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**Computer Vision for an  
Autonomous Mobile Robot**

Dr. Daniel Withey

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# Contents

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- **Vision systems**
- **Computer vision for a mobile machine**
- **Example: Autonomous exploration and mapping**
- **Applications**
- **Summary**

# Vision systems

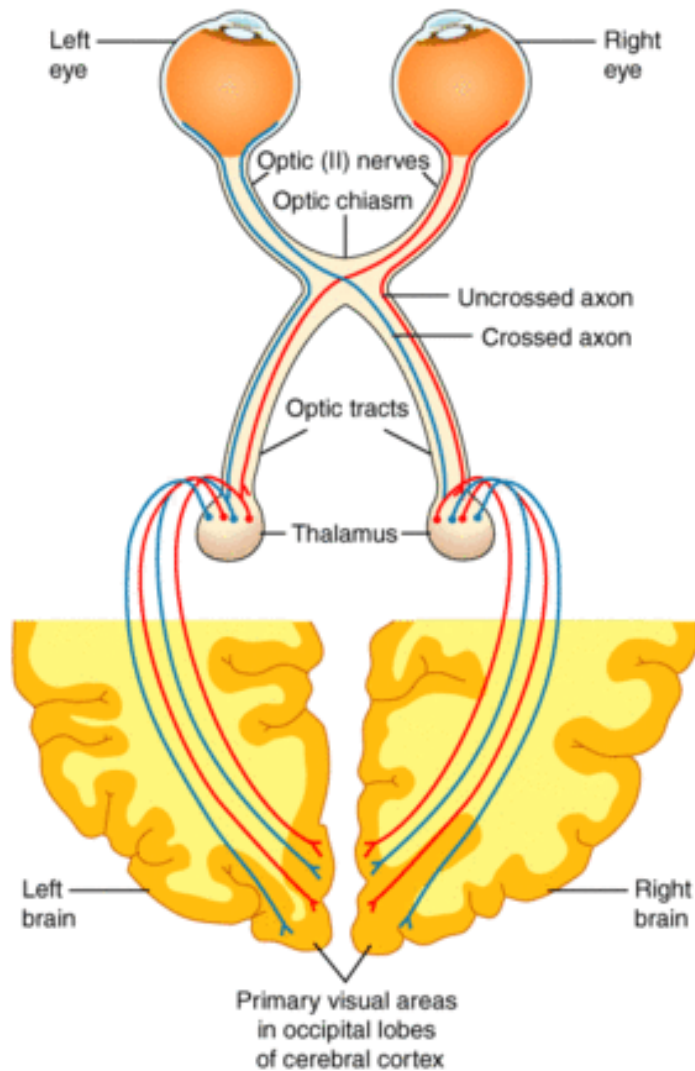
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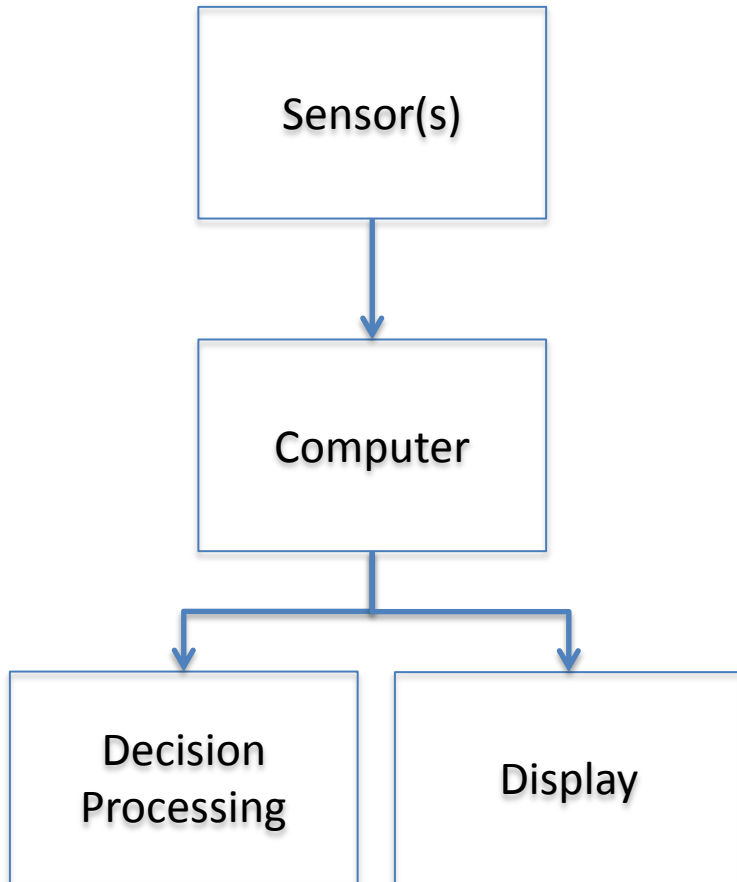


# Vision systems

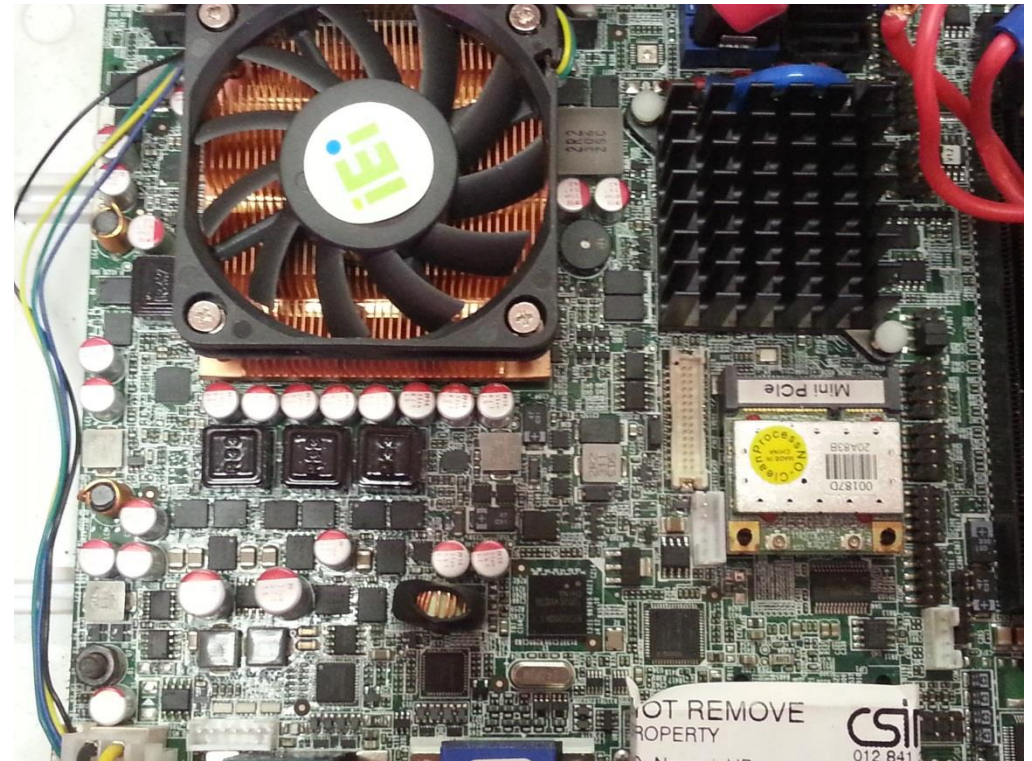


- Human vision system
  - Two primary vision sensors (eyes)
  - CNS: analysis and interpretation

# Vision systems



- Computer vision system
  - One or more vision sensors
  - Computer: analysis and interpretation





# Vision systems

- Common sensor types



**Monocular camera**



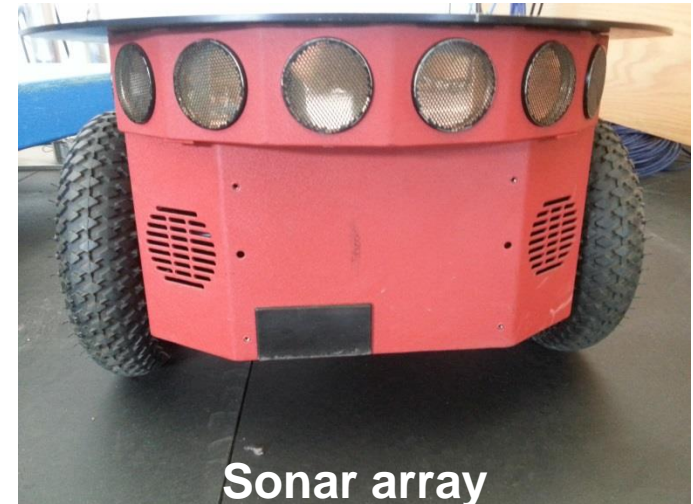
**Omni-directional camera**



**Laser scanner**



**Stereo camera**



**Sonar array**

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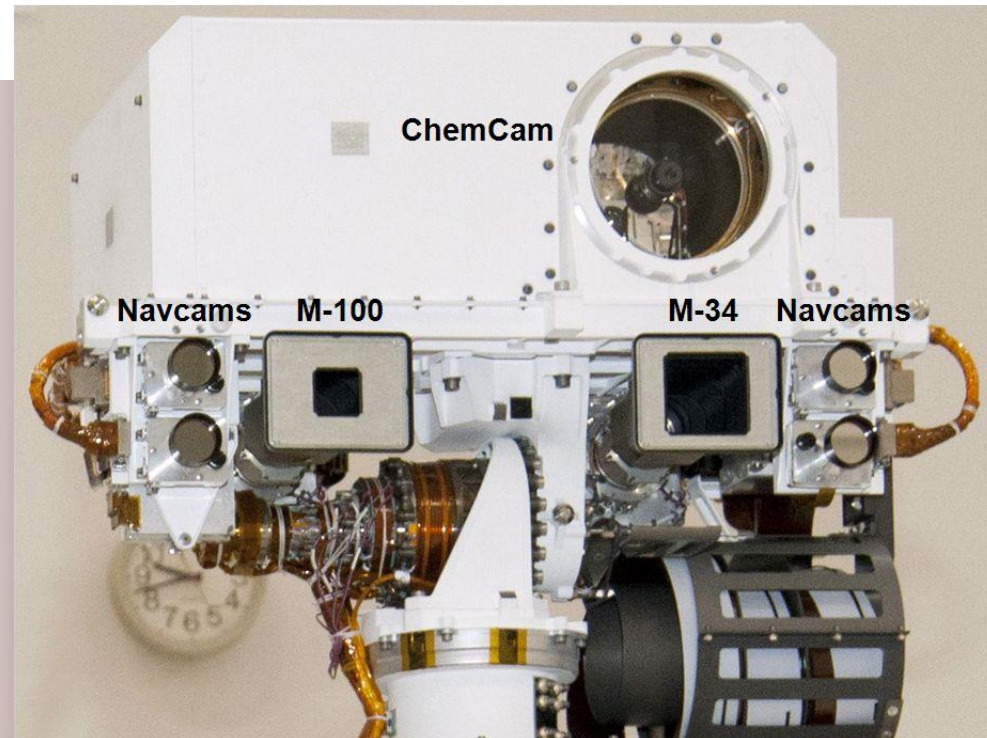
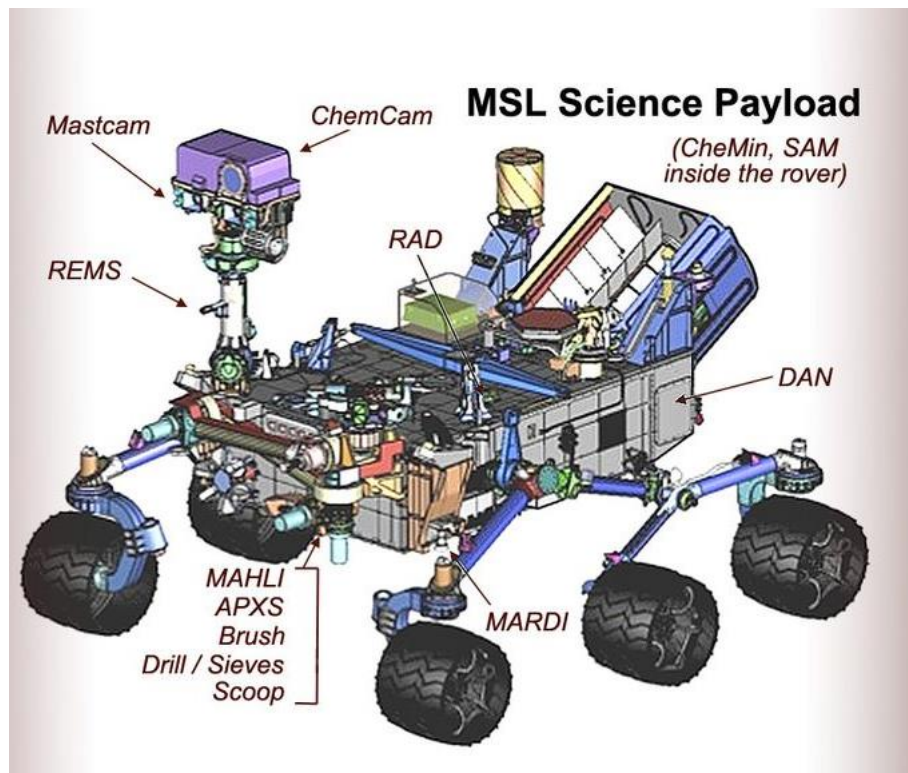
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- NASA Curiosity rover – Mars



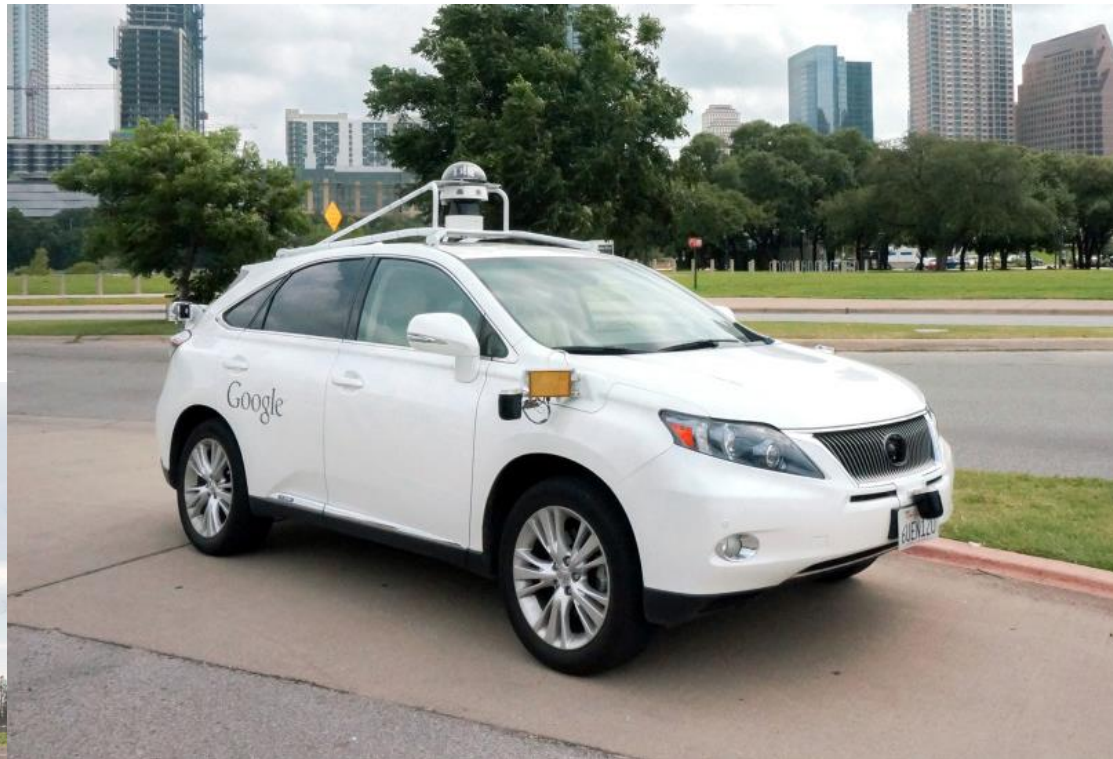


# Computer vision for a mobile machine

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- Google self-driving car
  - Lasers
  - Radars
  - Cameras
  - Proprietary software

Availability: possibly by 2020



<http://www.wired.com/2015/10/googles-lame-demo-shows-us-how-far-robot-car-come/>

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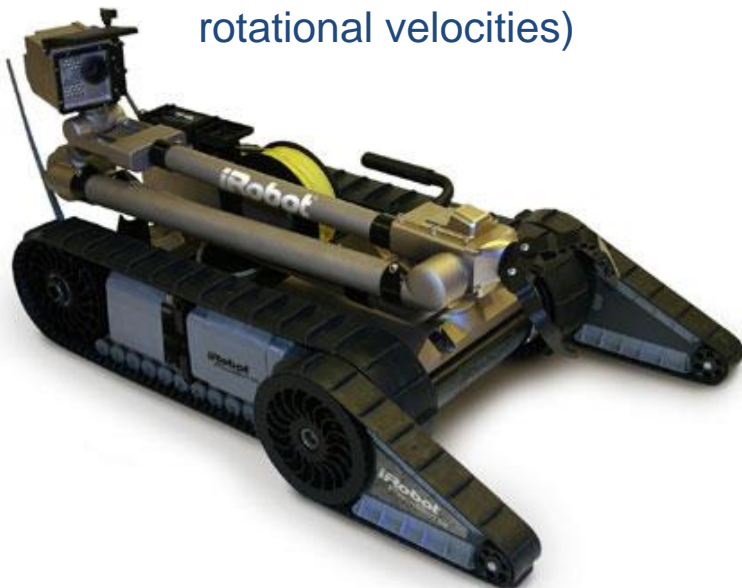
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- Robot system hardware
  - Wheels and frame
  - Electric motors
  - Batteries
  - Internal sensors
    - Odometry (wheel motion)
    - IMU (3D acceleration and rotational velocities)

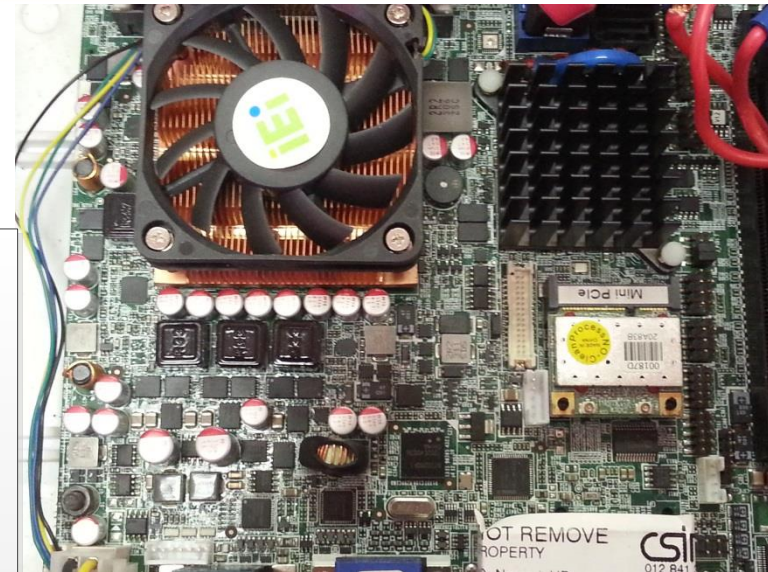
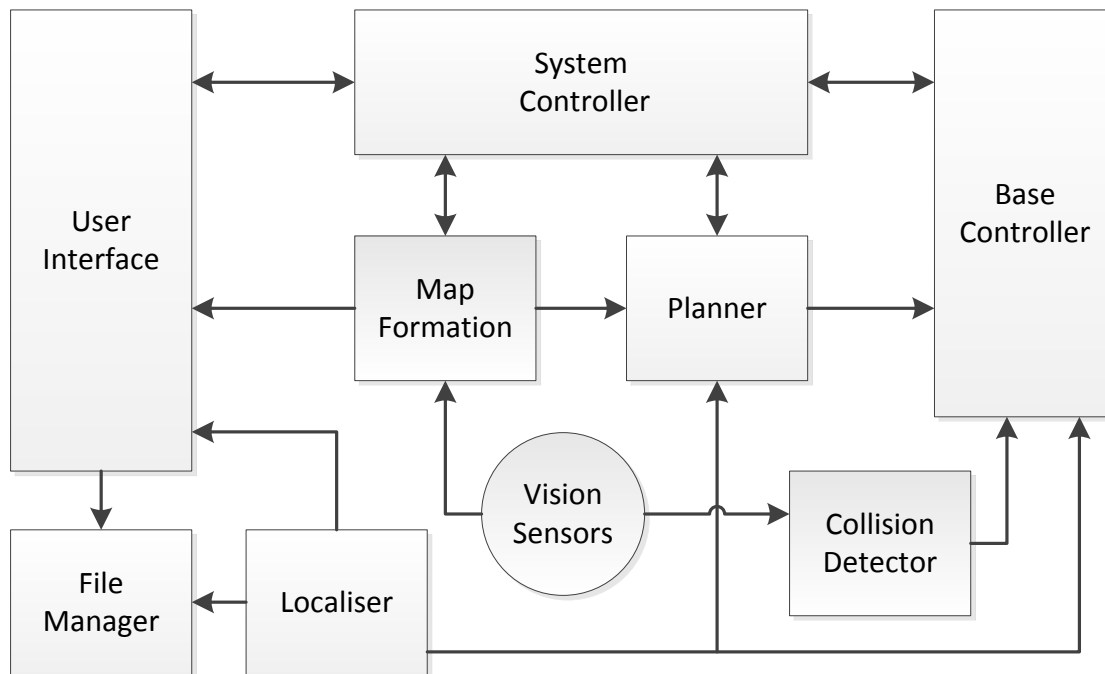




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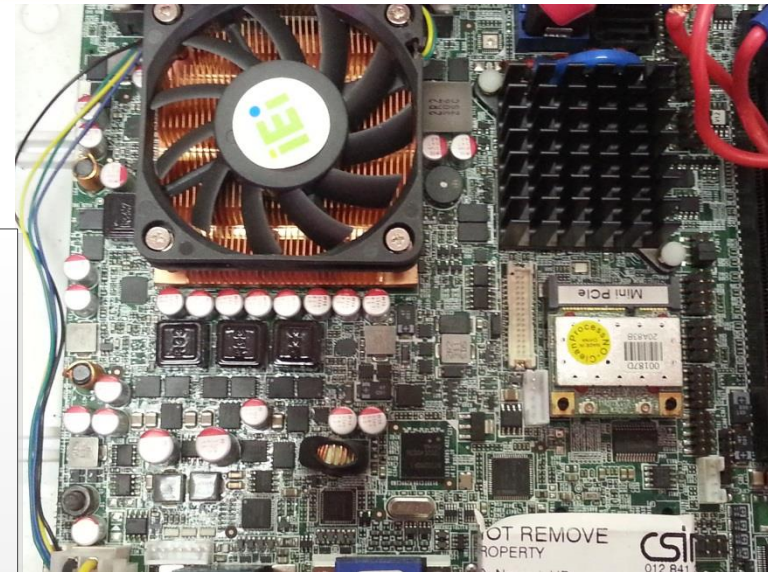
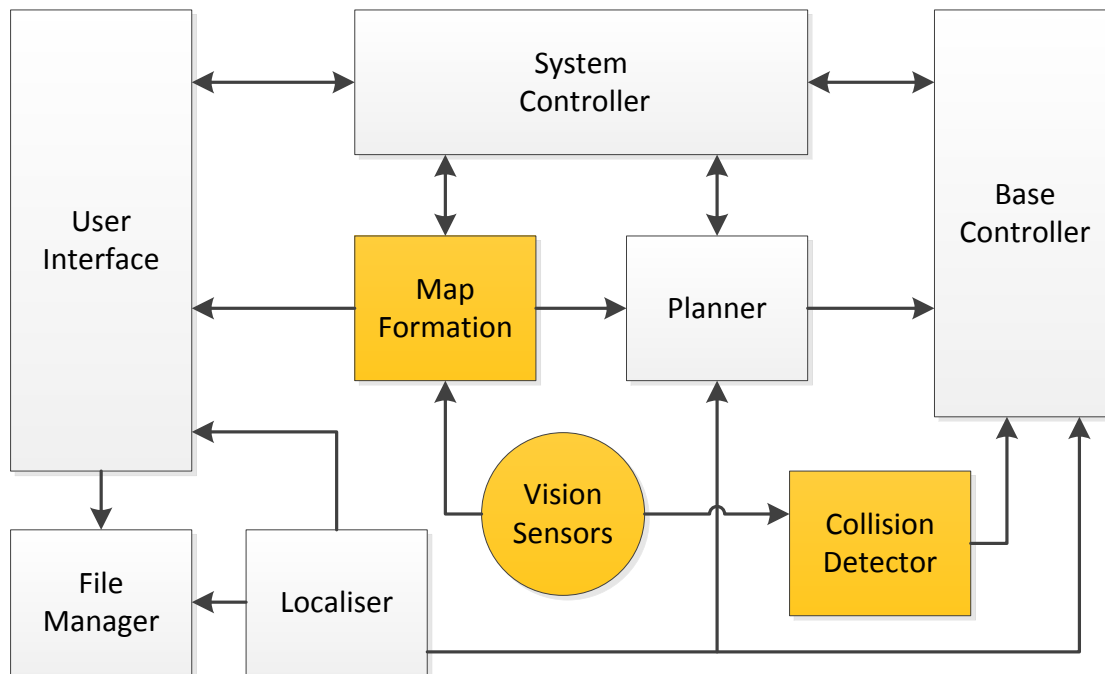
- System software



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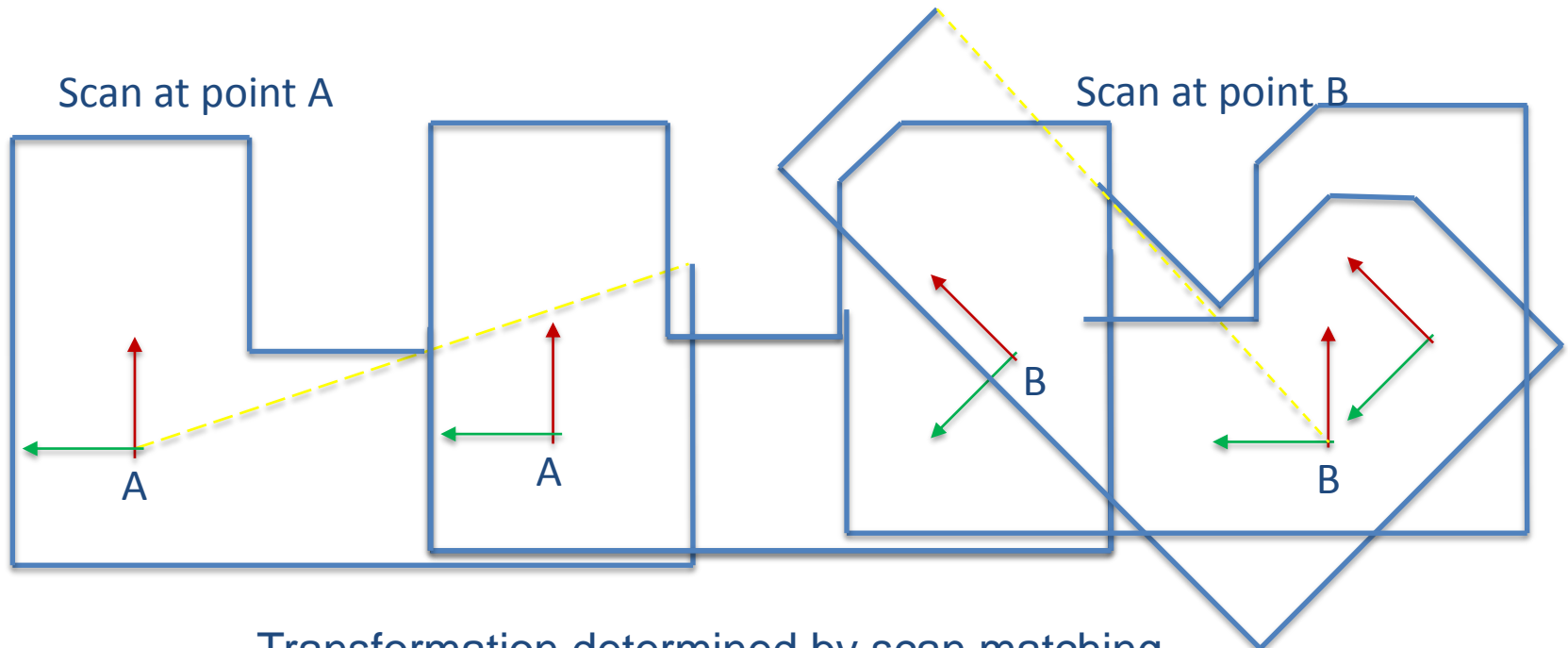
- Vision-related system software





# Computer vision for a mobile machine

- Computer vision algorithm – Map formation:  
Simultaneous Localisation And Mapping (SLAM) – Scan matching method



- Transformation determined by scan matching
- develops the map
  - gives the robot location within the map

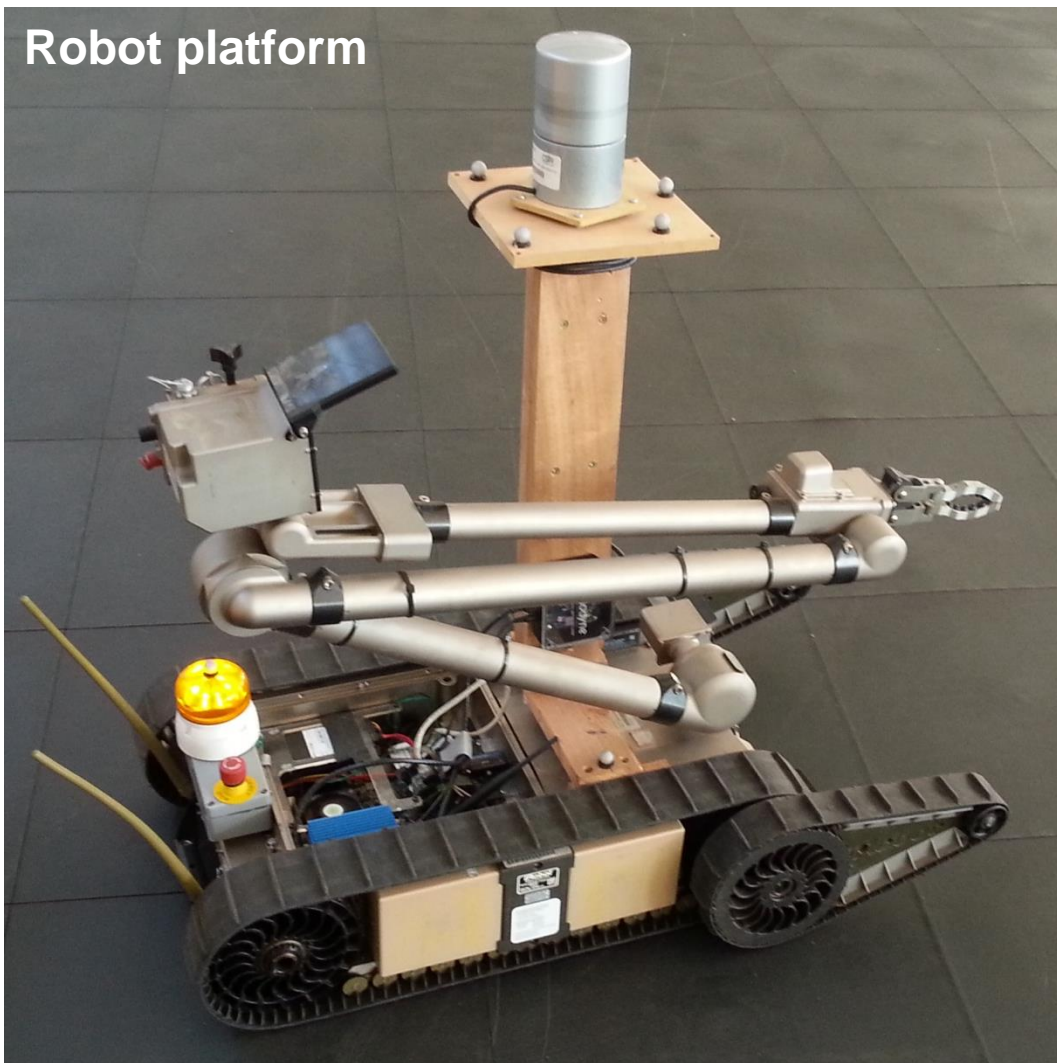
Example:  
**Autonomous exploration  
and mapping**



# Autonomous exploration and mapping

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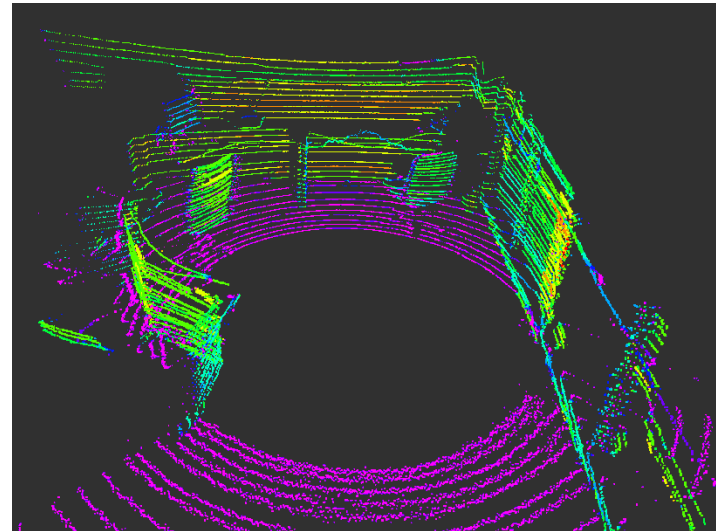
Robot platform



# Autonomous exploration and mapping

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- Primary vision sensor
  - 3D laser scanner
  - 32 laser beams



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# Autonomous exploration and mapping

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Interact Move Camera Select Focus Camera Measure 2D Pose Estimate 2D Nav Goal Publish Point

Operator

PHASE: **Exploration** OPERATION MODE: **Semi-Auto** Comm Status: **Connected** Execution: **Paused** Grab Frame Standby

Reset Autonomous Brakes: OFF

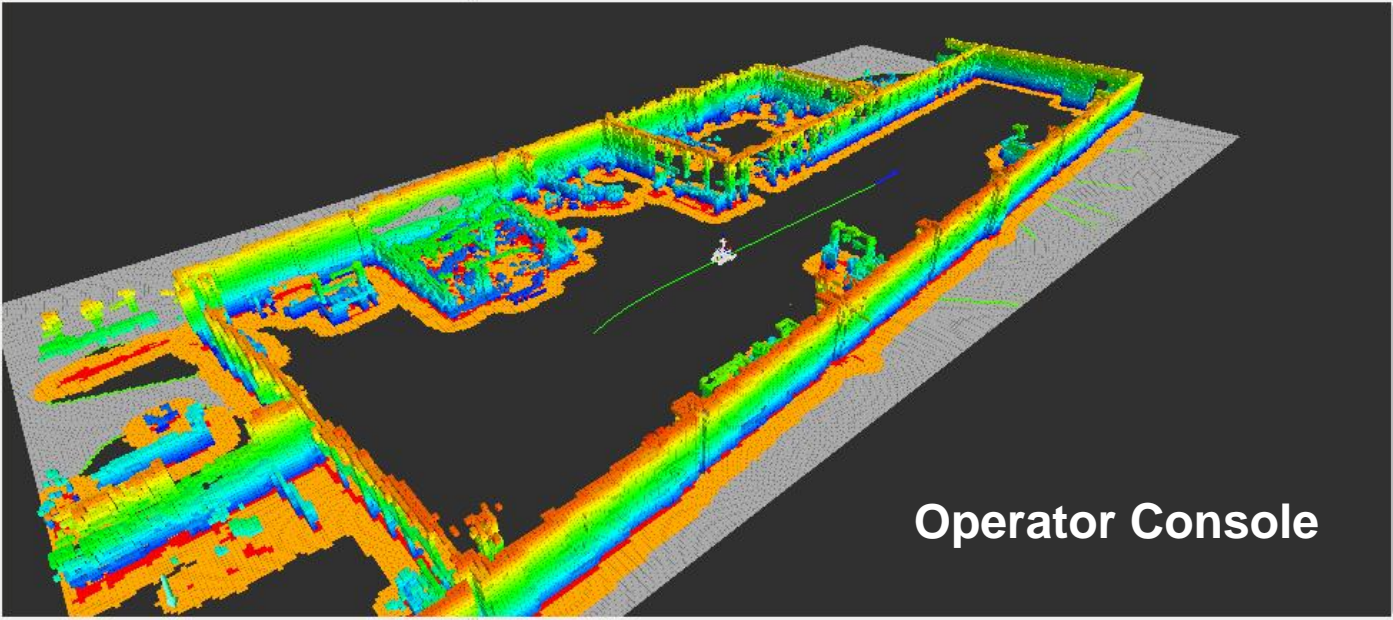
Explore Semi-auto Laser: ON

Survey Manual Battery %: 1 **E-STOP** LaserScan: OK

Distance To Collision: 2.785

Drive mode Low drive mode Stair ascent mode

Image Image



Operator Console

Time

ROS Time: 1438592503.34 ROS Elapsed: 1601.48 Wall Time: 1438592503.46 Wall Elapsed: 1601.43 Experimental

Reset Left-Click: Move X/Y. Right-Click: Move Z. Mouse Wheel: Zoom. 9 fps

# Autonomous exploration and mapping

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# Applications

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# Applications

- Remote reconnaissance

Obtain information about a selected area/region from a remote location.

Examples:

- Public safety, police operations
- Hazardous materials detection
- Military reconnaissance operations



<http://www.irobotweb.com/~media/Files/Robots/Defense/iRobot-Nuclear-Industry-Applications.pdf?la=en>



# Applications

- Remote inspection

Remote scans of selected structures/materials

- structural integrity
- operational status

Remote – due to hazards or space constraints.

Examples:

- Liquid chemical storage tank
- Nuclear plant
- Damaged infrastructure



<http://www.irobot.com/For-Defense-and-Security/Robots/510-PackBot#PublicSafety>

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# Summary

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# Summary

- Computer vision:
  - sensors and analysis hardware/software
- Autonomous mobile robot:
  - Unconstrained environments
  - Artificial intelligence
  - Control own motion
- Applications:
  - Exploration and mapping
  - Remote reconnaissance
  - Remote inspection



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Thank you

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