Introduction to Autonomous Systems

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Outline

- What are autonomous systems?
- Why and when are autonomous systems needed?
- What are engineering requirements for autonomous systems?

What are autonomous systems?

- Autonomous system (internet): a collection of IP networks and routers under the control of one entity.
- Autonomous system (mathematics): a system of ordinary differential equations which does not depend on the independent variable.
- Autonomous system (robotics): robots/drones which can perform desired tasks in unstructured environments without continuous human guidance.

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- Actuators: motors, wheels, rotors, arms, hands, legs, tracks
- Sensors: odometers, IMU, laser, radar, sonar, camera, GPS
- Communication devices: radio, optical, sound
- Processors

Functions:

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Functions:

- Motion
- Manipulation
- Perform tasks without direct control of a human operator

Sensors and Actuators

Sensors:

- IMU (magnetometer, accelerometer, and gyroscope)
  - Attitude and heading reference system (AHRS)
- GNSS (GPS, Glonass, Galileo)

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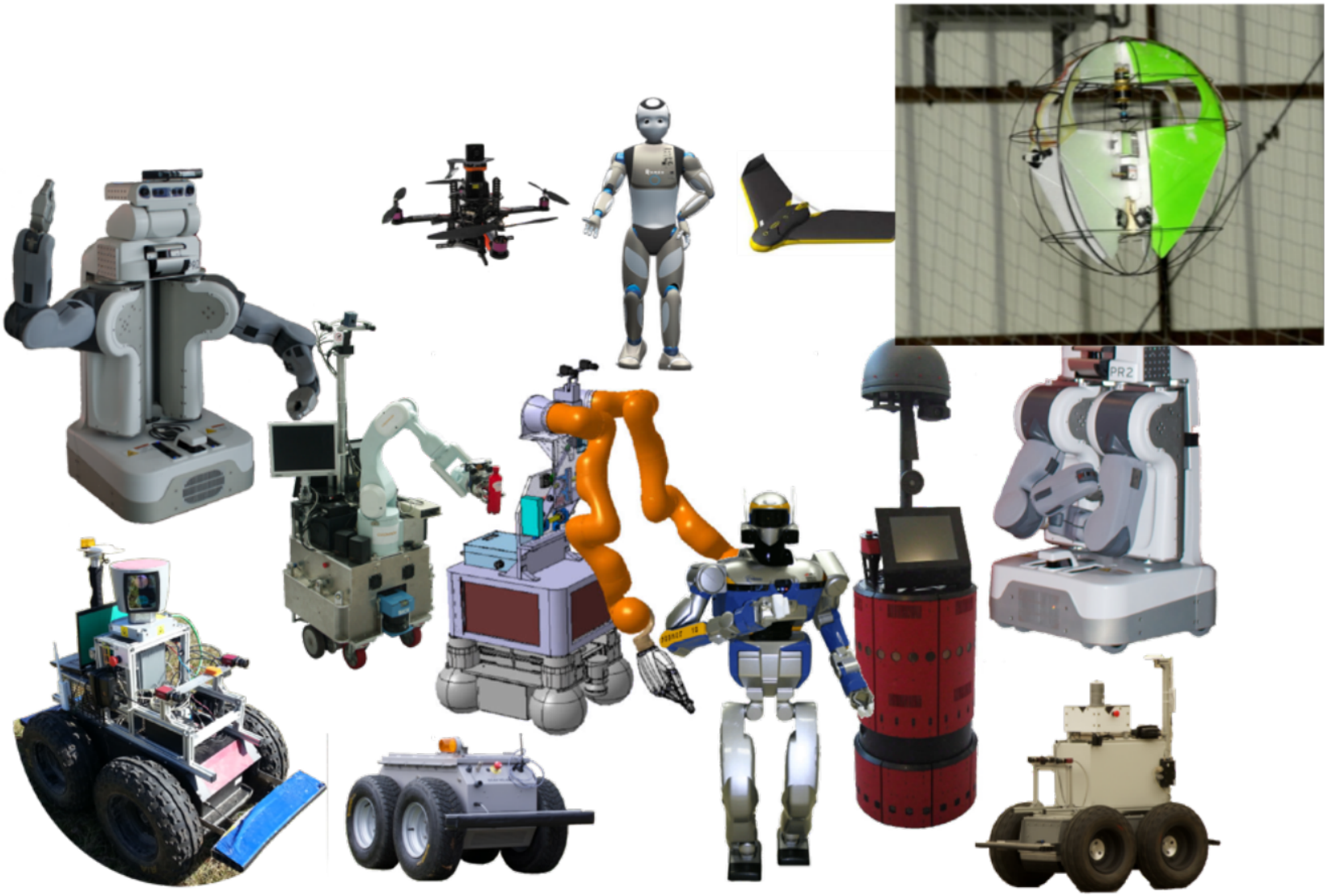
Actuators:

- Hydraulic (compressed oil)
- Pneumatic (compressed air)
- Electric (electric current and magnets)

What are autonomous systems?



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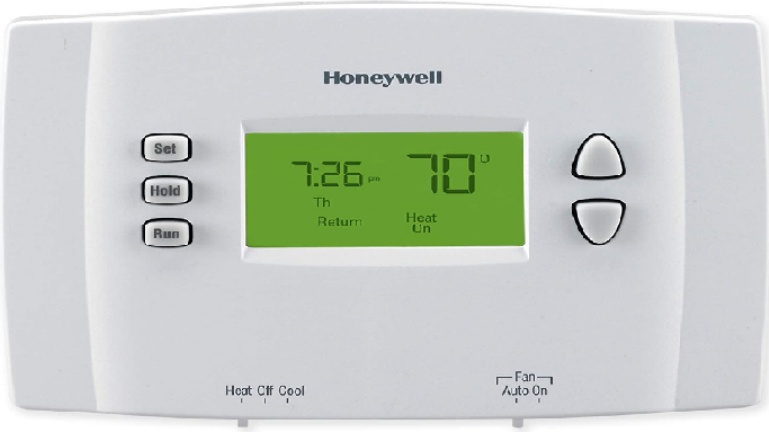

What are autonomous systems?

- Autonomous systems: unstructured environments.
- Automated systems: fixed well structured environments.

Why and when are autonomous systems needed?

Why:

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Why:

- Dangerous tasks
- Tedious repetitive tasks
- Significant improvement in safety
- Significant reduction in cost, energy and resources

When:

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- Tedious repetitive tasks
- Significant improvement in safety
- Significant reduction in cost, energy and resources

When:

- Constrained (tele)operation
- Functioning parameters beyond our sensing & control capabilities
- Multi-systems cooperative tasks with wide& precise interactions
- Complexity of the platform and tasks overload our cognitive capabilities

Why and when are autonomous systems needed?

What are engineering requirements for autonomous systems?

- Mechanical engineering (actuators, platform)
- Electronic engineering (energy sources, sensors, communication and processing)
- Computer architecture and software (functional properties)
- Sensory-motor control (kinematics and dynamics, trajectories and control laws)
- Sensing and perceiving (localization, mapping, and recognition)
- Autonomous planning & learning

Challenges?

- Safety (cyberattacks)
- Reliability (sensor and actuator faults)
- Privacy