CSCE274 Robotic Applications and Design
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Robot Components

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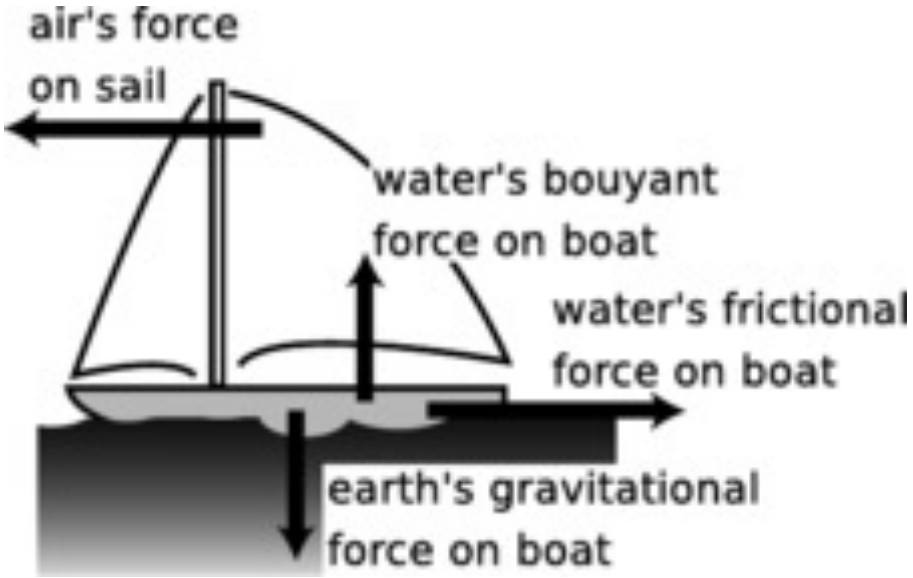
Robot's components

- Embodiment
- Sensors
- Effectors / actuators
- Controllers

Embodiment

- A robot must obey physical laws
  - Forces acting on the robot



Source: lightandmatter.com

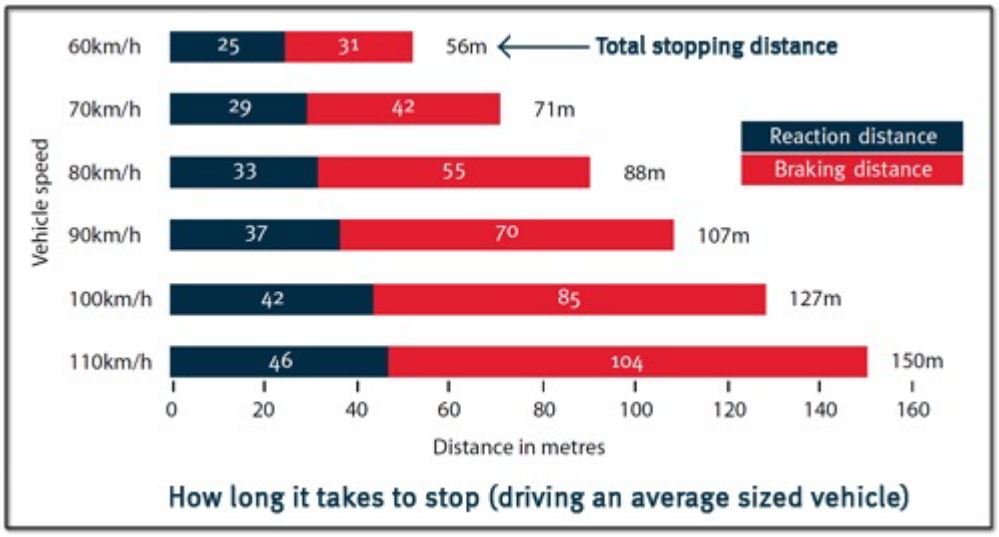
Embodiment

- A robot must obey physical laws
  - Energy necessary

Source: umnsvp.org

Embodiment

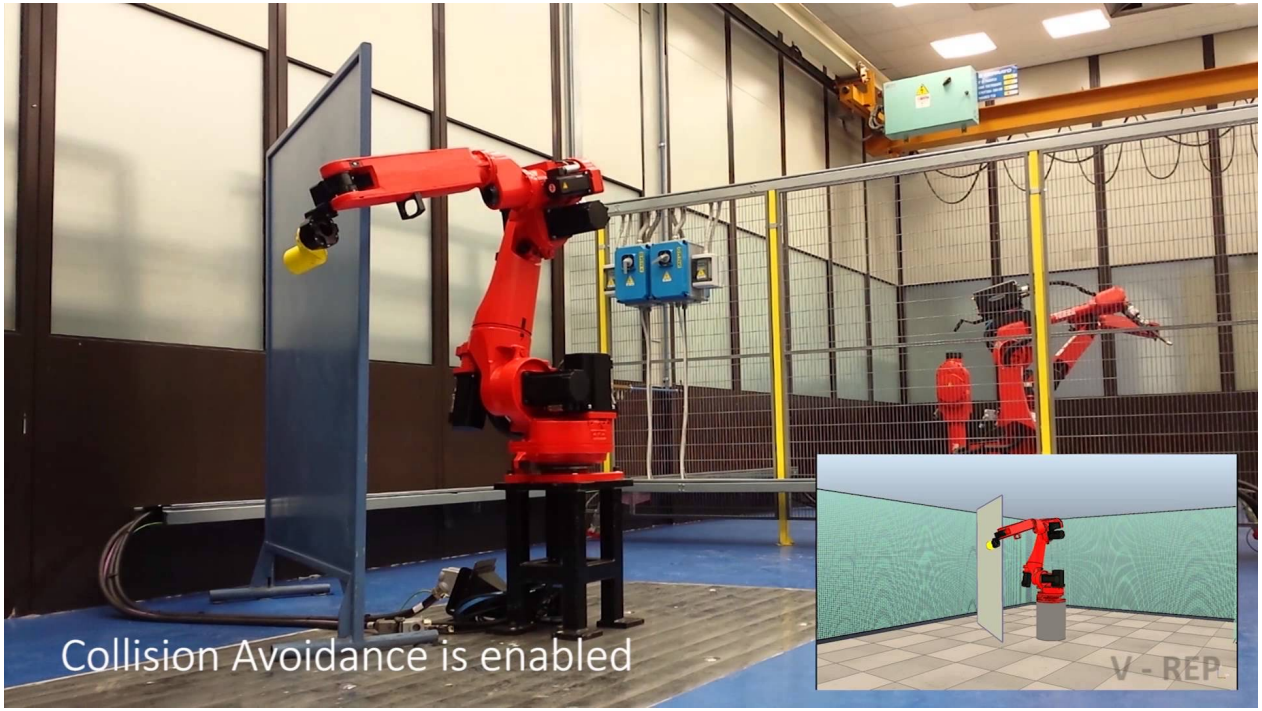
- A robot must obey physical laws
  - Actions take time



Source: rsac.tas.gov.au

Embodiment

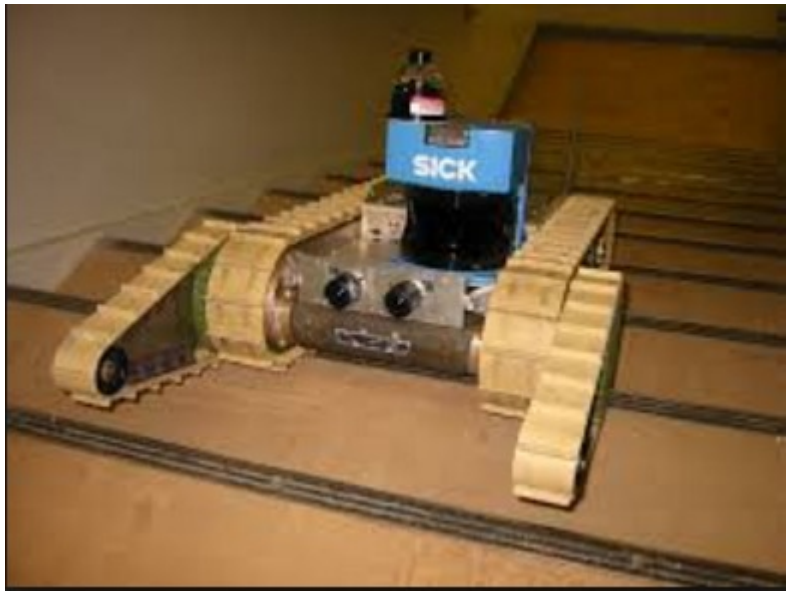
- A robot must be aware of the surroundings



Source: polito.it/LabRob

Embodiment

- A robot has its limitations

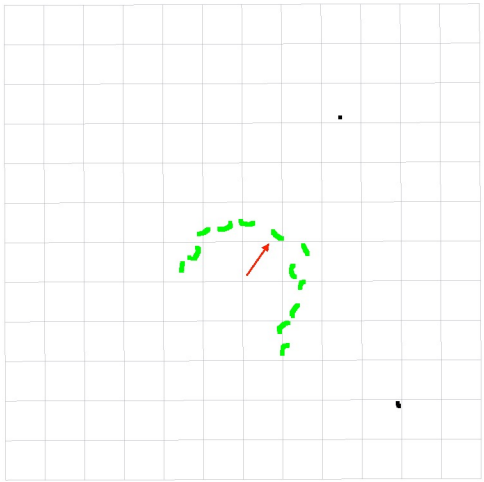


Source: jpl.nasa.gov

Sensing

- Sensors are physical devices that enable a robot to sense its physical environment to get information about itself and its surroundings

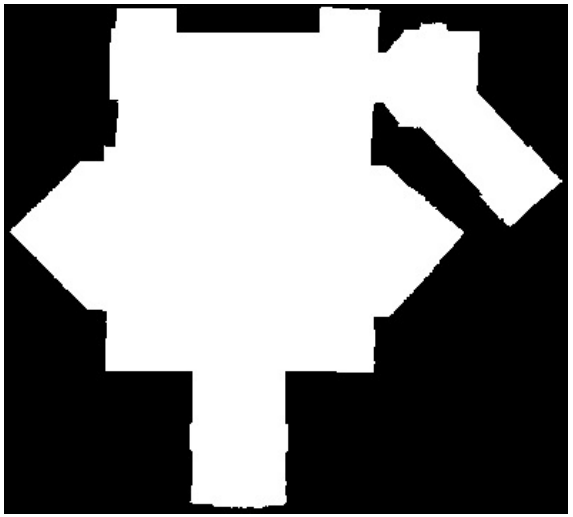
Laser range finder raw data



Perception

- Perception is the organization, identification, and interpretation of sensory information to represent and understand the environment

Map built using laser range finder data



Processing of raw data for self-driving cars

Source: cs.cmu.edu/~youngwoo

State

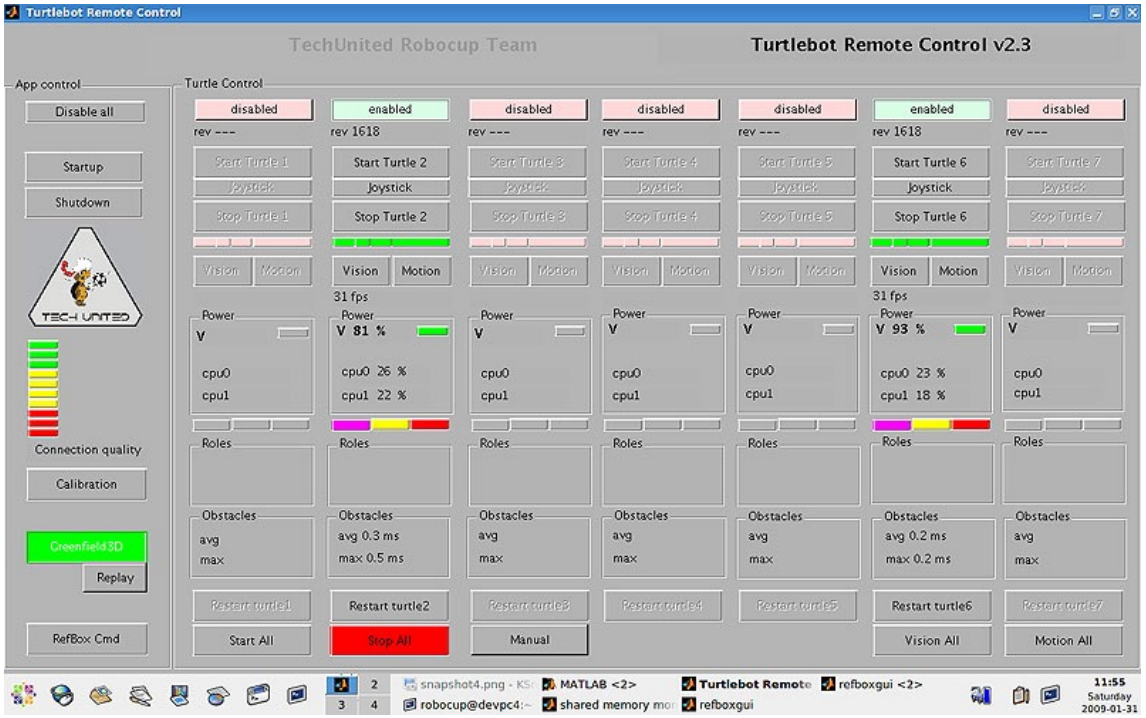
- Sensing allows the robot to know its state

GUI for search and rescue robots system

State

- State may be
  - Observable

GUI from Eindhoven University of Technology team participating to RoboCup Soccer



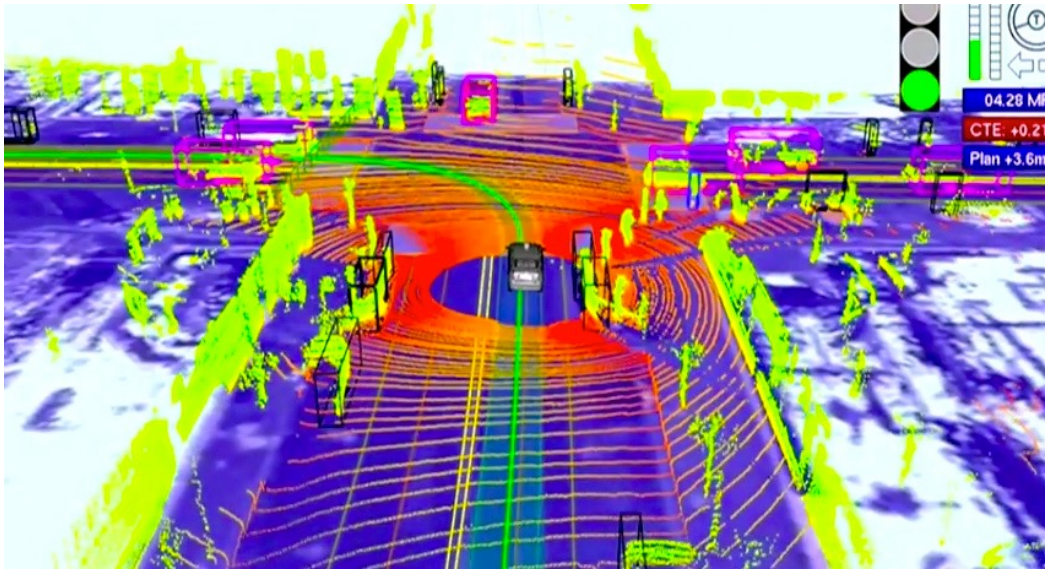
Source: mathworks.com

State

- State may be
  - Observable
  - Partially observable

Source: ieee.org

Self-driving car information



State

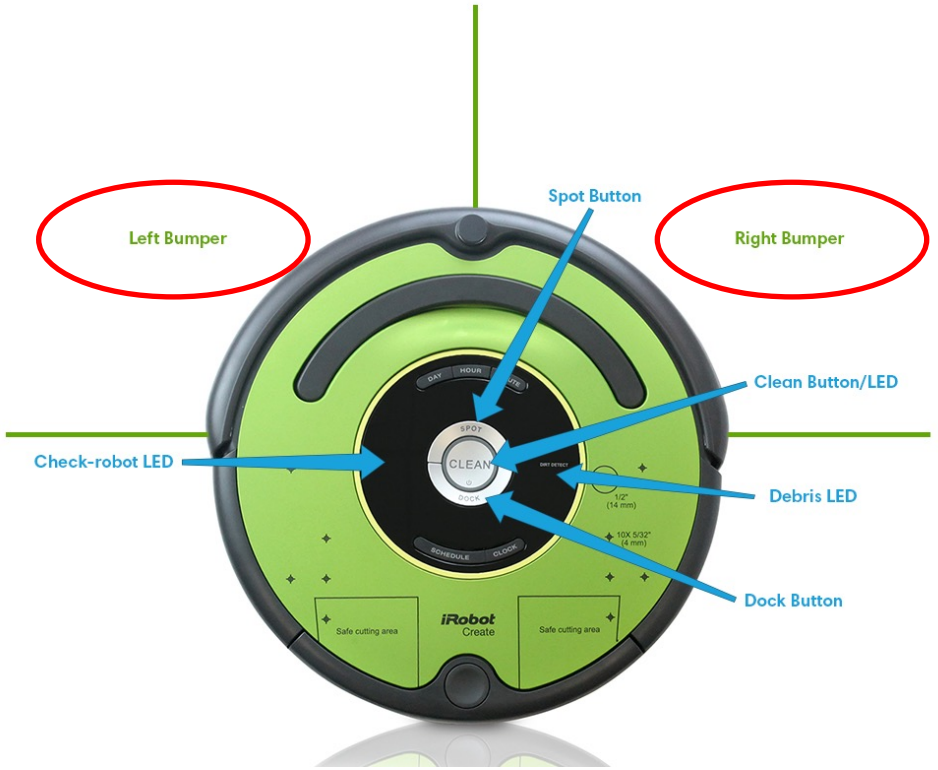
- State may be
  - Observable
  - Partially observable
  - Hidden

Gripper without touch sensor

Source: kuka-robotics.com

State

- State may be
  - Discrete



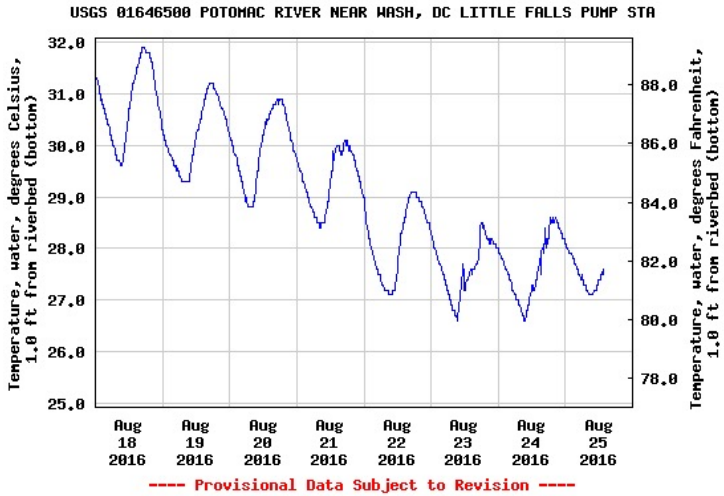
Source: irobotstem.github.io/CreateScratchX

State

- State may be
  - Discrete
  - Continuous

Sonde for water quality

Source: ysi.com



Source: usgs.gov

State

- Two types of states
  - Internal

Source: kuka-robotics.com

State

- Two types of states
  - Internal
  - External

Source: youbot-store.com

State Space

- Different type of representations, depending on the state information

- State space consists of all possible states a system can be in

Sensors

- How to choose?
  - Application
  - Environment
  - Cost/Accuracy
  - …

Laser rangefinder

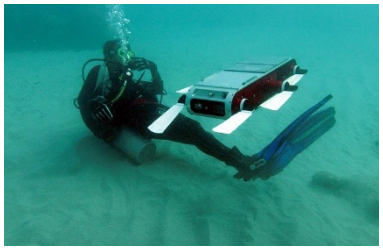
Source: hokuyo- aut.jp

Sonar

Source: hach.com

Stereo camera

Source: khhan.com



Source: whoi.edu

Effectors

- An effector is any device that affects the physical environment

Source: dji.com

Source: pololu.com

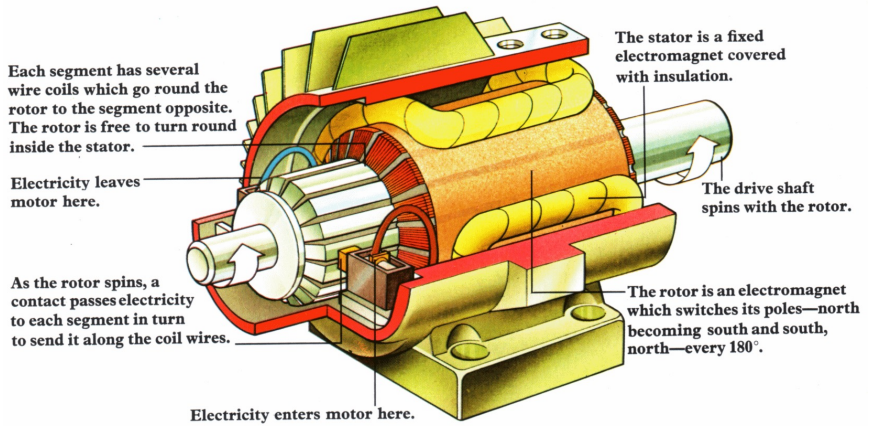
Source: trossenrobotics.com

Aqua walking

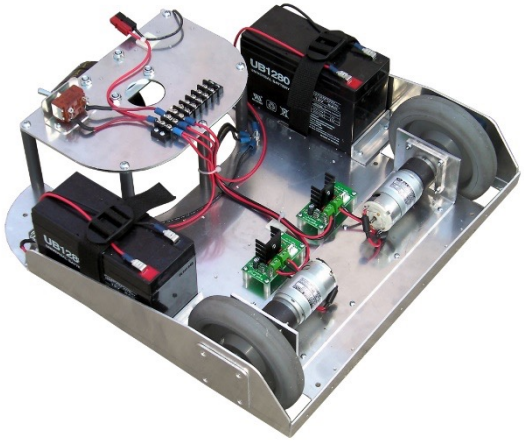
Actuators

- An actuator is the actual mechanism that enables the effector to execute an action

Electric motor



Source: wonderfulengineering.com

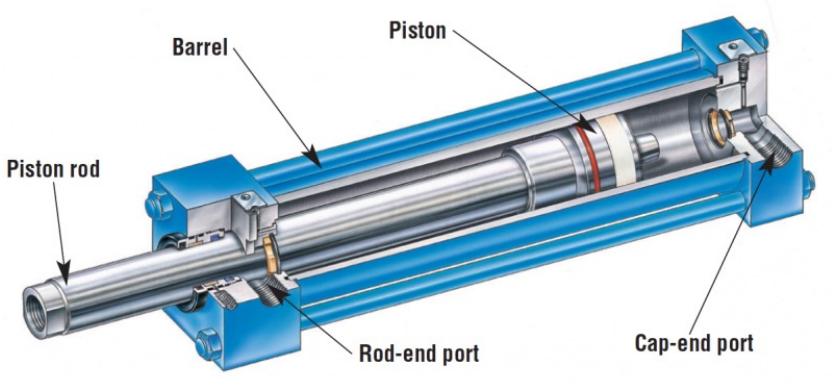


Source: superdroidrobots.com

Actuators

- An actuator is the actual mechanism that enables the effector to execute an action

Hydraulic cylinder



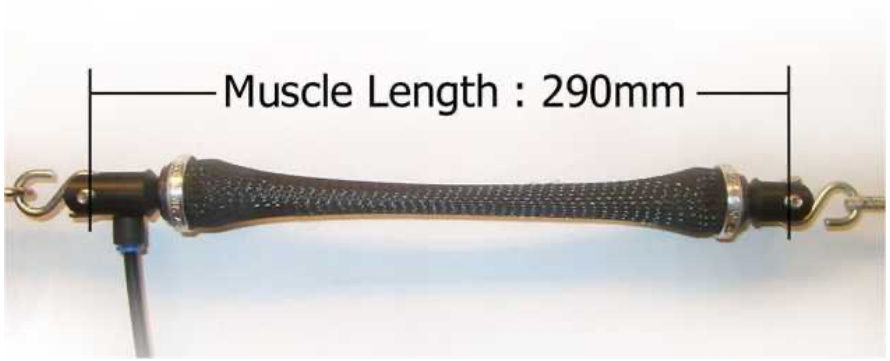
Source: hydraulicspneumatics.com

Source: Wikipedia.com

Actuators

- An actuator is the actual mechanism that enables the effector to execute an action

Air muscle



Source: hackedgadgets.com

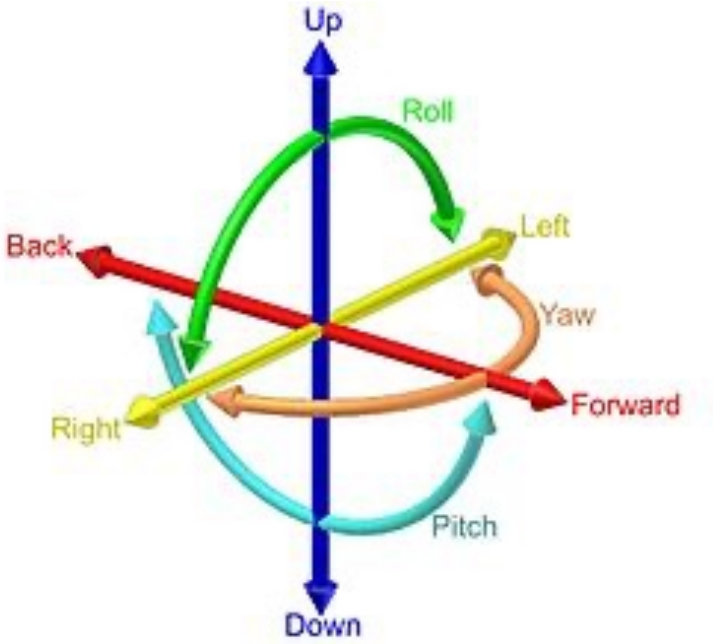
Source: makezine.com

Effectors and Actuators

- Two main activities:
  - Locomotion
  - Manipulation

Degrees of freedom

- Dimensions in which the robot can move



Source: Wikipedia.com

Controllers

- Controllers provide the hardware and/or software that makes the robot autonomous by using the sensor inputs and other information

- Multiple controllers
  - Parallelism
  - Redundancy
  - …

Autonomy

- *Autonomy* is the ability to make one's own decisions and act on them

Power issues

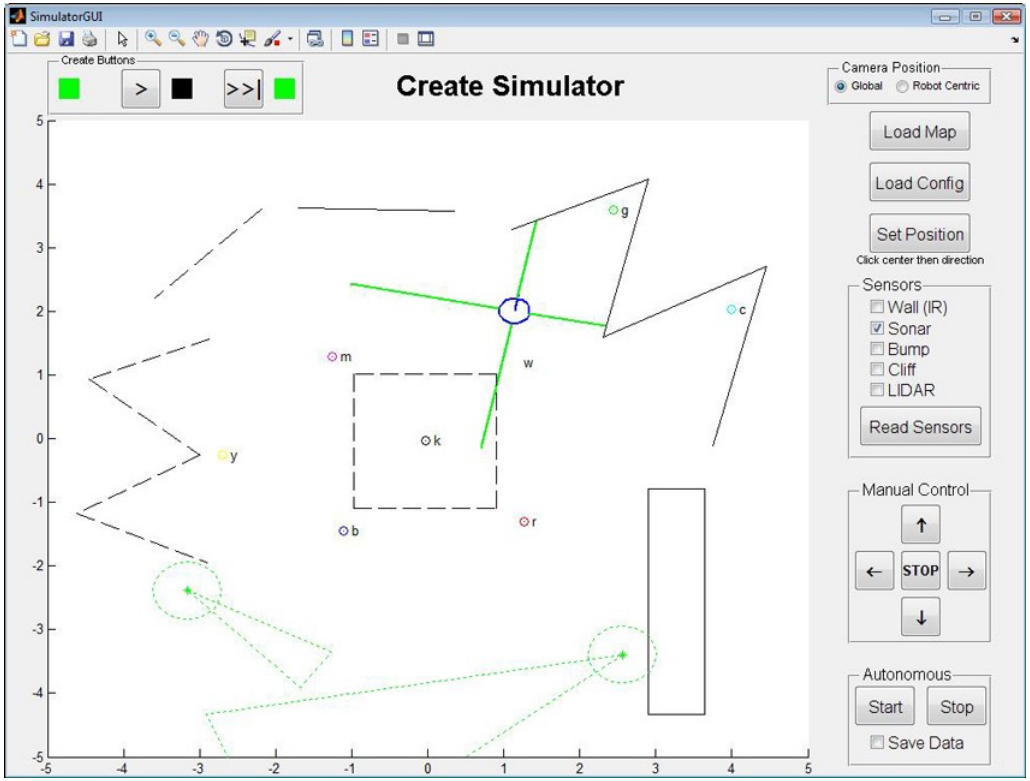
- Providing power while minimizing the weight
- Keeping the electronics isolated from the sensors and effectors
- Maintaining performance as power level drops
- Maintaining performance as sudden increase in load happens
- Autonomous recharging

Simulations

- Robotic simulators allow roboticists to test the algorithms before deploying on the real robots

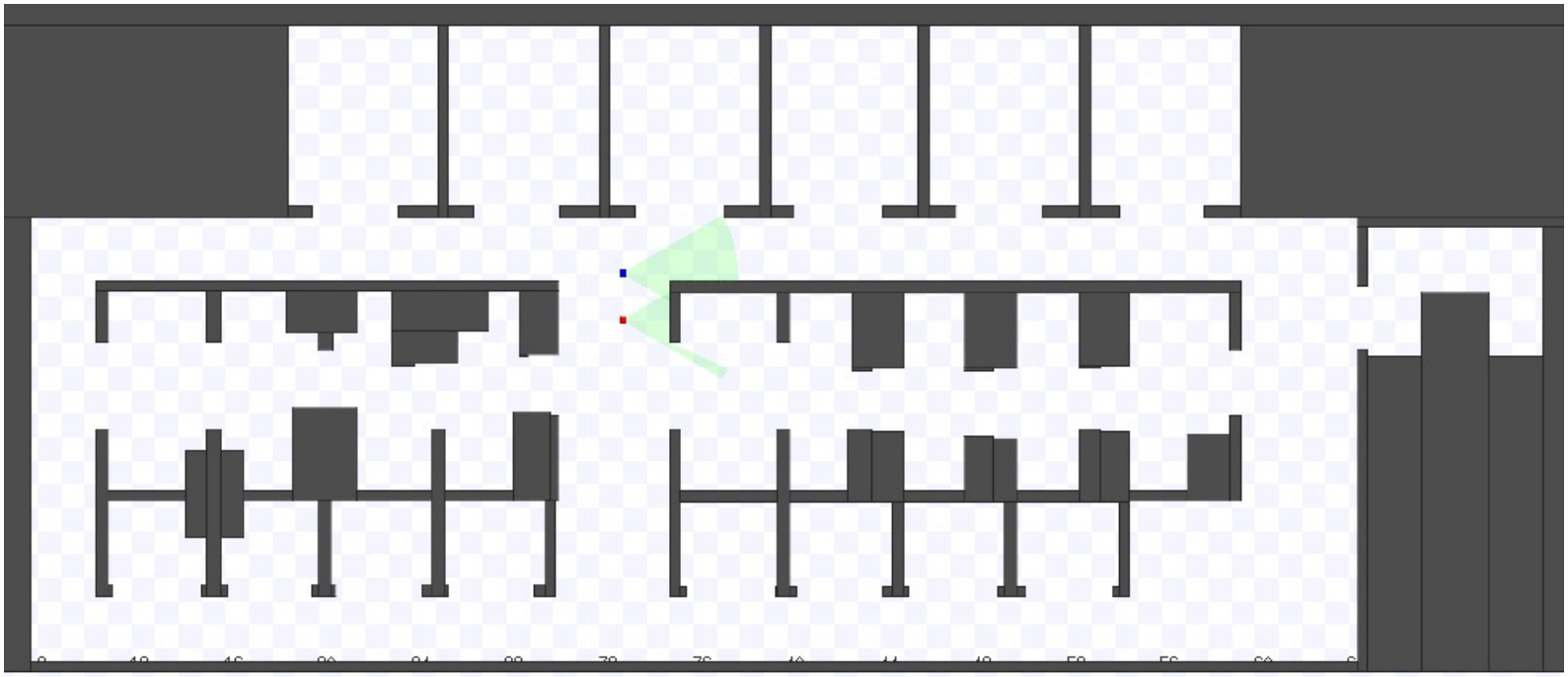
- Different levels of realism

Simulations



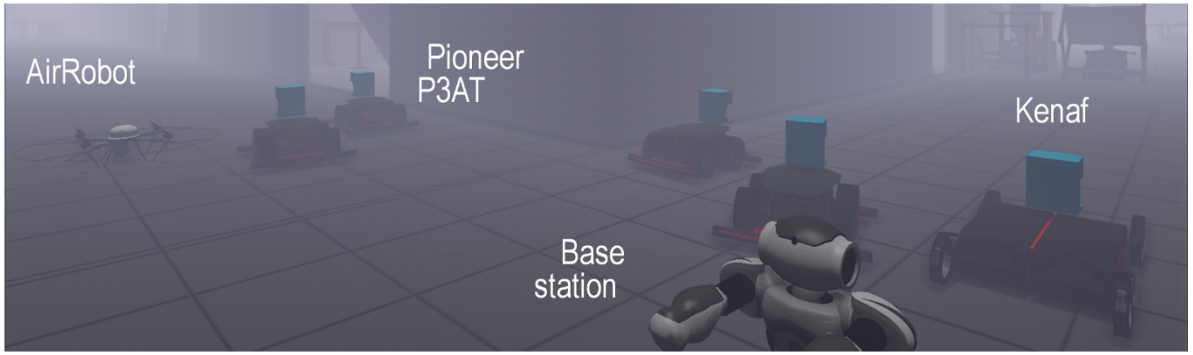
Source: mathworks.com

Simulations

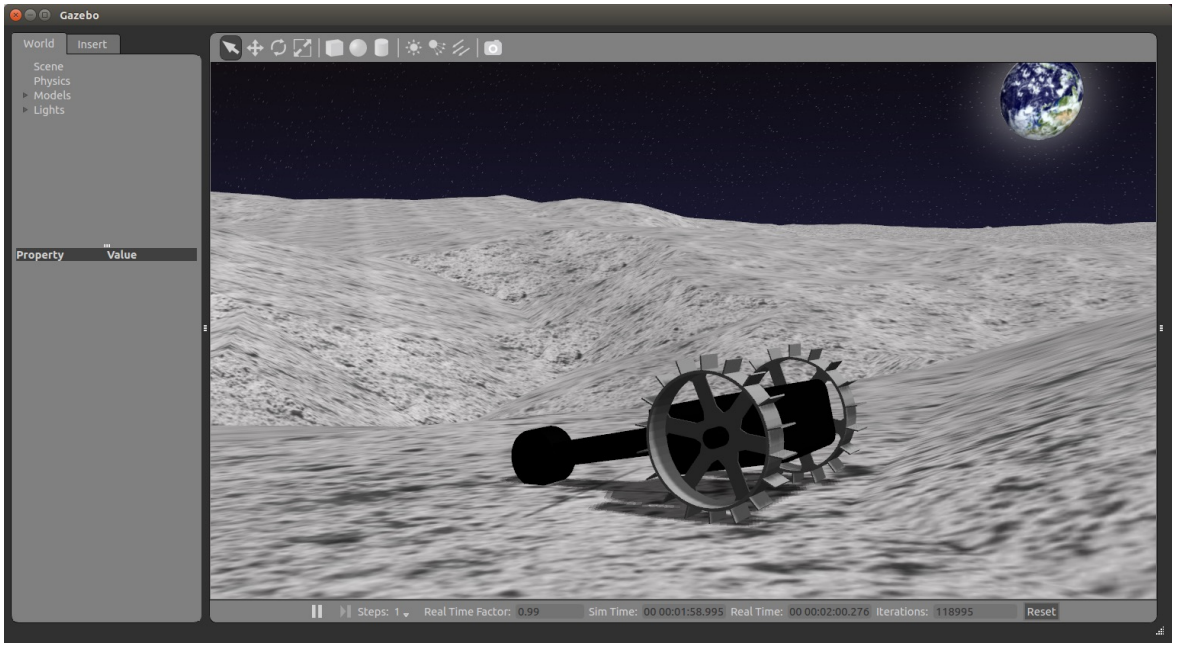


Stage

Simulations



USARSim



Gazebo

Simulations

Source: telegraph.co.uk

Simulations

- Note that *simulation* is not *animation*

Source: wikia.com