Foundations of Robotics: From Math to Control

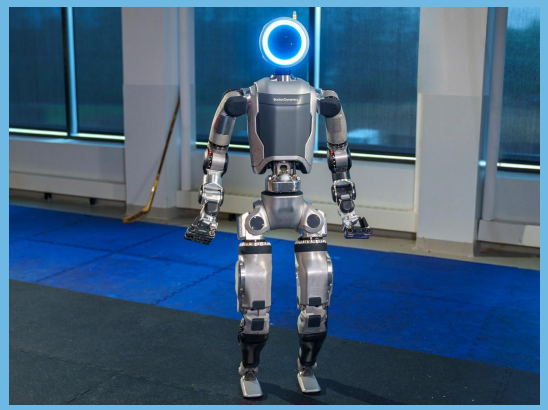
Chapter 0: Definitions and Motivation

Mahmoud ALMASRI

Robots are everywhere

Industrial robots, service robots, and much more ...

Atlas - Boston Dynamics

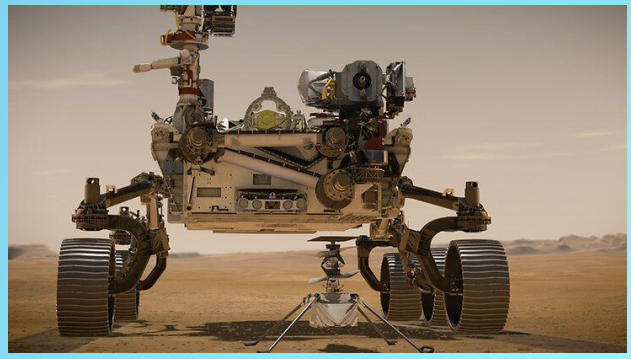


Paco -Les Companions

Jaguar 4X4 - Dr robot

Self driving car - WAYMO

robot Da Vinci Xi - Intuitive Surgical



Perseverance & Ingenuity - NASA

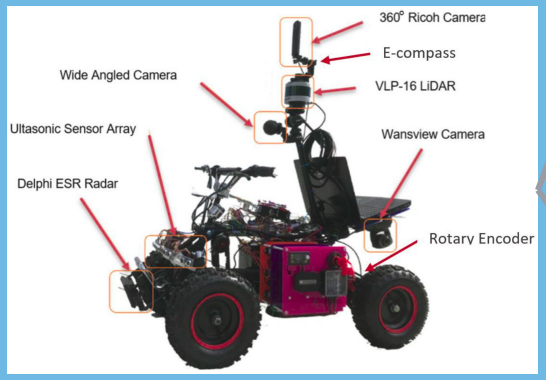
Robotics

- Ultimate goal: create **AUTONOMOUS** machines that can behave and think like humans
  - Perceive with sensors
  - Decide with algorithms
  - Act with actuators driven by control systems

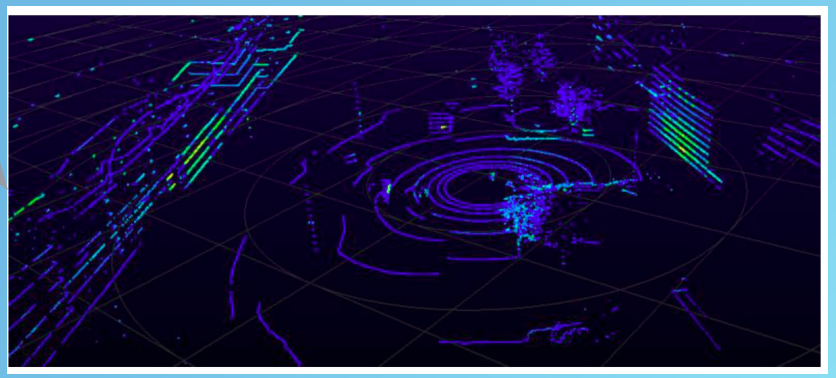
- Integration of mechanics, electronics, and programming
  - Heavy use of applied mathematics

OVERALL VIEW OF ROBOTICS WORKFLOW

Perception

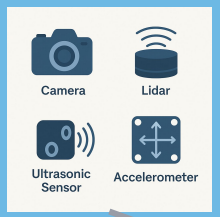


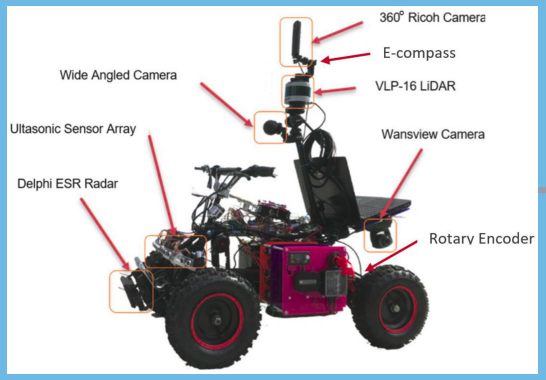
(Tibebu et al., 2022)



OVERALL VIEW OF ROBOTICS WORKFLOW

Perception

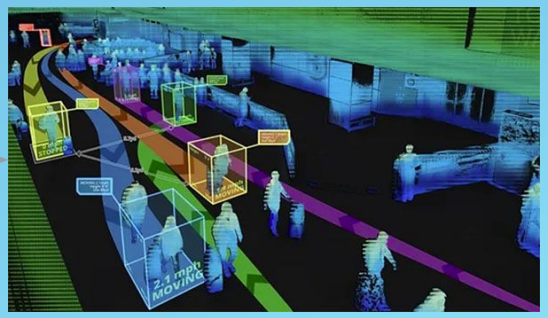




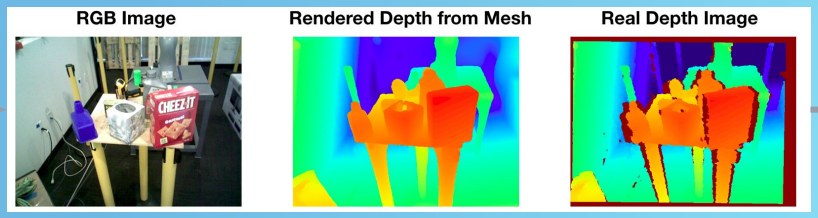
(Tibebu et al., 2022)

Sensor Fusion and perception algorithms

Understand the environment



Example



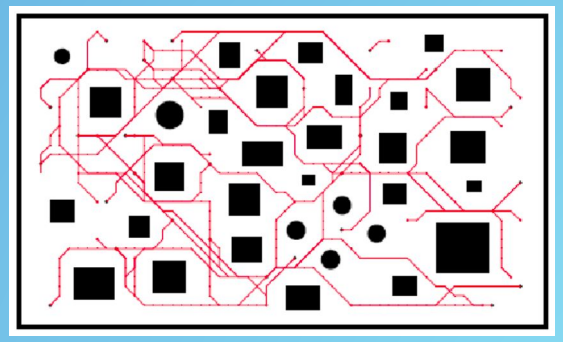
(Tedrake, 2024)

OVERALL VIEW OF ROBOTICS WORKFLOW

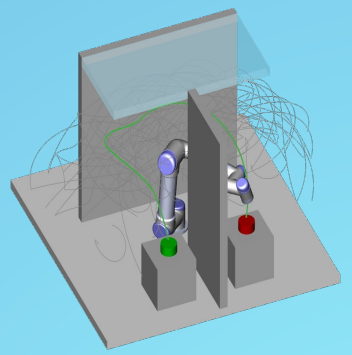
Perception - **Decision**

Localization

Trajectory planning



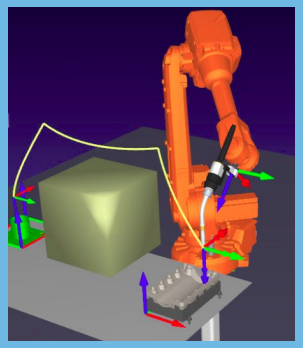
Motion planning

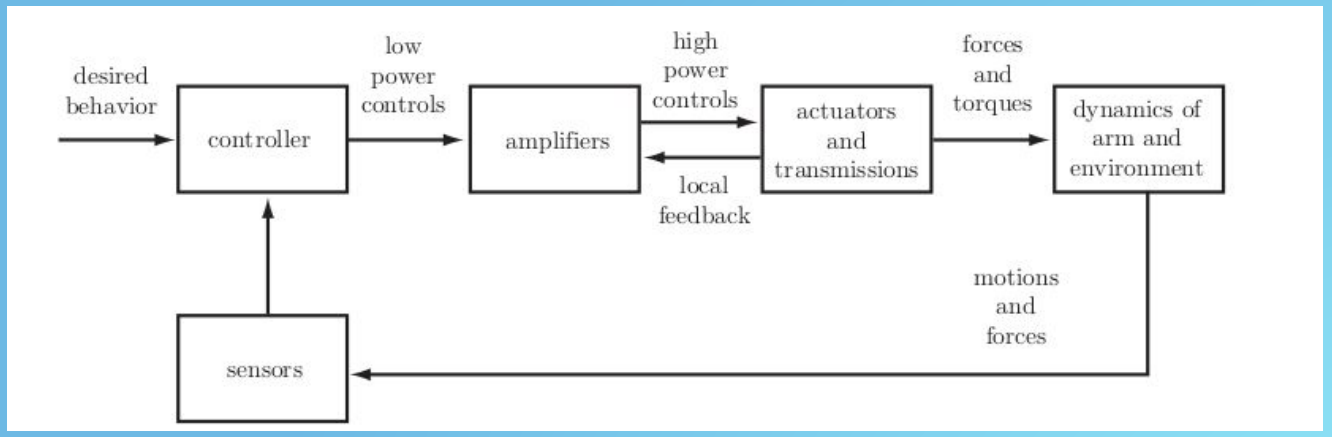


- Dynamic Obstacle avoidance
- Behaviours
- ...

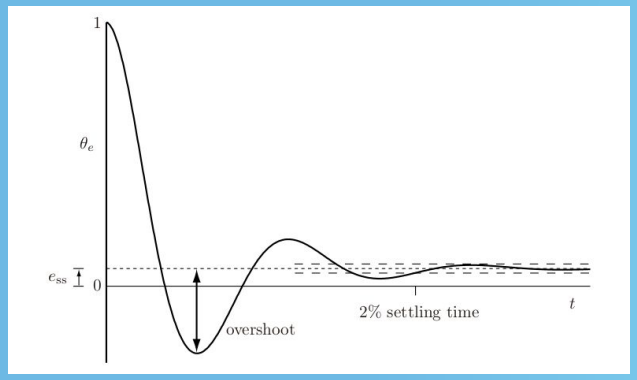
OVERALL VIEW OF ROBOTICS WORKFLOW

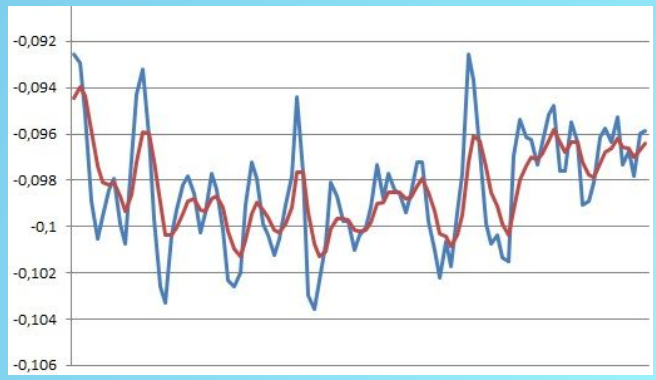
Perception - Decision - **Actuation**





Challenges





Scope of This Course

- Mathematical and programming foundations
- Spatial transformation and rigid body motion
- Kinematics and inverse kinematics
- Feedback control (PID, feedforward)

Exercices and programming examples

METHOD

- Language
- Applications

- almasri.mahm@gmail.com
- https://www.linkedin.com/in/mahmoud-almasri-78b9788a/

REFERENCES

- Tedrake, R. (2024). Robotic Manipulation. Perception, Planning, and Control. https://manipulation.csail.mit.edu/misc.html
- Tibebu, H., De-Silva, V., Artaud, C., Pina, R., & Shi, X. (2022). Towards Interpretable Camera and LiDAR Data Fusion for Autonomous Ground Vehicles Localisation. Sensors, 22(20), Article 20. https://doi.org/10.3390/s22208021