Designing an Autonomous Service Robot

Ioannis Havoutis, Lars Kunze

3rd Year Design Project

Synopsis

Service Robotics is one of the most actively researched technologies of today, starting to reach every-day urban, industrial, natural and domestic environments.

With no established core tech, no standard processing pipeline and no killer app, the research is wide open to anyone curious enough to tackle it.

The Challenge

Design all aspects of an **Autonomous Service Robot**.

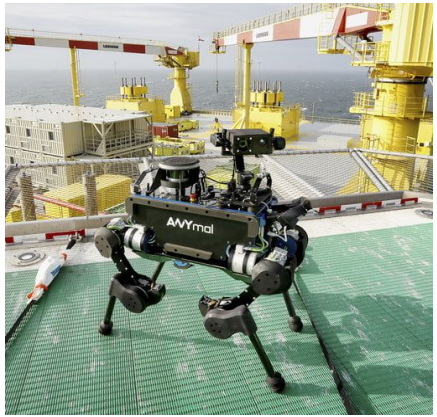
- Hardware
- Software
- Ecosystem

Open ended problem in

Engineering Design

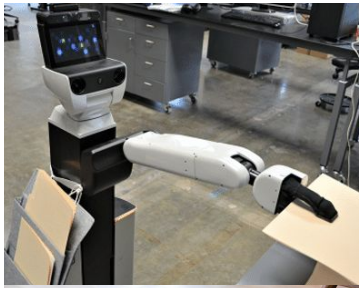
Domains, features, targets, etc.,

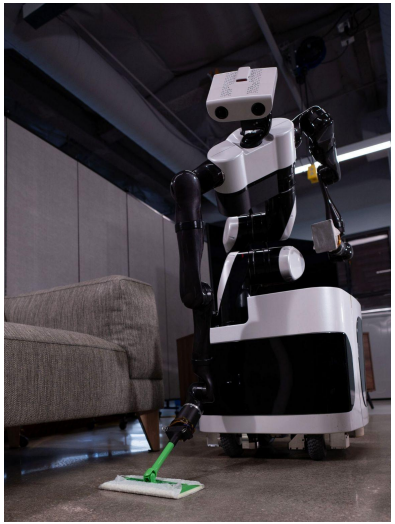
- Useful
- Interesting
- Cost-effective
- Possible



This Year’s Theme

- Domestic Robotics






The Project

- Select an application domain and design all aspects of an **Autonomous Service Robot** and ecosystem.
  - Hardware:
    - Robot – arms, legs, actuators, transmissions, sensors, …
    - External – tracking cameras, controllers, …
  - Software:
    - Robot: SLAM, path planning, motion generation, missions, …
    - External: command & control, Cloud compute, …

Organization

- Log-books (10 marks)
  - Record everything that you do or think about for the project.
- Group work (10 marks)
  - Overall standard of performance for the whole team.
- Final Presentation (20 marks)
  - Coordinated presentation, typically 5’ for each student, followed by Q&A.
- Final report (60 marks)
  - Collaborative, but individual parts clearly marked.

Remarks

Do not underestimate the workload required for the 3YP. A **consistent work pattern** through the two terms and during the write-up stage is essential.

The 3rd year project is worth ***1 Examination Unit*** out of 5.5 Examination Units for the year. It should therefore take up a commensurate amount of time during your year.

Calendar

	Michaelmas Term	
Week 1	Groups	Intro (now), Guest Lecture (Dr. Dimitrios Kanoulas - UCL)
Week 2		Guest Lecture (Dr. Gaya Kazhoyan - U. Bremen), One-slide concepts
Week 3		Talks (1, 5, 9, 13) - Pitch, Guest Lecture (Dr. Christian Dondrup - HW)
Week 4	Log Books	Talks (2, 6, 10, 14) - Device Hardware
Week 5		Progress
Week 6		Talks (3, 7, 11, 15) - Device Software
Week 7	Log-books	Talks (4, 8, 12, 16) - External hardware + software
Week 8		

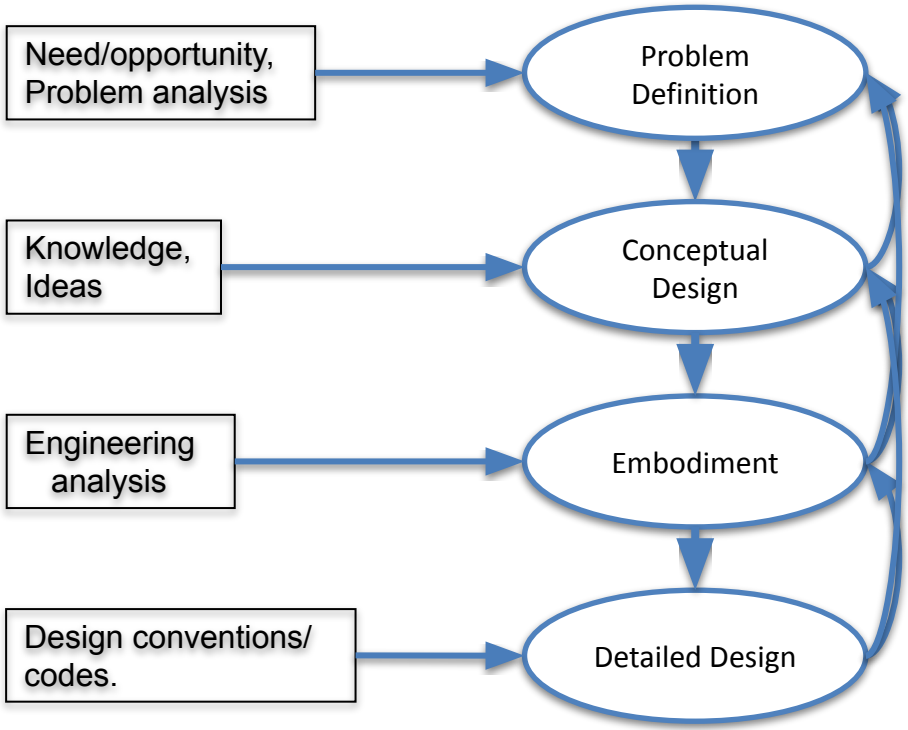
Calendar

	Hilary Term	
Week 1		Challenge problem brief
Week 2	Log Books	Guest Lecture ()
Week 3		Challenge Problem Progress Talks (1, 5, 9, 13)
Week 4		Challenge Problem Progress Talks (2, 6, 10, 14)
Week 5		Challenge Problem Progress Talks (3, 7, 11, 15)
Week 6		Challenge Problem Progress Talks (4, 8, 12, 16)
Week 7	Log Books	Guest Lecture
Week 8		Practice Final Presentation

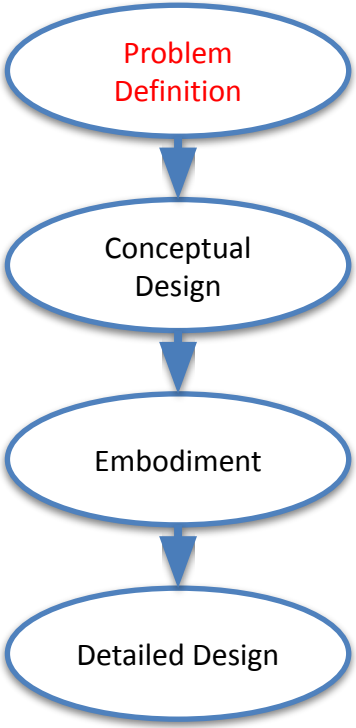
Calendar

	Trinity Term	
Week 0		Draft of report
Week 1		A possible date for final presentation. (to be scheduled)
Week 2		A possible date for final presentation. (to be scheduled)
Week 4		Reports

Engineering Design



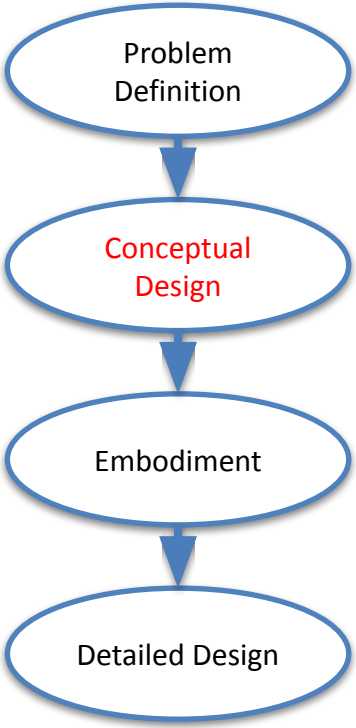
Engineering Design



You'll have to do this in the next 2 weeks!

You'll have to produce a **design brief (slides)**, i.e. a plan that identifies a problem, its criteria, and its constraints.

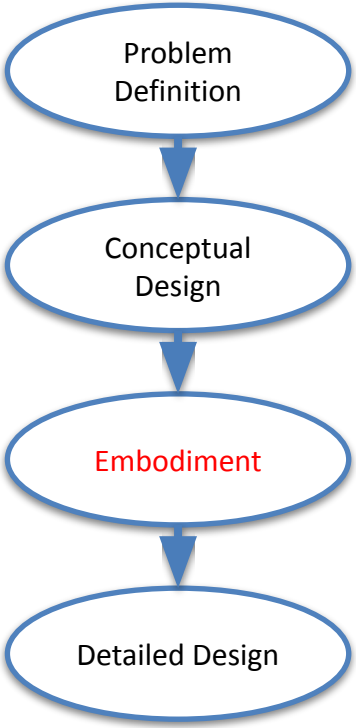
Conceptual Design



- Establish criteria, i.e. the **functional requirements** (FRs).
- Come up with **ideas/solutions**.
- Combine ideas to get **concept solutions**.
- You may want to use a **decision matrix**.

	Ideas			
FR	Idea 1	Idea 2	Idea 3	Idea 4
Big FoV	3	2	1	3
Interactio	1	1	1	3
Cheap	4	5	1	3

Embodiment Design

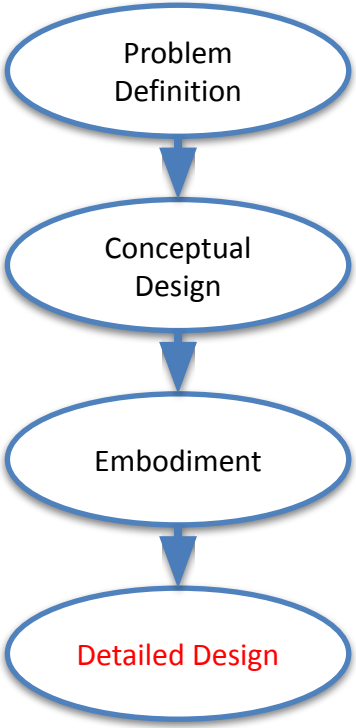


Typically this may involve:

- Analysis and optimisation of individual components
- Modelling/analysing of connections between components
- Modelling of entire system
- Modification of components to optimise system

Next you'd build a prototype, which you'd have to evaluate. We won't ☹.

Embodiment Design



Hardware:

- Specify the exact components and materials.
- Specify all the dimensions.
- Specify production route.
- Estimate production costs.

Software:

- Specify overall **architecture**.
- Specify **algorithmic implementation** for the individual components.
- Estimate **processing/memory requirements**.

Produce **full documentation.**

For the 3YP, full detail design is not normally needed, though an **economic analysis** is desirable.

Team and Project Management

You will learn how to:

- Make design and economic **decisions**.
  - **Selecting** among several, possibly conflicting, design possibilities.
- **Organise** project team meetings and **allocate** work packages.
  - Outside of the weekly timetabled sessions, **organize** and **divide up** the tasks.
- **Manage** project documents and **keep records of your work**.
  - **Collaborate** in writing and editing reports and presentations.

Support

We will provide notes and advice on developing ideas around robotics technologies such as:

- Actuation and Control
- Sensing and Navigation
- Localization and Mapping
- Path and Motion Planning

More details

Starting from a design brief you should learn how to

- Make design and economic decisions
  - Selecting among several, possibly conflicting, design possibilities
- Organise project team meetings and allocate work packages
  - Outside of the weekly timetabled sessions, organize and divide up the tasks
- Manage project documents and keep records of your work
  - Collaborate in writing and editing reports and presentations

Final Result

The ‘deliverable’ is a **technical report** and **presentation** describing the detailed design, its rationale and costings.

Other Info

- Project website:

  https://ihavoutis.github.io/teaching/3YP_ASR/index.html

That's all! - Questions?