Lecture 3, Sep 14, 2023

Taxonomy of Robotics

- A common paradigm is that of "sense, plan, act" which we will use in this course
  - Sometimes these stages are combined with no clear boundaries, such as neural networks or learning-based paradigms
- The typical chain of processing is perception → information processing → mapping → localization → planning → navigation → action
  - Perception is done through basic sensors such as odometry, gyroscopes, IMUs, etc and rich sensors such as cameras, lidars, tactile sensors, etc
  - Information processing involves reducing noise, antialiasing, and fusion of sensor measurements
  - Mapping involves locating features and landmarks and creating a map of the environment
  - Localization uses the map to determine where we are on the map with techniques such as Kalman filtering, particle filtering (Monte Carlo) or Bayesian localization
    * Localization and mapping can be combined into SLAM (simultaneous localization and mapping), which solves the chicken-and-egg problem
  - Planning involves pathfinding, with techniques such as Voronoi diagrams, cell decomposition and potential fields
  - Navigation involves following the planned path; it can be methodical and map-based or behaviour-based which is reactive (e.g. behaviour trees)
  - Action directly controls actuators, e.g. PID control
- Levels of autonomy:
  - Assistant: fully supervised and teleoperated
    * Unilateral teleoperation involves no feedback, bilateral has position feedback only and multilateral has force feedback as well
    * Teleoperation faces issues with interfacing, time delays and flexibility
  - Apprentice: able to execute low-level tasks unsupervised
  - Associate: able to execute elements of tasks autonomously (but cannot break down large tasks)
  - Agent: fully autonomous