioning

An Effective Multi-Cue Positioning System for Agricultural Robotics

Marco Imperoli*, Ciro Potena*, Daniele Nardi,
Giorgio Grisetti, Alberto Pretto

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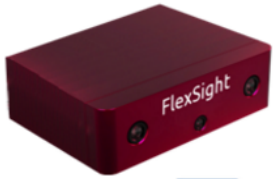
Use case 2: the FlexSight project

Goal: design a perception system based on an integrated smart camera that is able to recognize and localize several types of deformable objects that can be commonly found in many industrial and logistic

CAD model + deformation parameters

Upload

The FlexSight smart camera



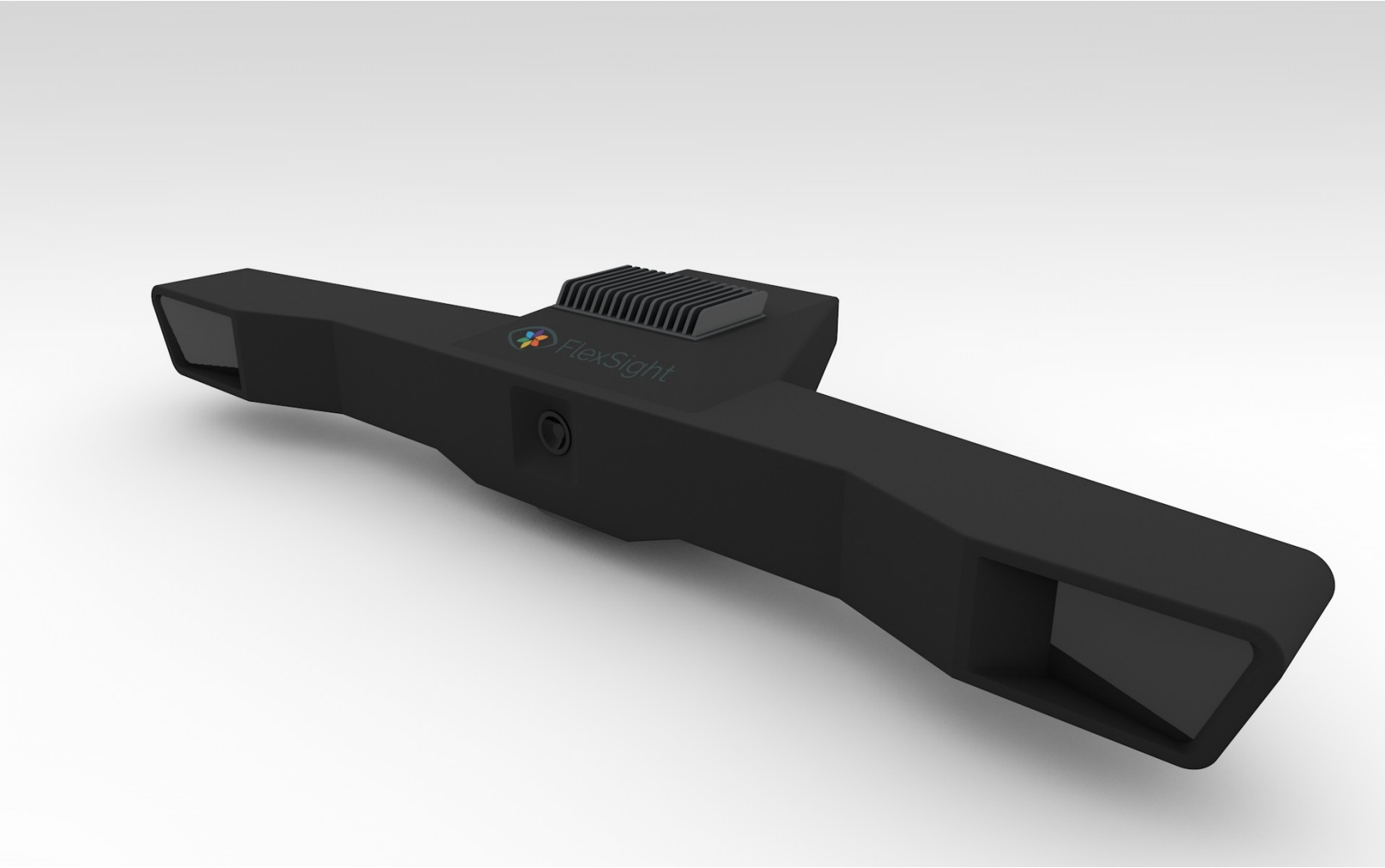
FlexSight

Guide

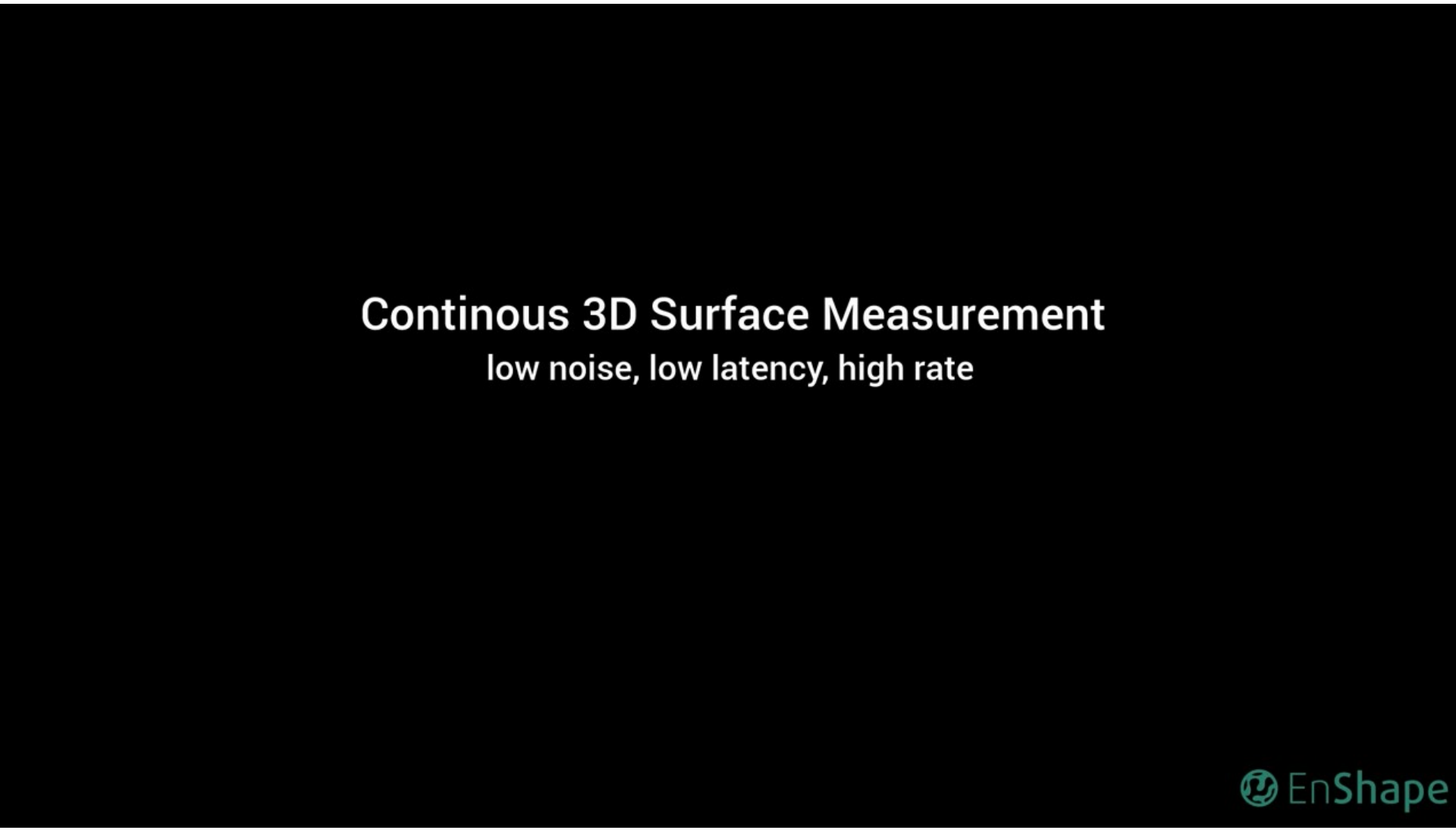
Pick&Place

FlexSight: the first prototype

FlexSight: the final prototype



FlexSight: State of the art



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