IFA
Institut für Arbeitsschutz der
Deutschen Gesetzlichen Unfallversicherung

- Institute for Occupational Safety and Health

Freed from fences

Human Robot Collaboration in the Institute for Occupational Safety and Health (IFA)

Björn Ostermann

Sopot, 13.09.2012

CV

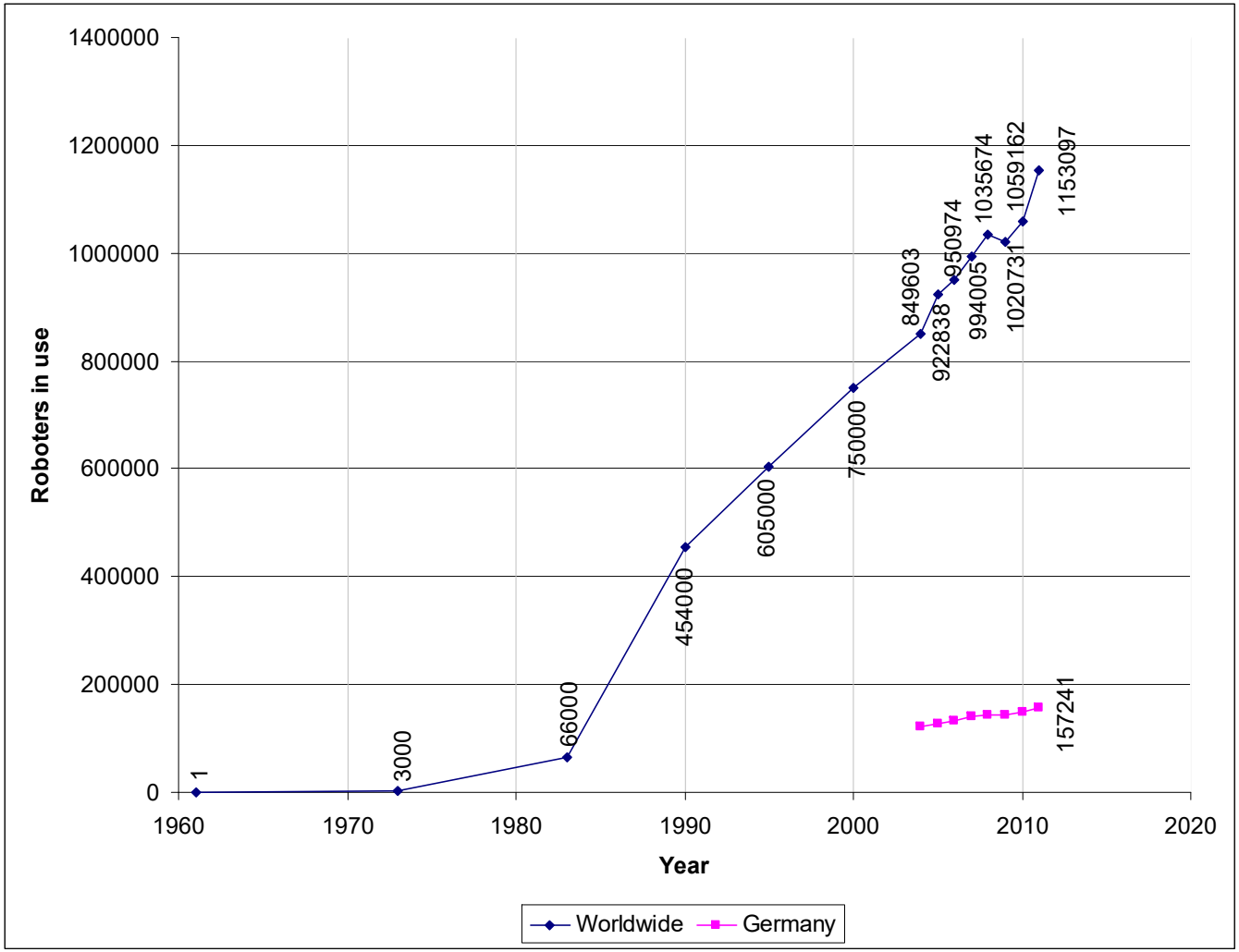
- Björn Ostermann
  - Bonn-Rhine-Sieg University of Applied Sciences
    - 2006 Dipl.-Ing. (FH) Mechanical Engineering / Mechatronics
      - Course on industrial robots
    - 2009 M.Sc. Autonomous Systems
      - Master-Thesis “Industrial jointed arm robot evading dynamic objects”
  - University “Bergische Universität Wuppertal”
    - Since 2009 student for “Dr.-Ing.”
      - “Principle of a person recognizing system, used as a safety measurement with collaborating robots”

Content

- Statistical data
- Sensors in Collaboration
- Collaboration at the IFA
- Topics in Collaboration and their coverage at the IFA
- Projects
  - Collision avoidance using a 3D camera
  - Collision avoidance using an ultrasonic array

Robots worldwide

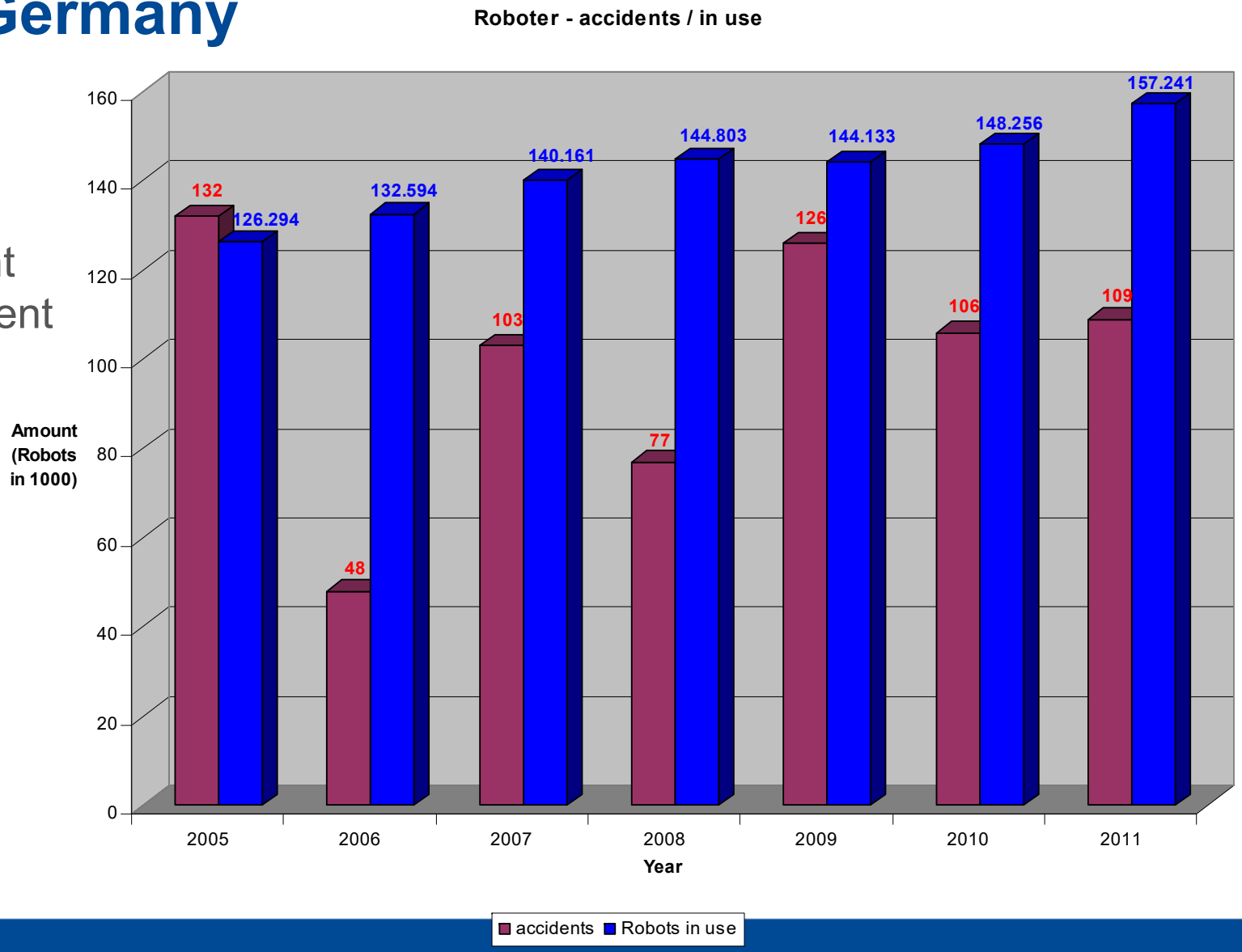
- Robots / 10.000 workers in 2010
- Japan 306
- South Korea 287
- Germany 253
- overall 51



[Source: IFR Statistical Department]

Robots in Germany

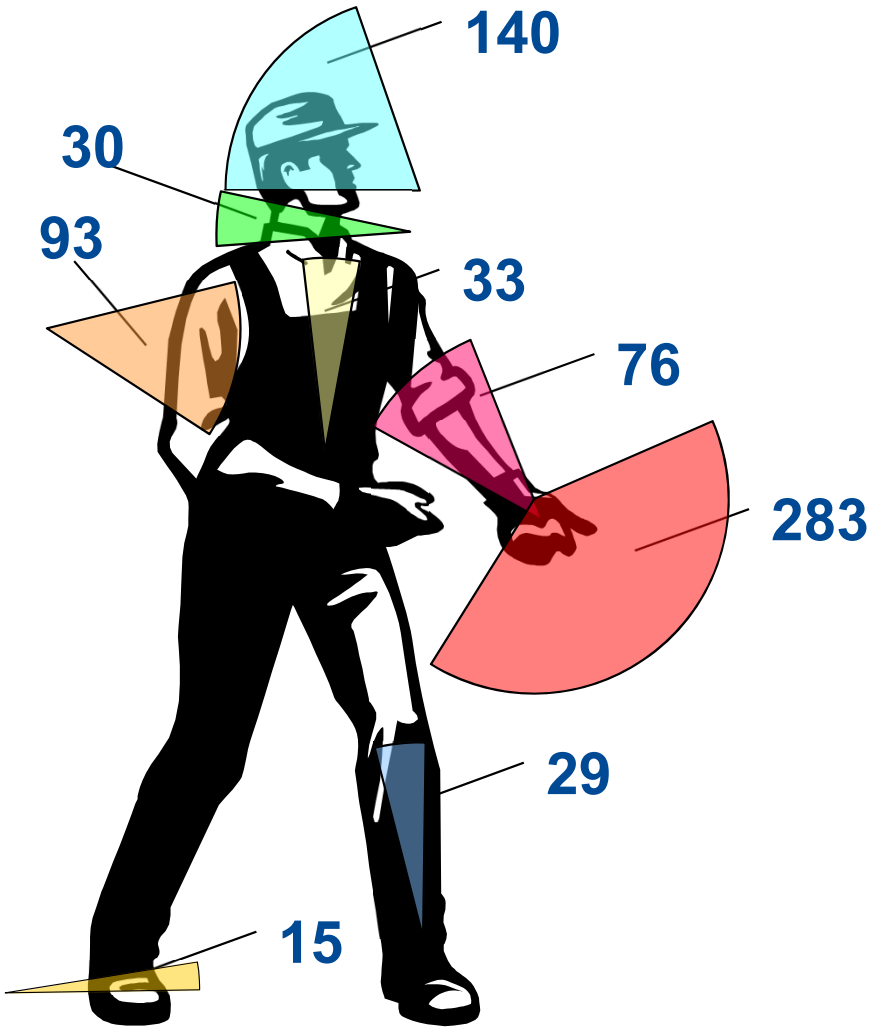
- 2005-2011
  - 3 death
  - 15 retirement due to accident
  - 683 other accidents



[Source: IFR Statistical Department & DGUV]

Hazard Zones

- Deadly injuries
  - head, whole body
- Retirement due to accident
  - hand, arm, head, lower torso



[Daten-Quelle: DGUV (Statistik - Makrodaten, Arbeits- und Schülerunfälle) 2005-2011]

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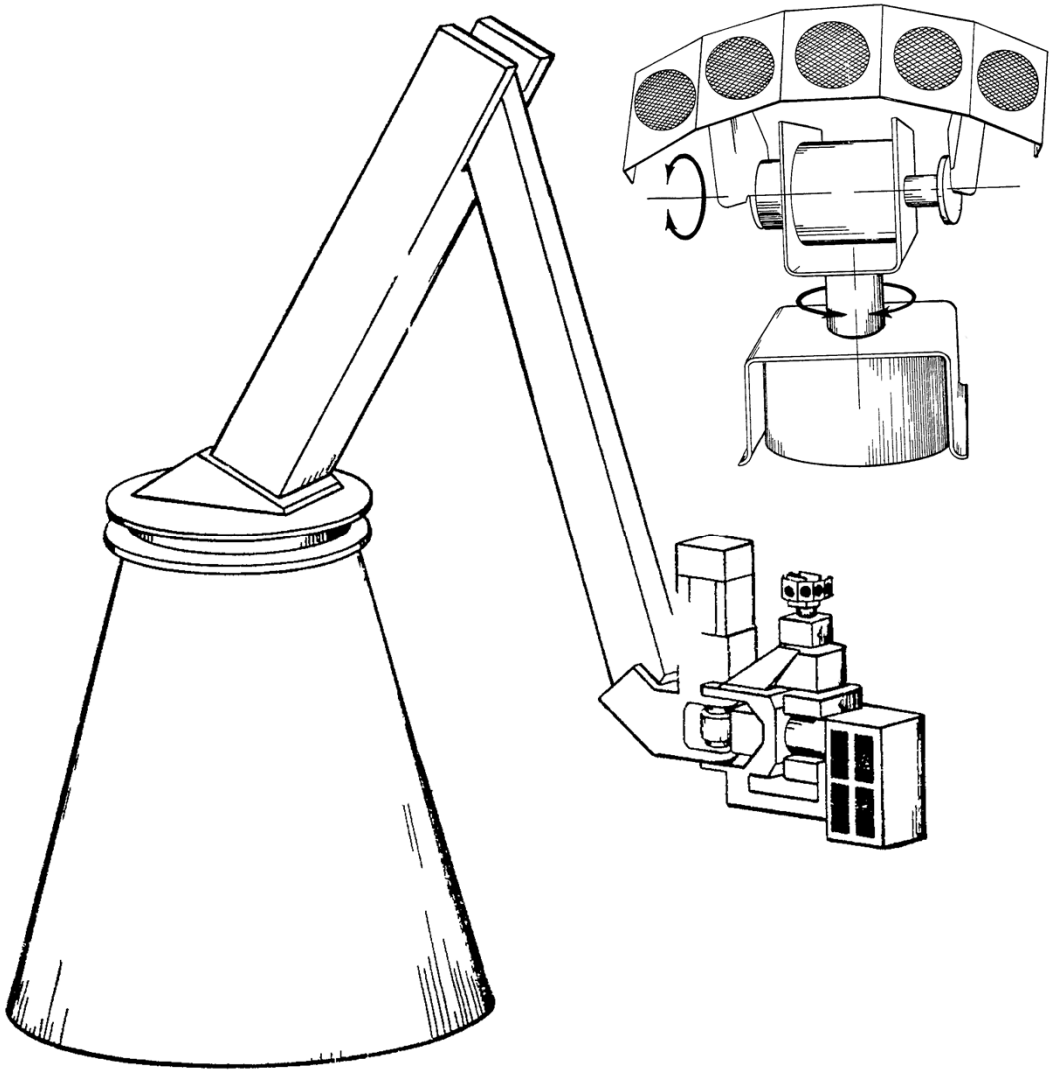
Sensors

- Research work using
  - Force / torque sensors
  - Capacitive sensors
  - Cameras (2D)
  - Laser-scanners (2D and 3D)
  - Cameras (3D)
  - Ultrasonic sensors
  - …



[Source: US Patent 4,674,057]

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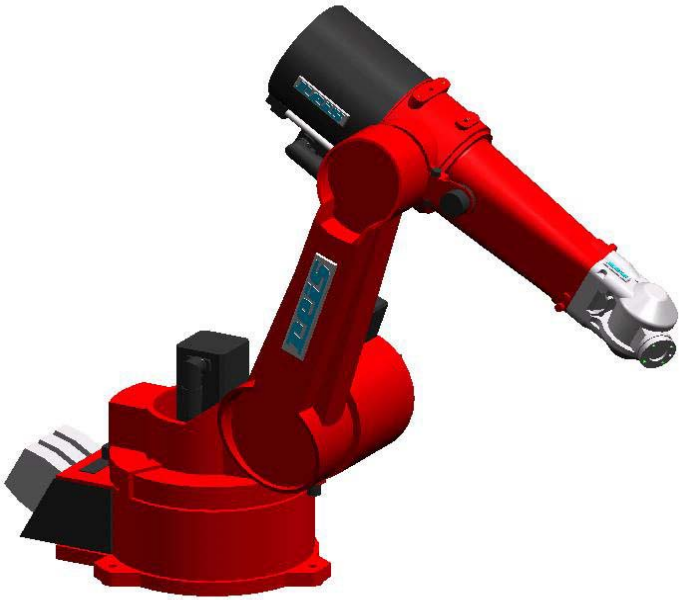
Research „Collaborating Robots“ in the IFA

- Division 5 „Accident prevention – Product safety“
  - Unit 5.1 „New technologies, Man & technology“
- Start of research activities in the IFA in 2008
  - 7 finished Projects
  - 4 ongoing Projects
    - 10 Employees
- Team consisting of physicists, psychologists, medical engineers, electrical engineers, mechanical engineers und computer scientists

Research object

- REIS RV 30-16
  - Maximal load
    16 kg (35 lb)
  - Accuracy
    ±0,08 mm (±0.003 inch)
  - Maximal speed
    ca. 11 m/s (36 ft/s)
    reduced to 4 m/s (13 ft/s)
  - Weight
    360 kg (794 lb)
  - Maximal reach
    2200 mm (7.2 ft)



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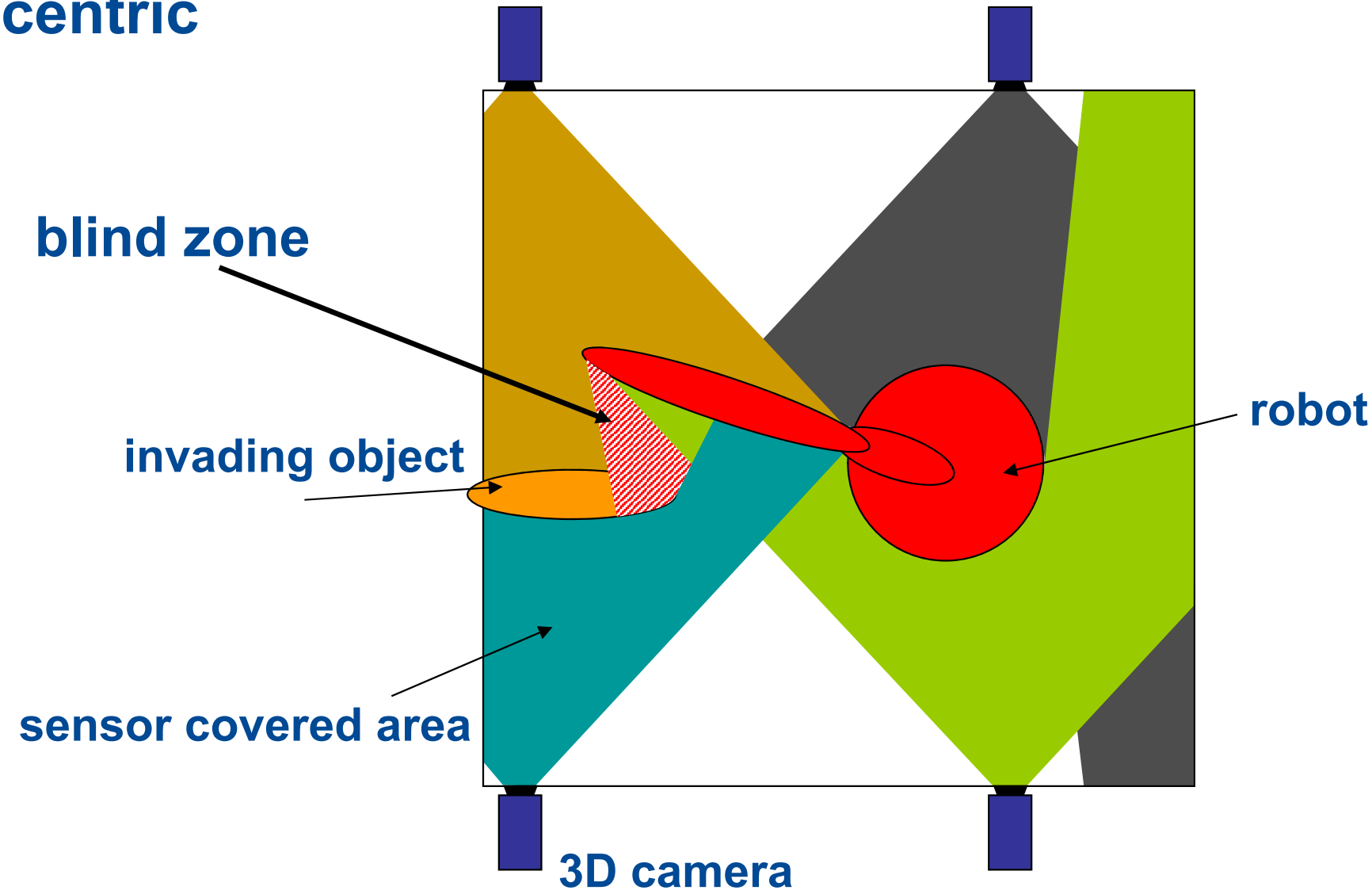
Allocentric

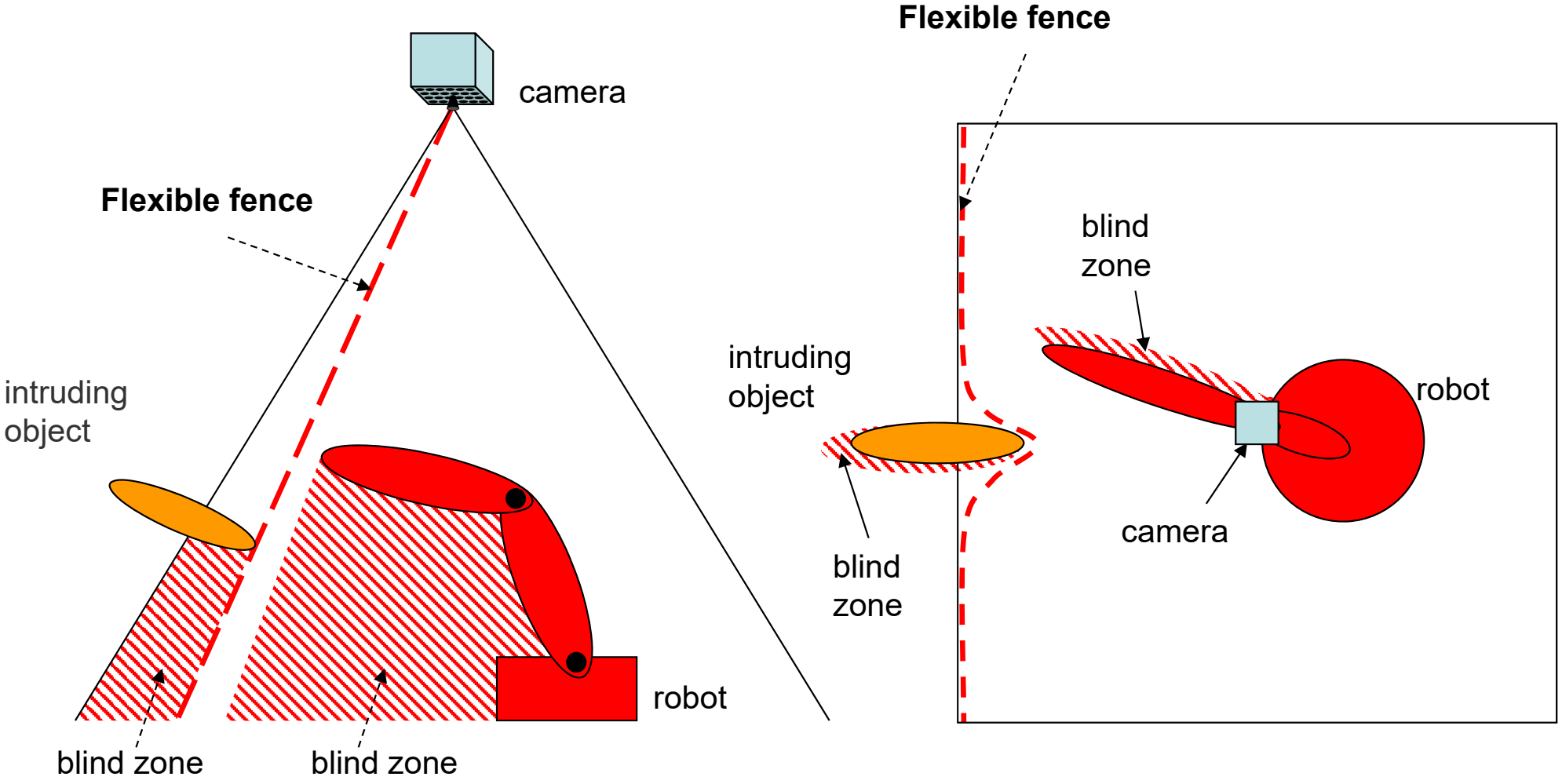


Allocentric sensor

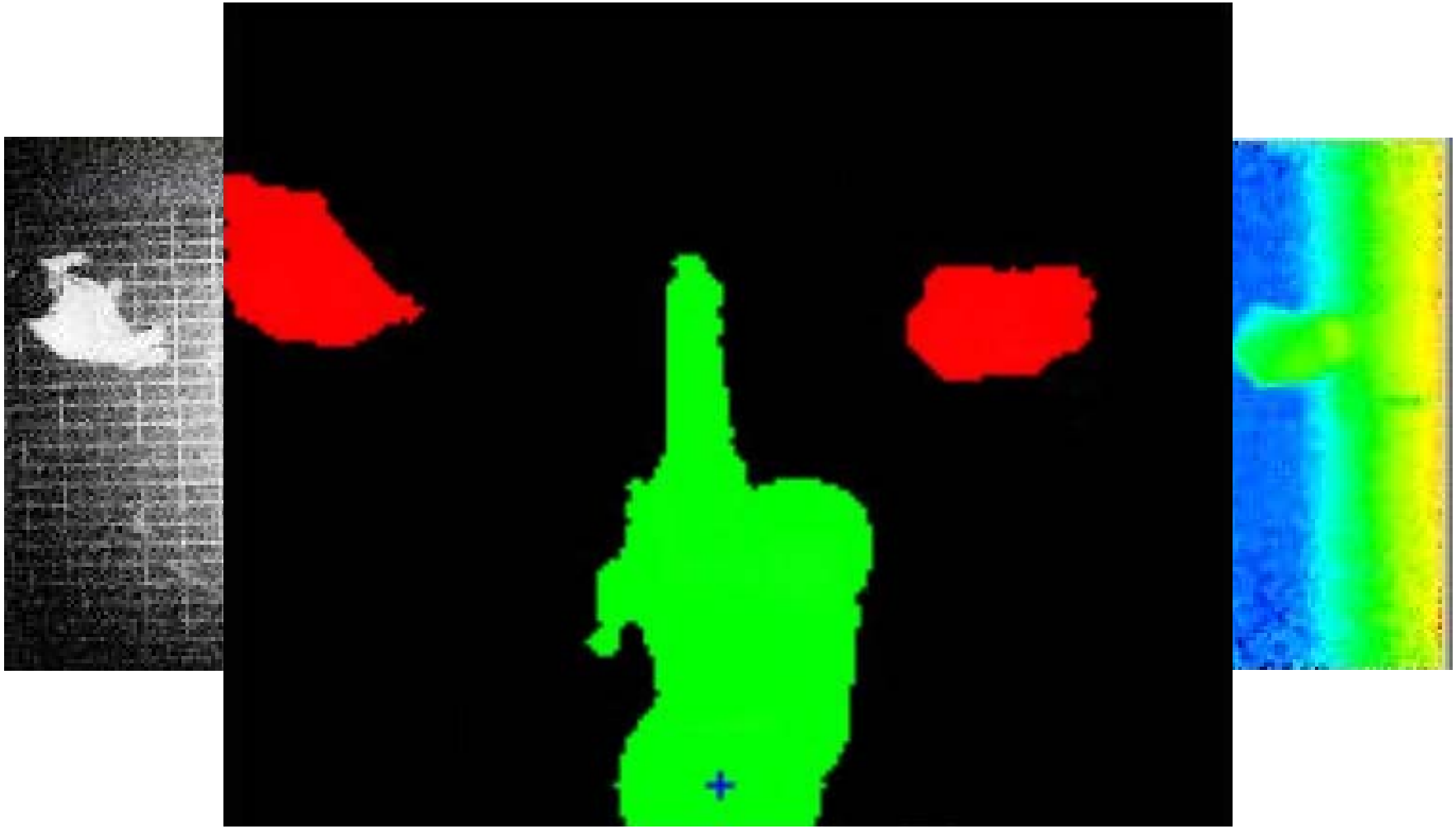
Mesa Swissranger 3000

[Source: Mesa]

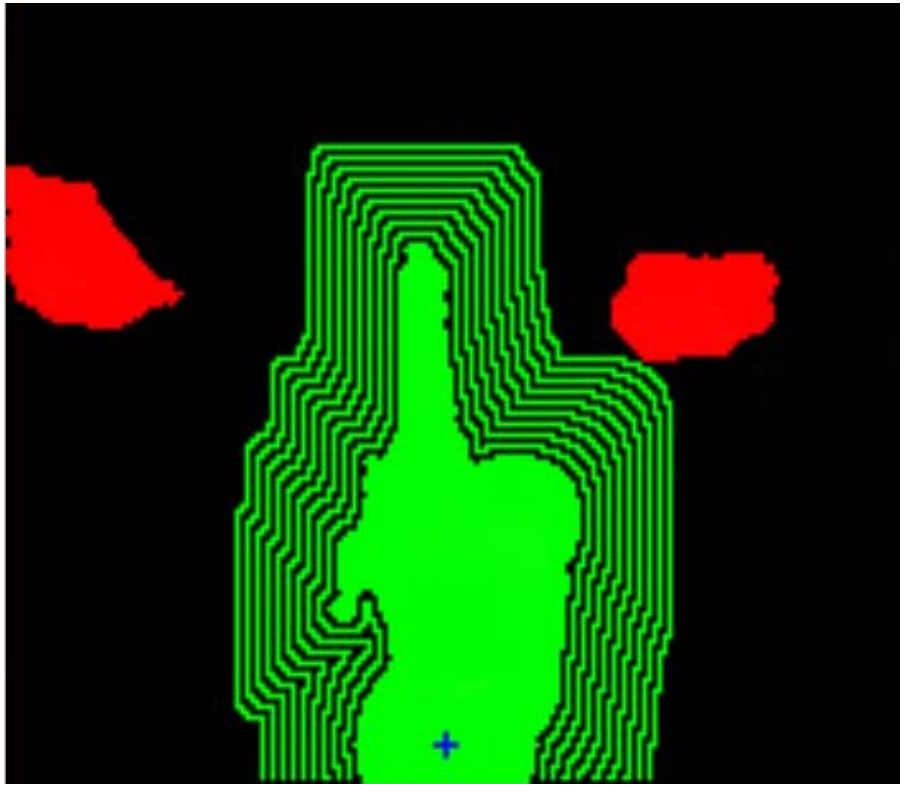
Working principle of the „Flexible fence“



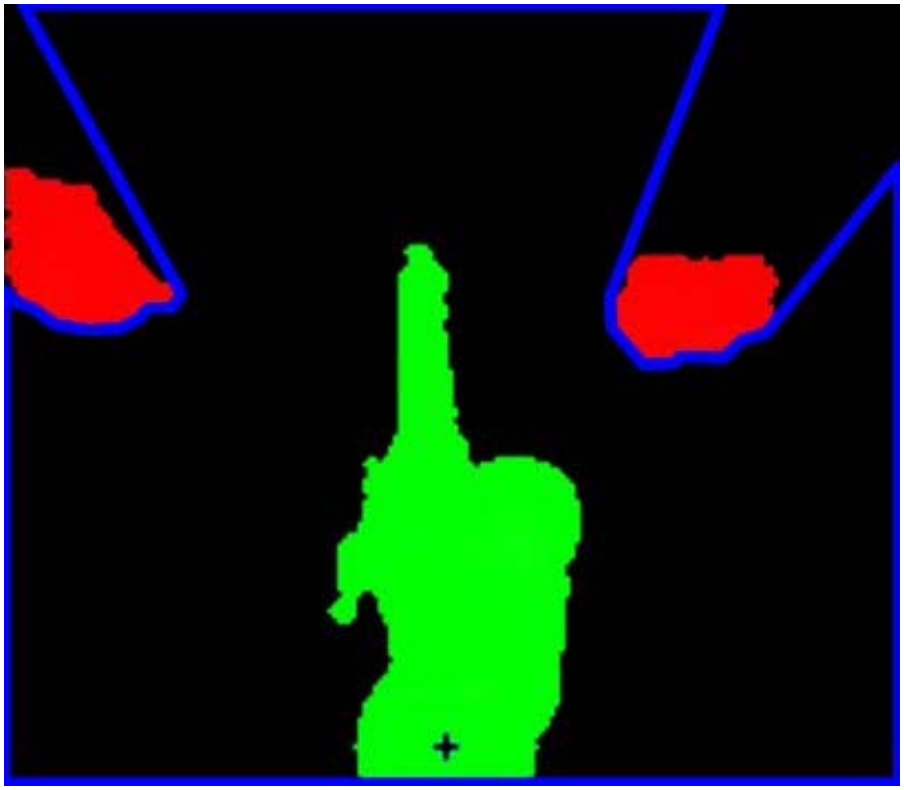
Information required by the control



Results



Distance



Evasion

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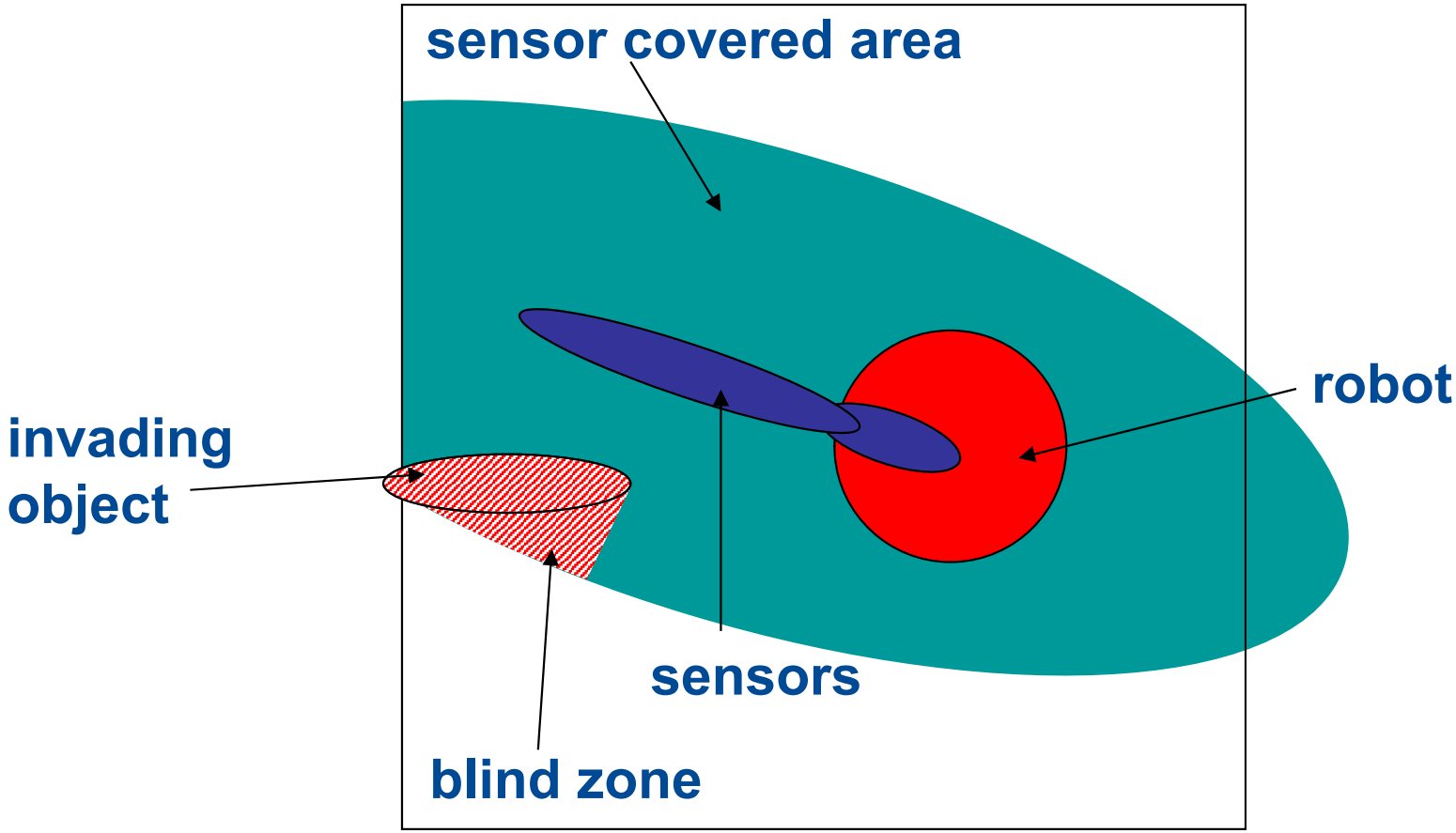
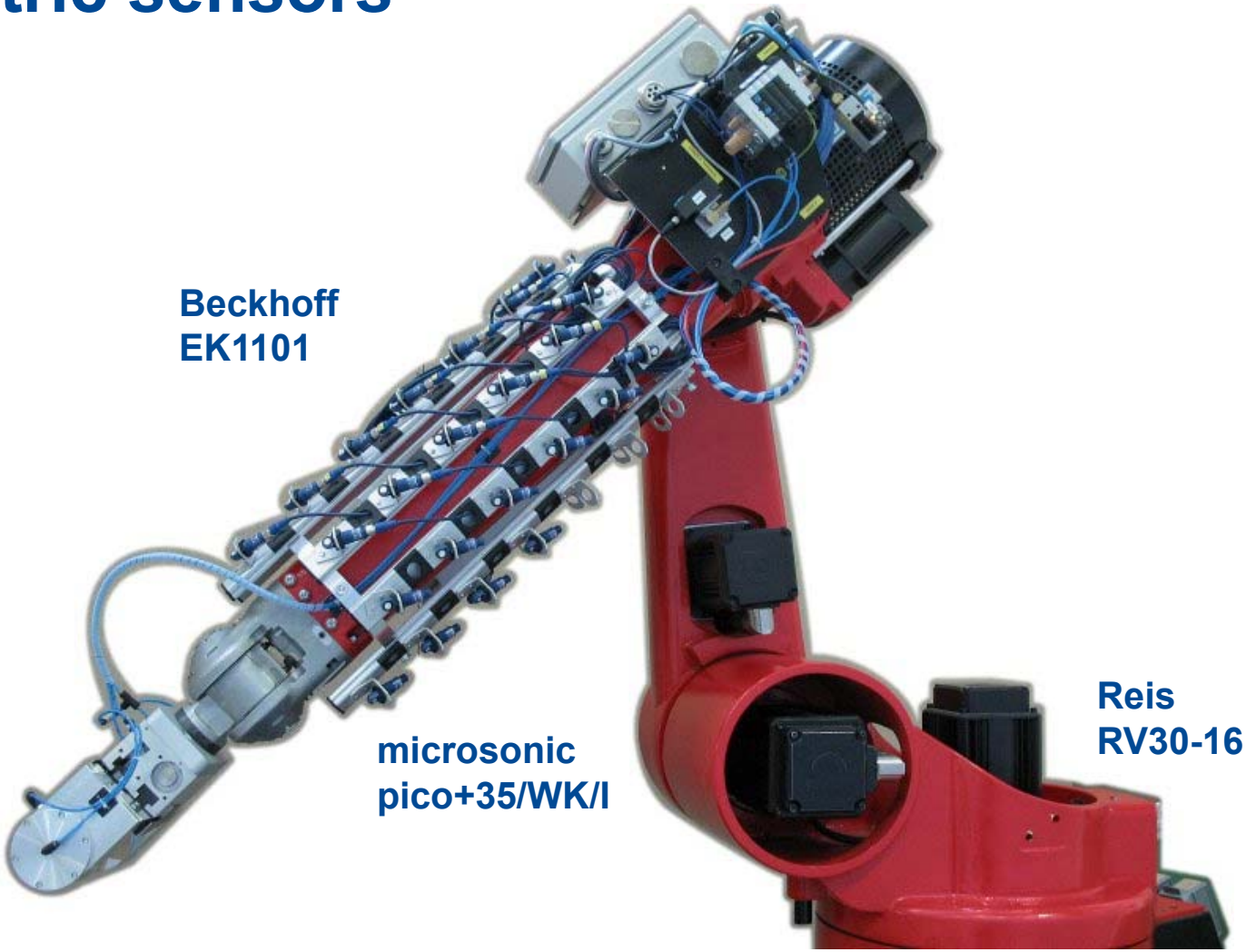
Egocentric


sensor covered area
robot
invading
object
sensors
blind zone

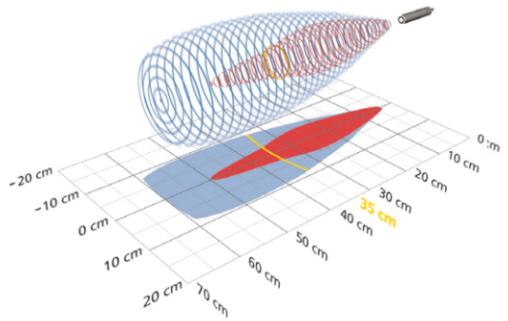
Egocentric sensors



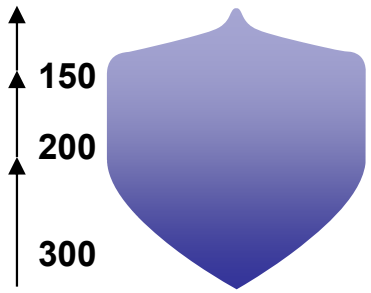
ultrasonic sensors

Different ultrasonic sensors

- Industrial sensor
  - Frequency 400kHz
  - Small cone
  - Fast measurement (17ms)
  - Higher price
- Car manufacturer
  - Frequency 40kHz
  - Wide cone
  - Slower measurement (30ms)
  - Bulk product



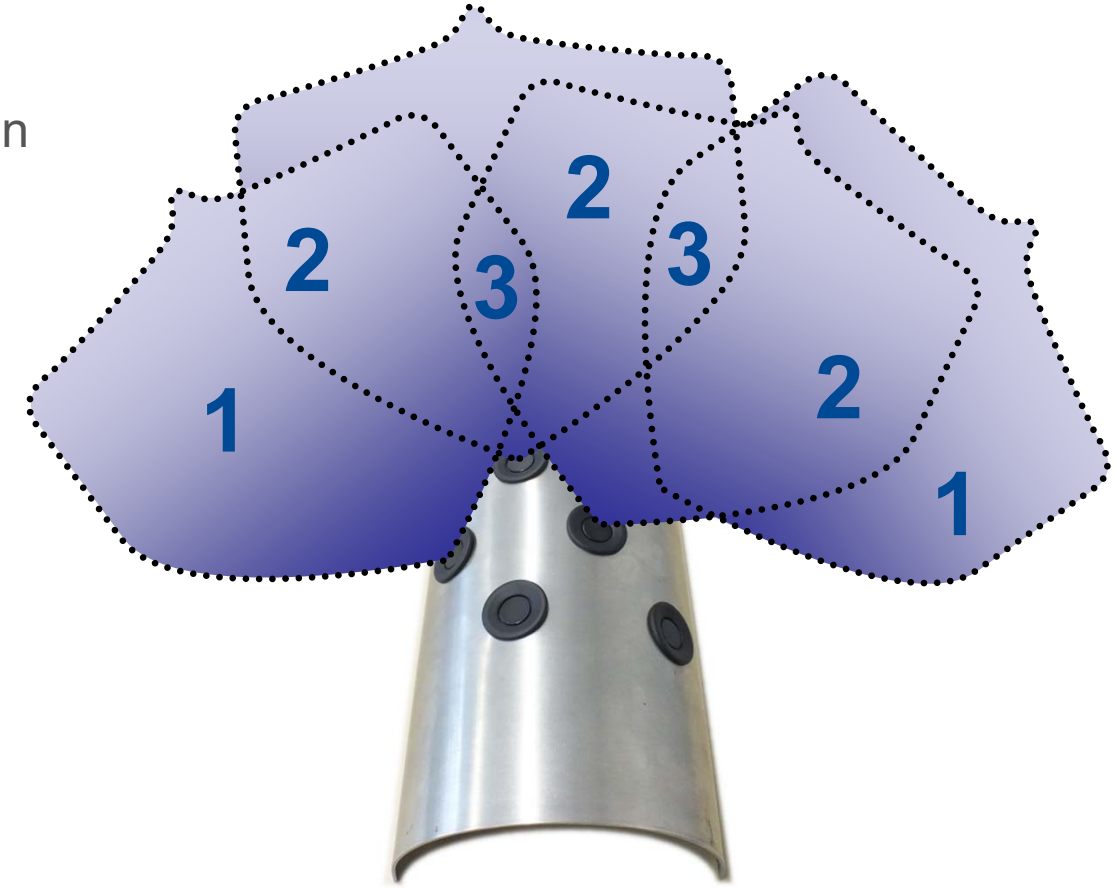
[Quelle: microsonic]



[Daten-Quelle: microsonic]

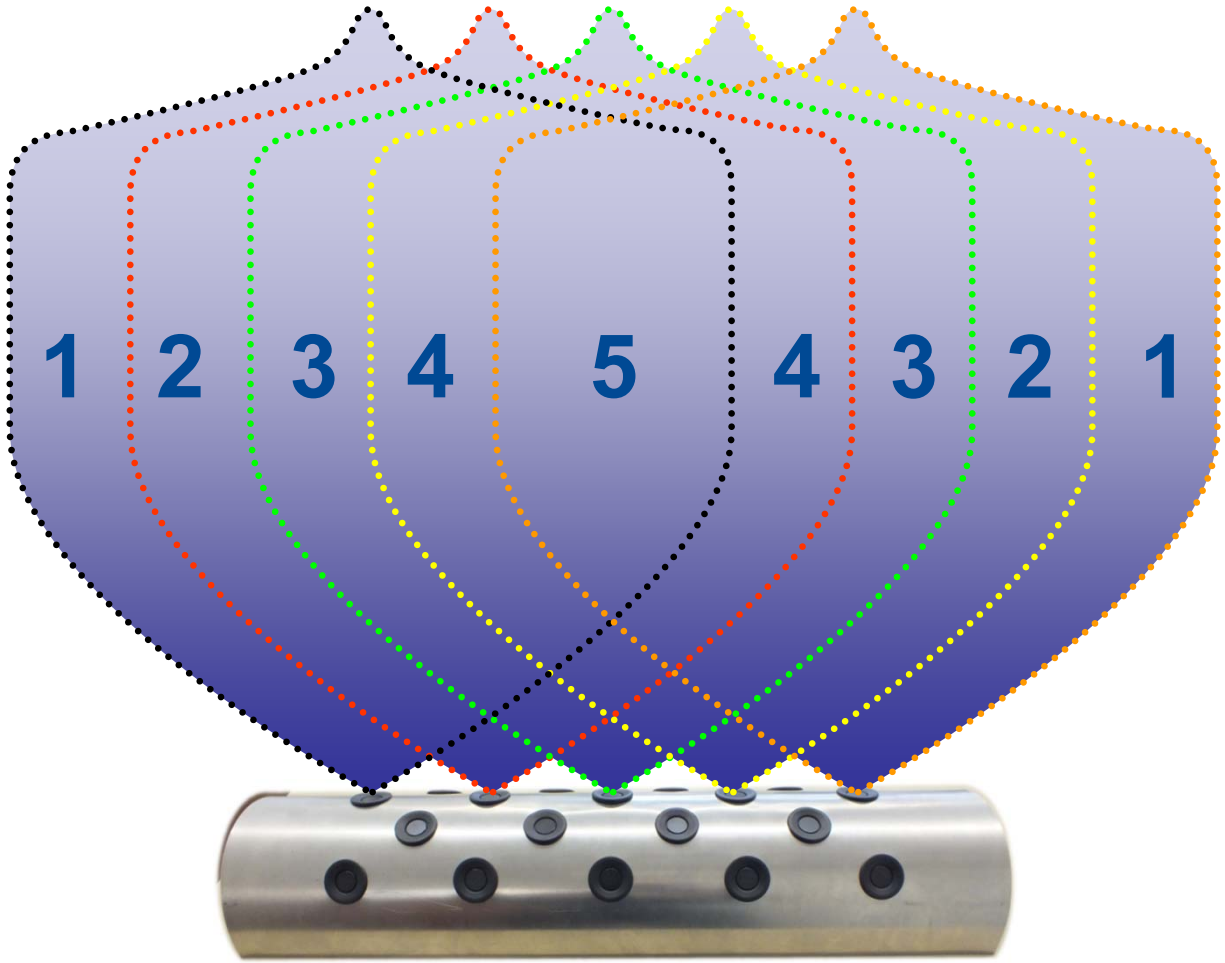
Allocation

- One row each 30°
- 12 rows around the arm
- At least 2 cone-rows at each position

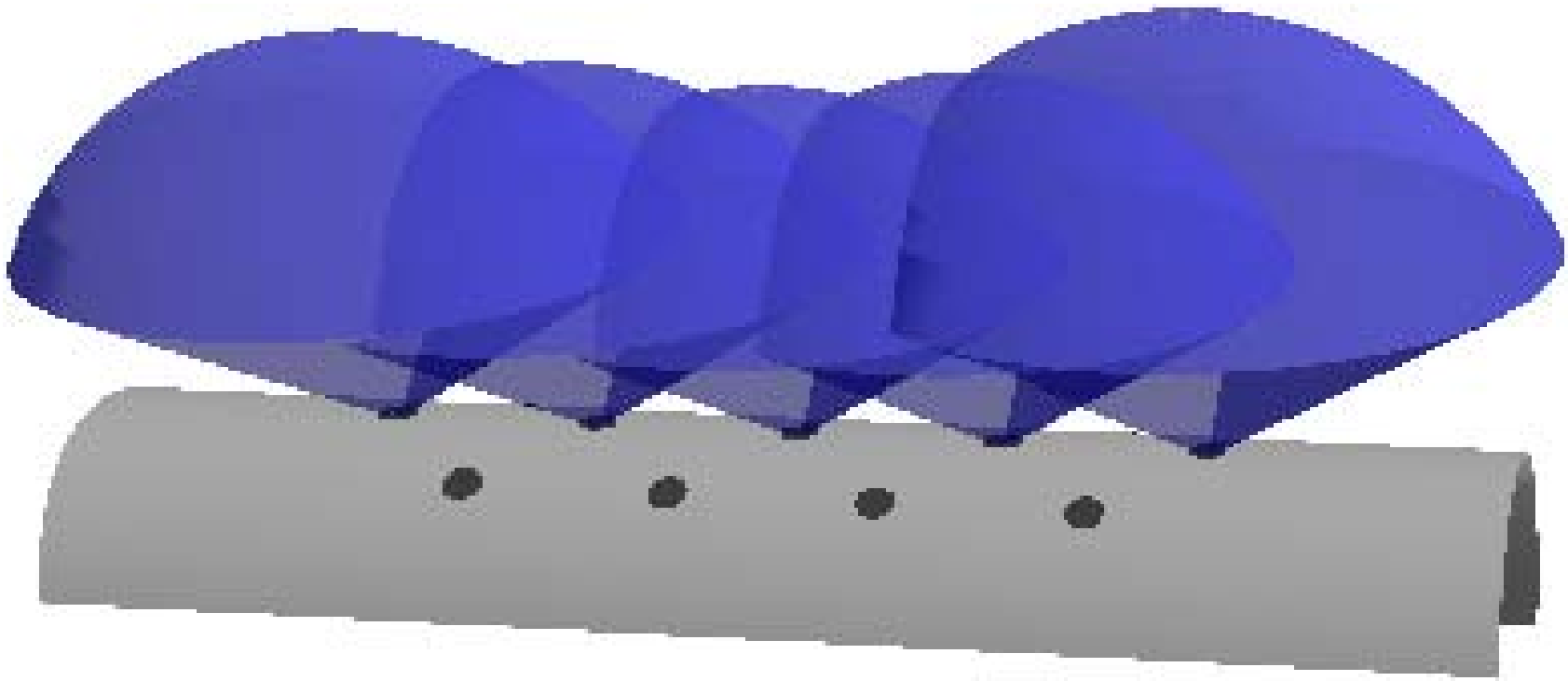


Allocation

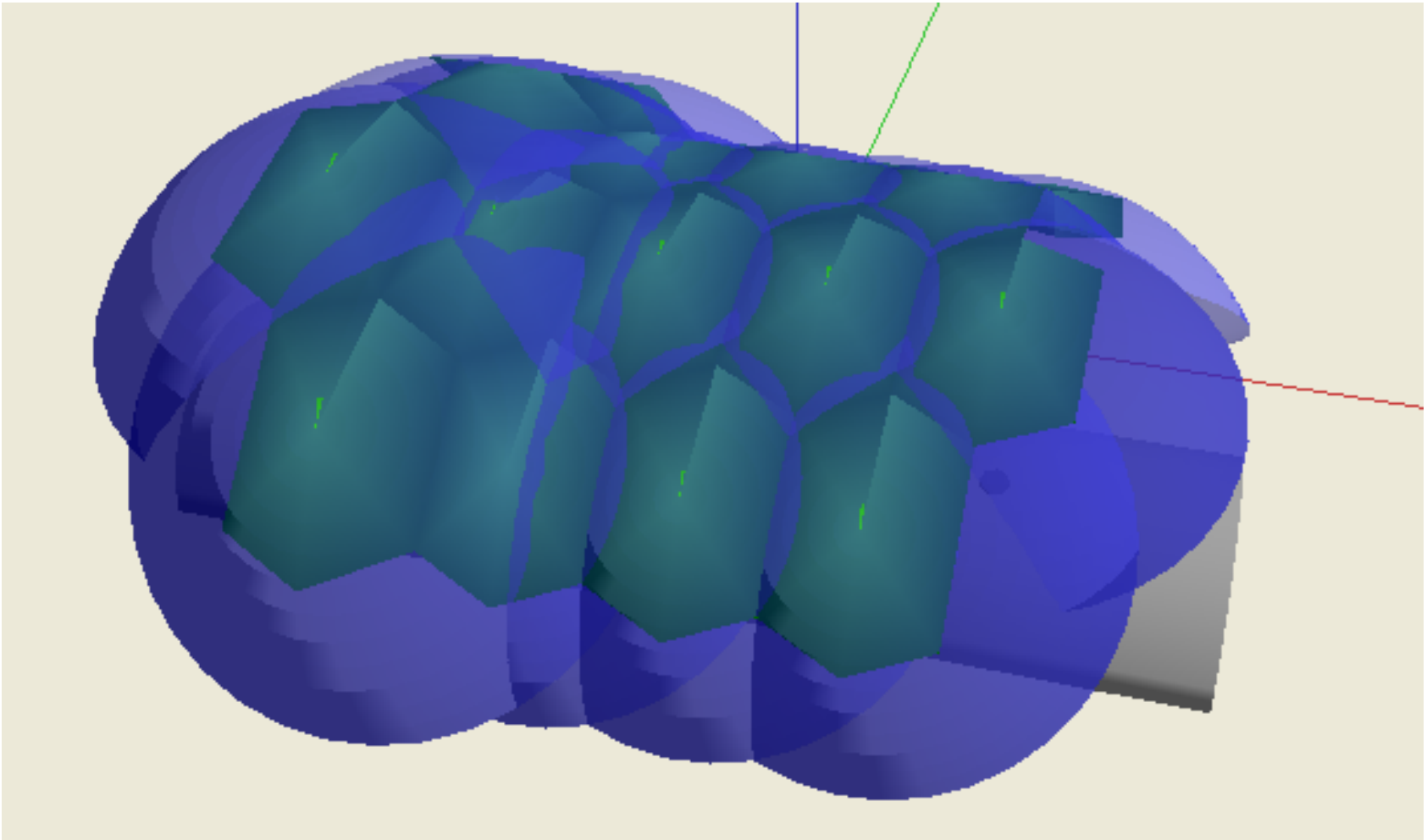
- One sensor every 10cm
- Multiple coverage



Working principle of the „Flexible SafeZone“



Working principle of the „Flexible SafeZone“



Working principle of the „Flexible SafeZone“

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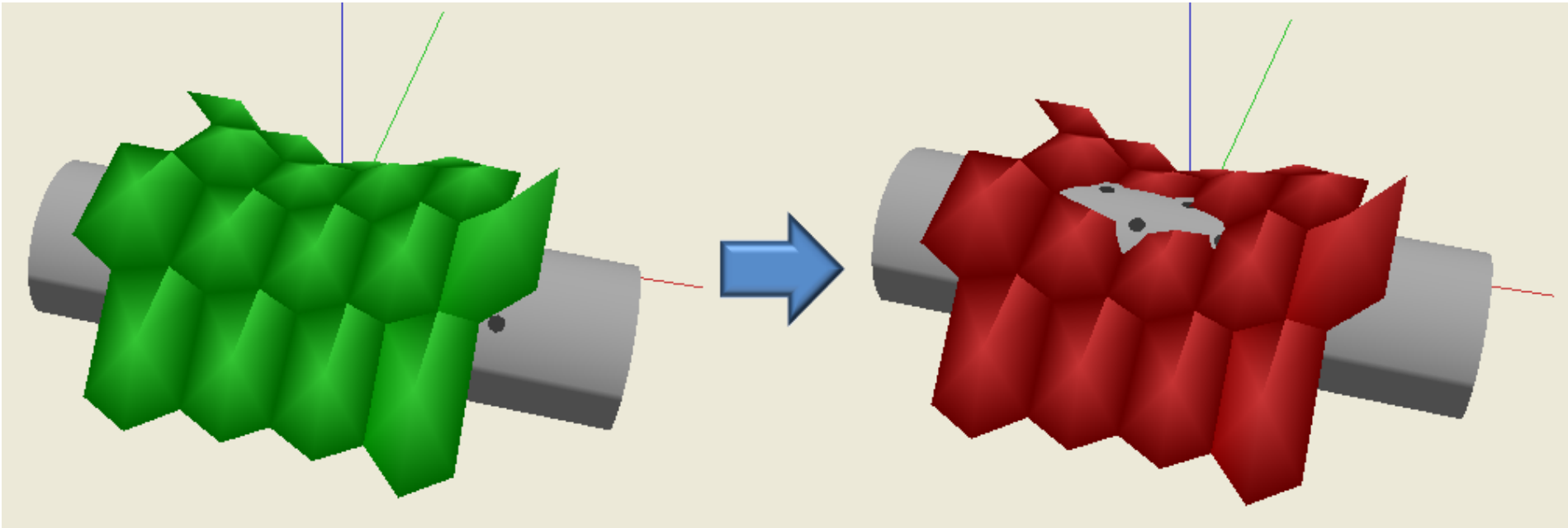

Results of the current project

- Sensors work as a PL d System
  - PFH $1*10^{-7}$
- Detection can be done in 30ms
- Collision can be calculated in < 1ms
- With REIS robot RV 30-16 movement can start at 20cm distance
- Top speed of 2m/s can be allowed at 40cm distance and above

Thank you!