MTRN4110 Robot Design
Week 10 – What's next?

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https://sites.google.com/site/wuliaothu/

Today’s agenda

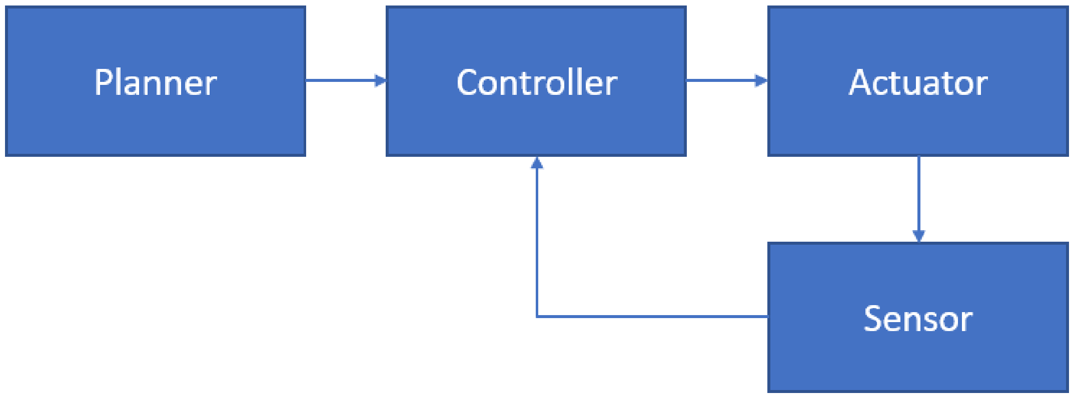
- Summary of MTRN4110 ROBOT DESIGN 21T2
- Assignment Phase D Clarification
- The MicroMelomys Competition

myExperience

Why your feedback is much appreciated

Feedback control

- Use the measurement of sensors to adjust the commands generated by the controller and sent to the actuators.



How feedback from last year has informed this year

- Keep up with what has been well received
  - Real-world examples and Slido interactions in lectures
  - Clear organisation of contents and activities
  - Interesting assignments and detailed specs
  - Quick responses

- Improvements made directly from feedback
  - Use one main learning platform (Teams) instead of two (Moodle and Teams)
  - Include example cases in test sets
  - Reduce number of quizzes
  - Allow more time for revision

- Improvements indirectly informed by feedback
  - Introduce plagiarism check
  - More hints for quizzes during lectures
  - More reminders about assignments such as providing checklists

- Feedback that is well understood but a bit out of control
  - Missing hands-on experience with real robots (This could have been improved if students were all on-shore)
  - Tight time limits for quizzes (This could have been improved if invigilated in-class quizzes were possible)

Shape our Future

Extension of Phase D available based on completion rate!

Complete your myExperience and shape the future of education at UNSW.

Click the myExperience link in Moodle

https://moodle.telt.unsw.edu.au/mod/lti/view.php?id=3979662

or login to myExperience.unsw.edu.au

(use z1234567@**ad**.unsw.edu.au to login)

The survey is confidential, your identity will never be released

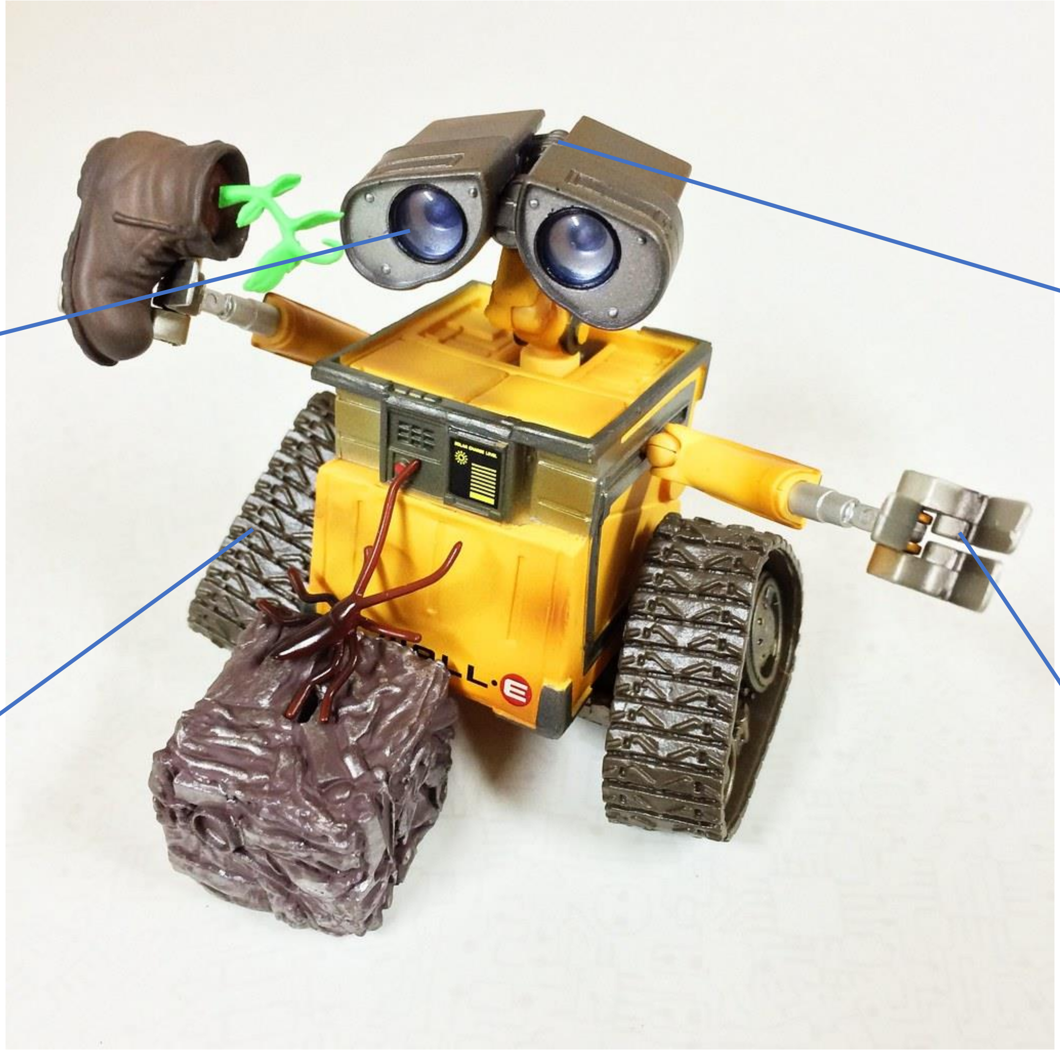
Survey results are not released to teaching staff until after your results are published

Autonomous Mobile Robots

Key capabilities of mobile robots

Eye - Perception
including Vision

Foot - Locomotion
and Kinematics

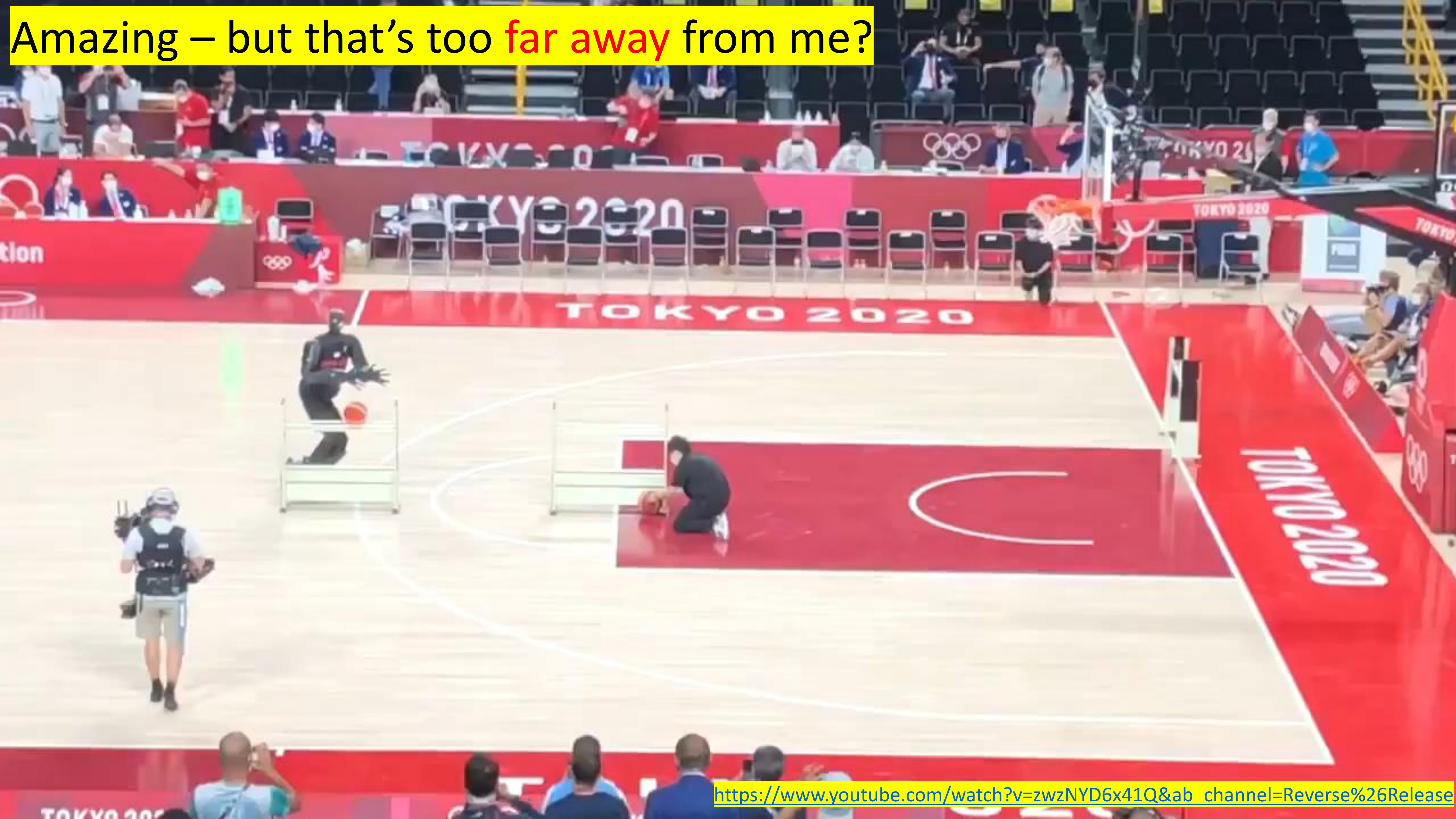


Brain – Localisation
and Planning

Hand – Manipulation
(Covered by MTRN4230)

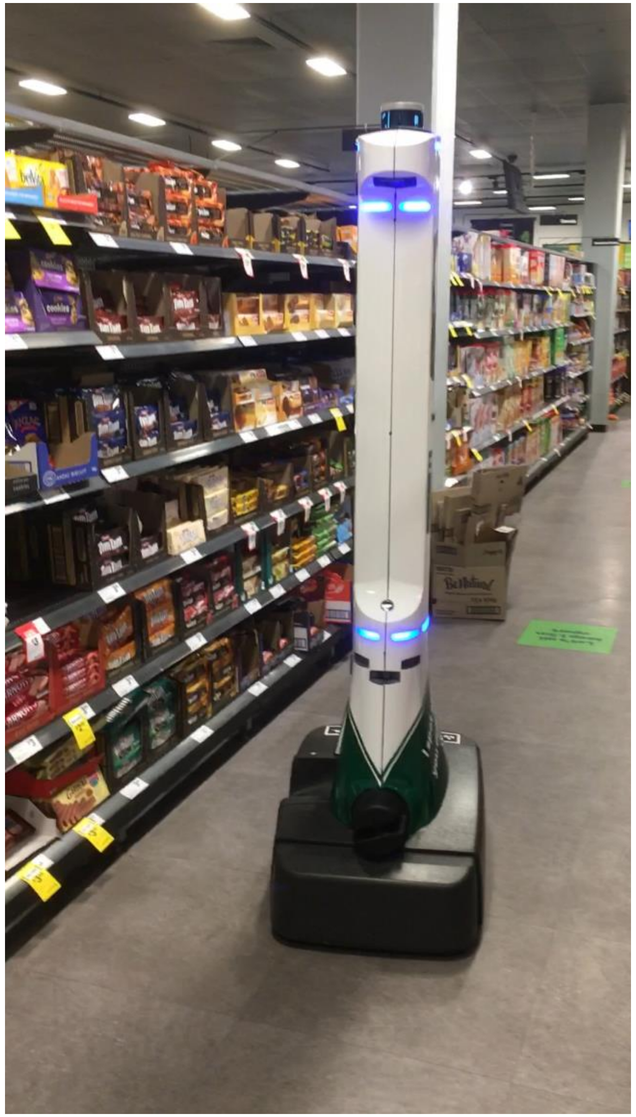
https://mars.nasa.gov/news/8611/nasa-adds-return-sample-scientists-to-mars-2020-leadership-team/

Amazing – but that's too far away from me?



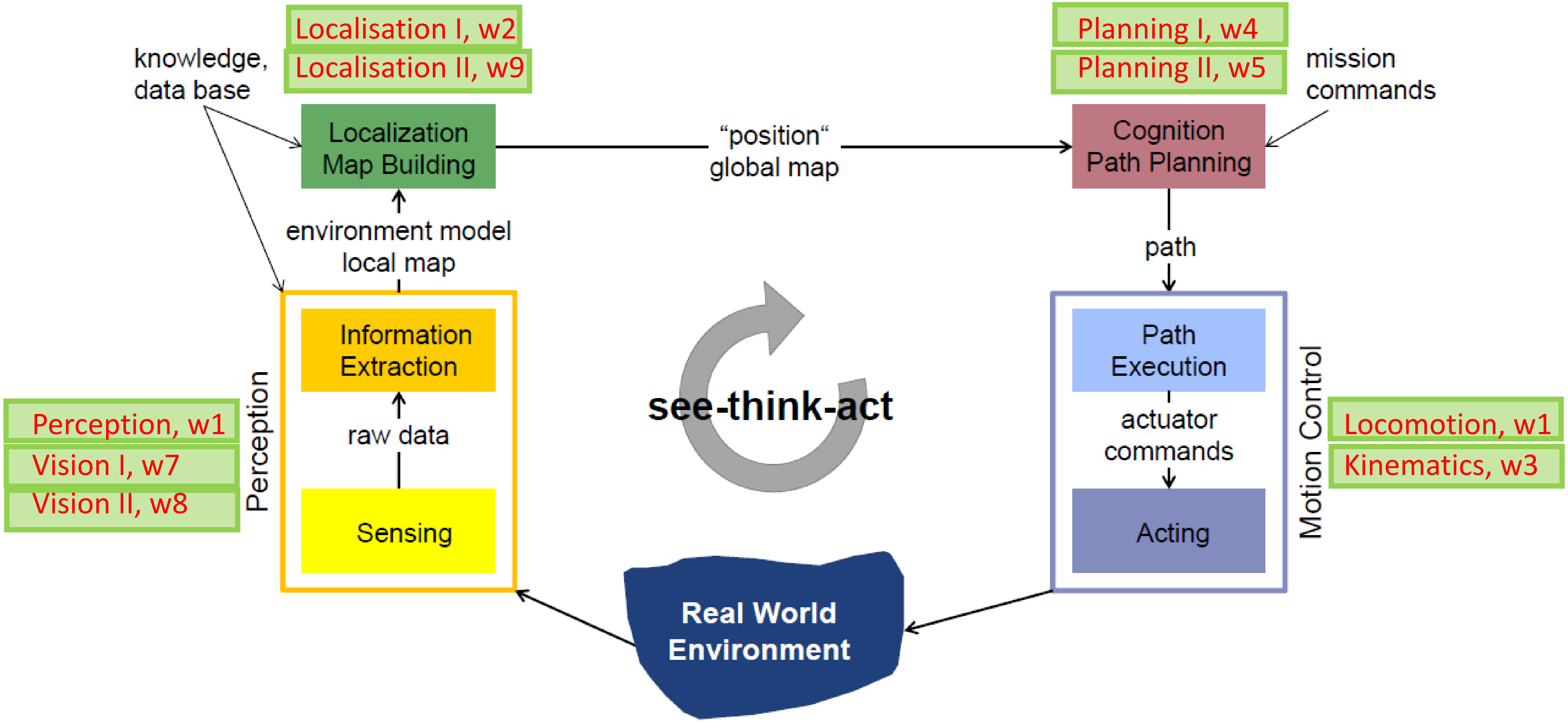
https://www.youtube.com/watch?v=zwzNYD6x41Q&ab_channel=Reverse%26Release

Cool – but still a bit distant?



Knowledge & Skills

The See-Think-Act cycle



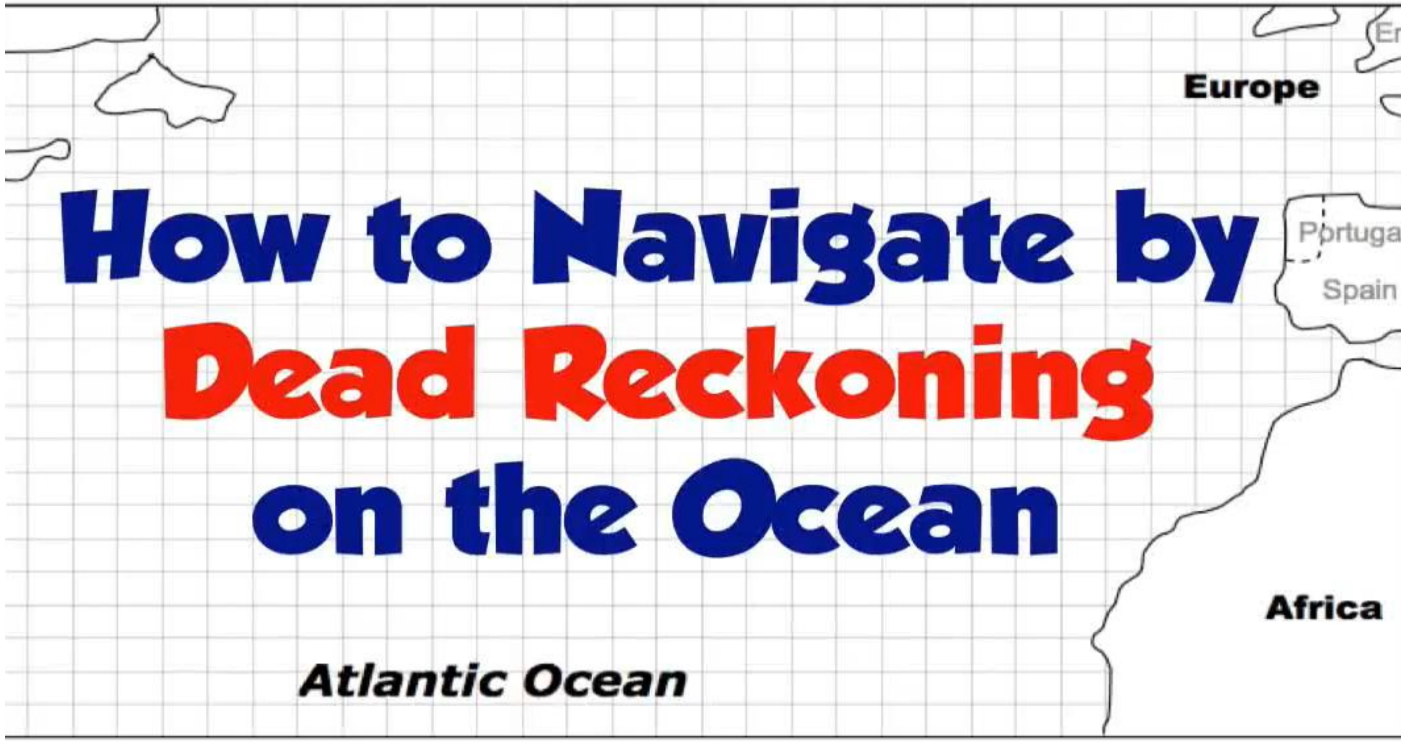
R. Siegwart, I. R. Nourbakhsh, D. Scaramuzza. Introduction to autonomous mobile robots. The MIT Press. Second edition. 2011.

Key knowledge concepts

Map-based
Dead reckoning/Odometry
Visibility graph
Behaviour-based
Modified flood fill
Dijkstra's algorithm
Occupancy grid
Markov localisation
Bug algorithms
Depth-first
Monte Carlo methods
Breadth-first
Particle filter localisation
Bayes rule
Tree
Flood fill
Voronoi diagram
SLAM
Topological map
Kalman filter
Configuration space
A*
IMU
Hough Transform
Bellman-Ford algorithm
Pixel
Holonomic
Corner detection
LiDAR
Artificial potential field
Thresholding
Encoder
PID
Nonholonomic
Bang-Bang control
Edge detection
Marker detection
Differential-drive
Steerability
Ultrasonic sensor
Cubic polynomial trajectory
Manoeuvrability
Colour space
Perspective Transform
Mobility
Bang-Bang trajectory

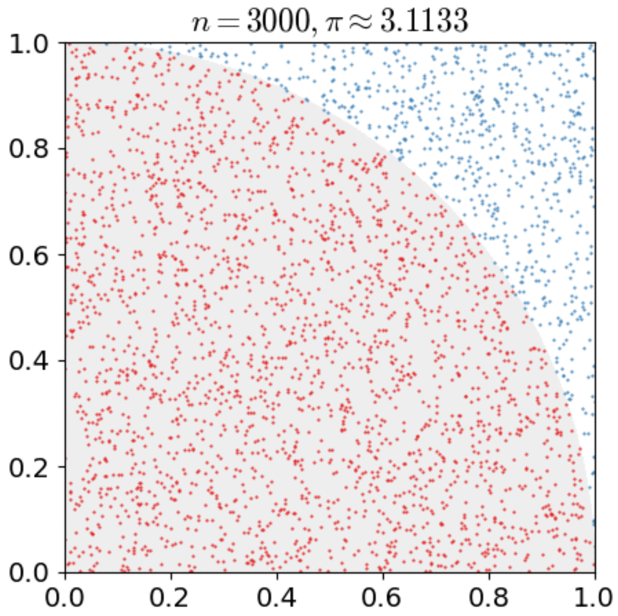
Dead reckoning/Odometry

- Dead reckoning (Deduced reckoning)
  - A simple mathematical procedure for determining the present location of a vessel by advancing some previous position through known course and velocity information over a given length of time.
- Odometry
  - Dead reckoning by using only wheel encoders, sometimes interchangeable with Dead reckoning



https://www.youtube.com/watch?v=TxAdmbuu93I

Particle filter localisation (Monte Carlo localisation)



- Monte Carlo (MC) methods are a subset of computational algorithms that use the process of repeated random sampling to make numerical estimations of unknown parameters.
- There are a broad spectrum of Monte Carlo methods, but they all share the commonality that they rely on random number generation to solve deterministic problems.

Monte Carlo Casino, Monaco

- *"Being secret, the work of John von Neumann and Stanislaw Ulam required a code name. A colleague of von Neumann and Ulam, Nicholas Metropolis, suggested using the name Monte Carlo, which refers to the Monte Carlo Casino in Monaco where Ulam's uncle would borrow money from relatives to gamble."*

https://en.wikipedia.org/wiki/Monte_Carlo
https://en.wikipedia.org/wiki/Monte_Carlo_method
https://towardsdatascience.com/an-overview-of-monte-carlo-methods-675384eb1694

Knowledge -> Skills

- Hard skills
- Soft skills (More important!!!)
  - Problem-Solving
  - Critical-Thinking
  - Precision & Prudence
  - Time Management
  - Teamwork
  - …

Robustness!

What you'll do:

- Implementing a continuous improvement and deployment framework for model development and deployment;
- Building systems and productive relationships to support the transition of research prototypes into production-ready products;
- Liaising with security engineers to understand risk profiles and required security controls for all deployment scenarios;
- Maintaining internal corporate knowledge of developments in automated machine learning and seeking ways to integrate these in the and
- Complying with all company policies, procedures and guidelines including those relating to information security.

About you:

- Strong coding ability in Python, with a focus on code quality, replicability and tool-agnosticism;
- Knowledge of machine learning theory and technique, or a demonstrated ability to convert mathematical concepts into code; and
- Ability to work with a variety of cloud and non-cloud environments effectively.

Self-driving Uber killed a pedestrian as human safety driver watched

Uber is halting tests of its self-driving vehicles in Arizona, San Francisco, Pittsburgh, and Toronto

AL By Alex Lubben

March 20, 2018, 4:35am Share Tweet Snap

https://www.vice.com/en_us/article/kzxq3y/self-driving-uber-killed-a-pedestrian-as-human-safety-driver-watched

Simulation

Simulators for robotics

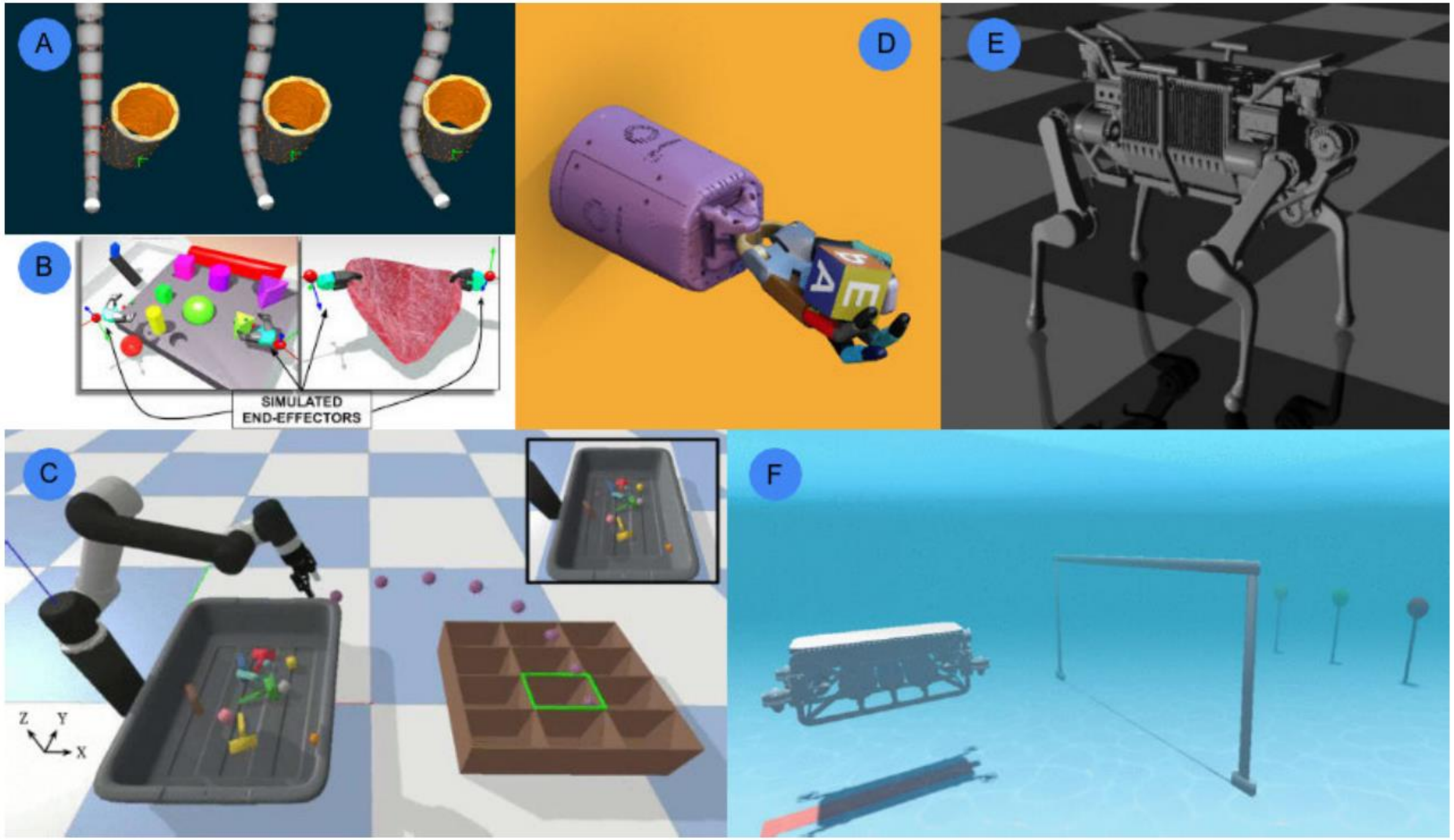


FIGURE 1. Diversity of simulation scenes and environments throughout robotics (a) soft robotics in Simulation Open Framework Architecture [3], (b) medical robotics in Asynchronous Multi-Body Framework [4], (c) manipulation in PyBullet [5], (d) dexterous manipulation in MuJoCo [6], (e) legged locomotion in RaiSim [7] and (f) underwater vehicles in URSim [8].

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9386154

Simulators for mobile robotics

TABLE 2. Feature comparison between popular robotics simulators used for Mobile Ground Robotics.

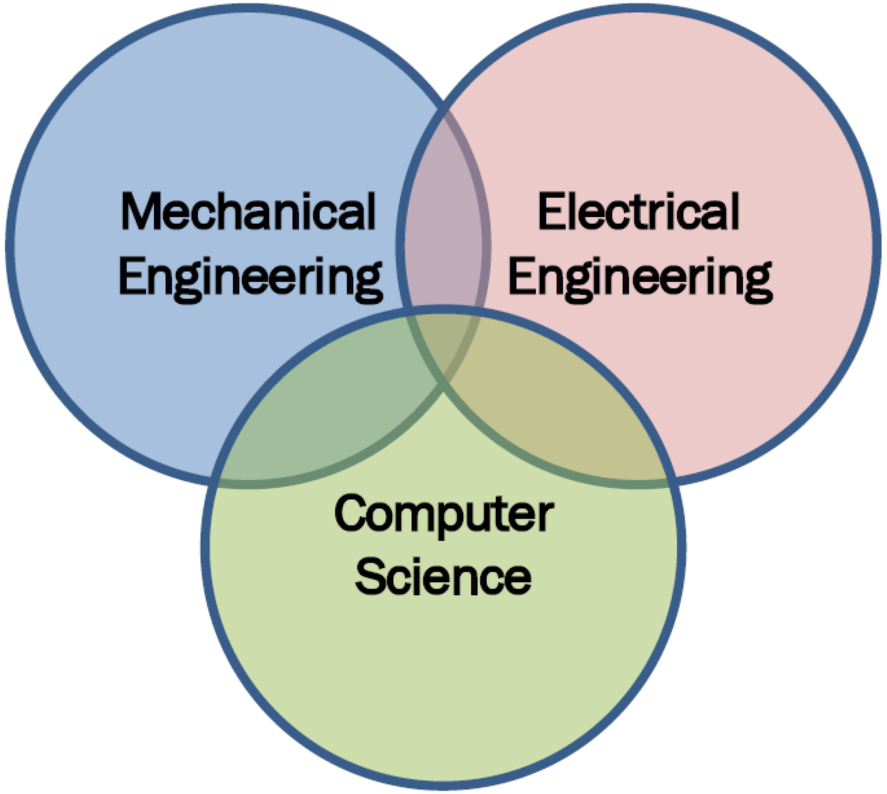
Simulator	GPS	Tracks	Wheels	Legs	Mecanum / Omni Wheels	Heightmap Import	OpenDrive / OpenStreetMap	Pathplanning	ROS Support	RGBD	LiDAR	Realistic Rendering
Gazebo	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✗
CoppeliaSim	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	✗
Raisim	✗	✗	✓	✓	✗	✓	✗	✗	✗	✓	✓	✓, Unity
Webots	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
PyBullet	✗	✗	✓	✓	✗	✓	✗	✓	✗	✓	✓	✗
CARLA	✓	✗	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓, Unreal
Project Chrono	✓	✓	✓	✓	✓	✓	✗	✗	✗	✓	✓	✓, POV-Ray

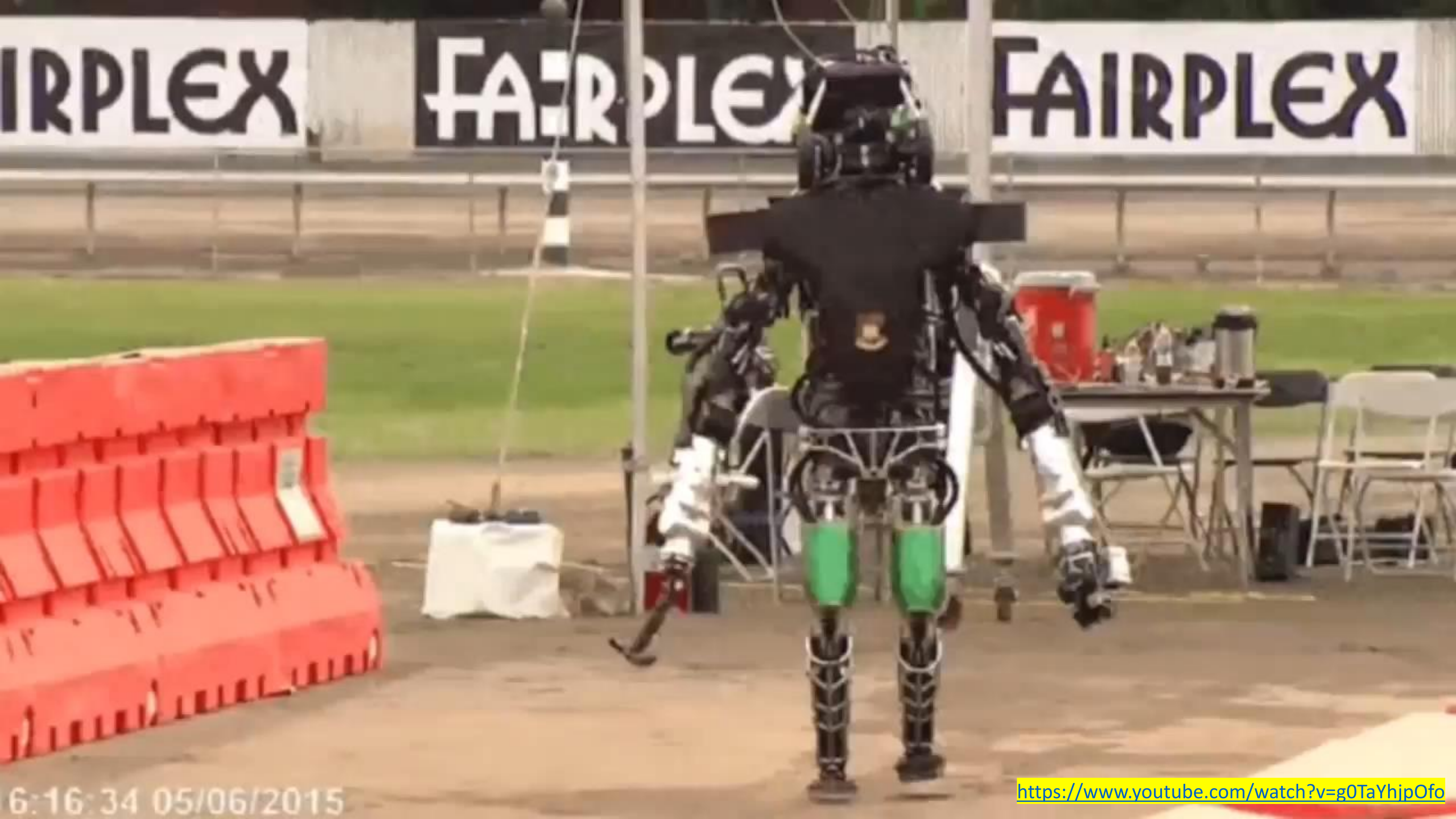
Failure

Competition entails hard work, but hard work does not guarantee success. ☹

Robotics – An interdisciplinary area of engineering and science

When you work on software, you need to be smart.

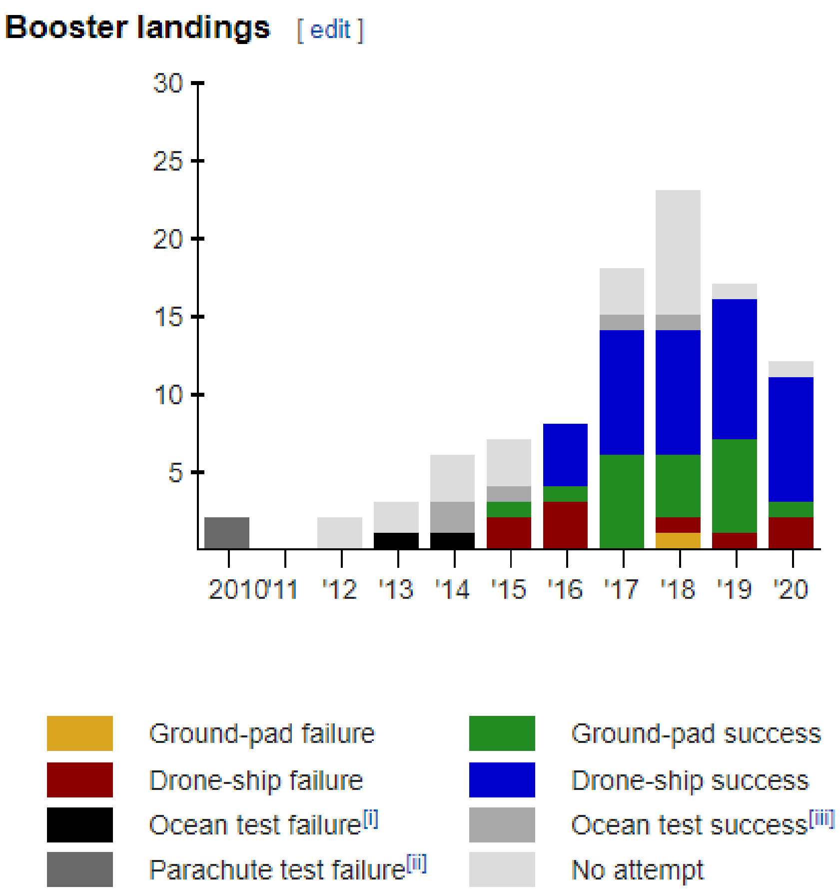




https://www.youtube.com/watch?v=g0TaYhjpOfo

https://www.youtube.com/watch?v=bvim4rsNHkQ

Space X booster landings success rate



i. ^ Controlled descent; ocean touchdown control failed; no recovery

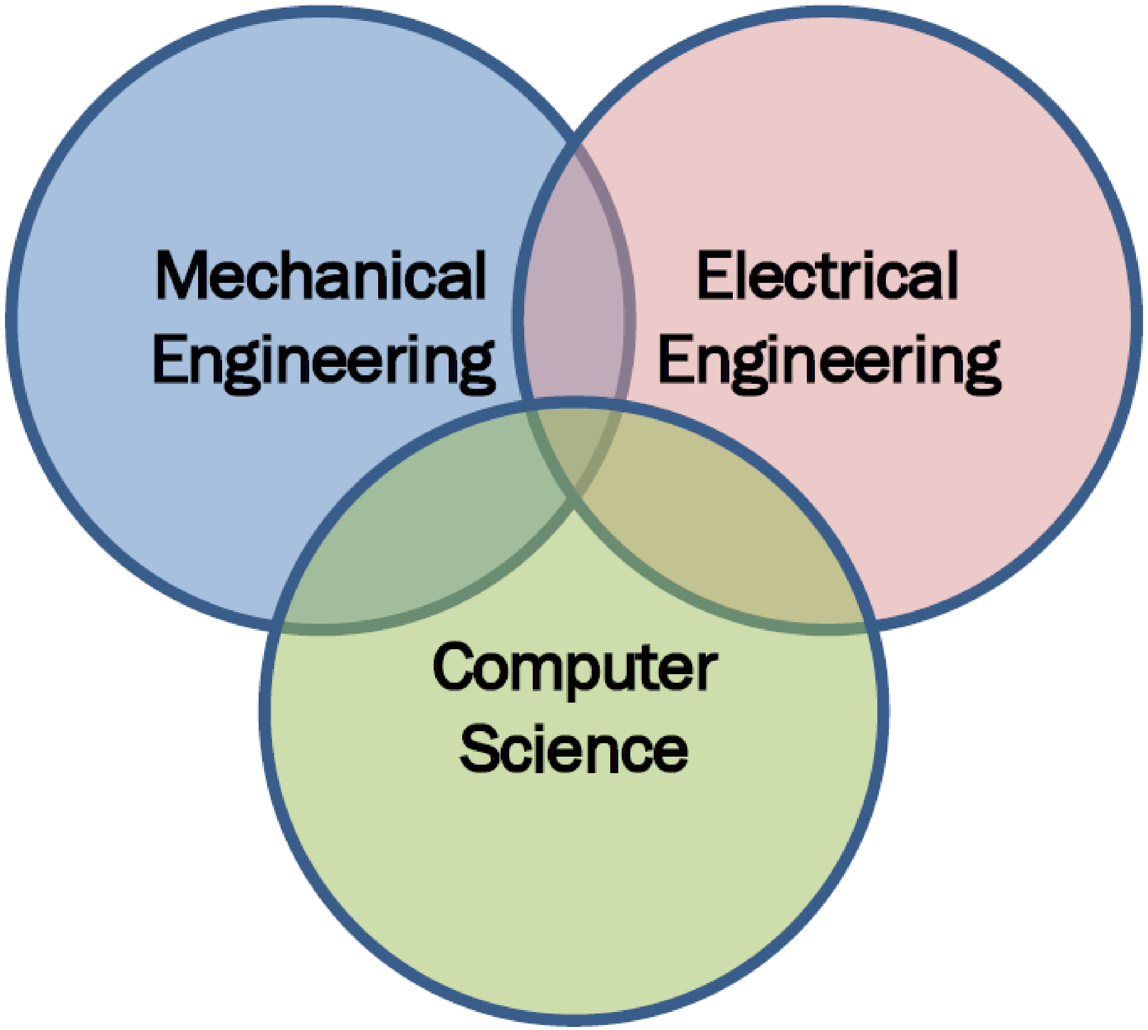
ii. ^ Passive reentry failed before parachute deployment

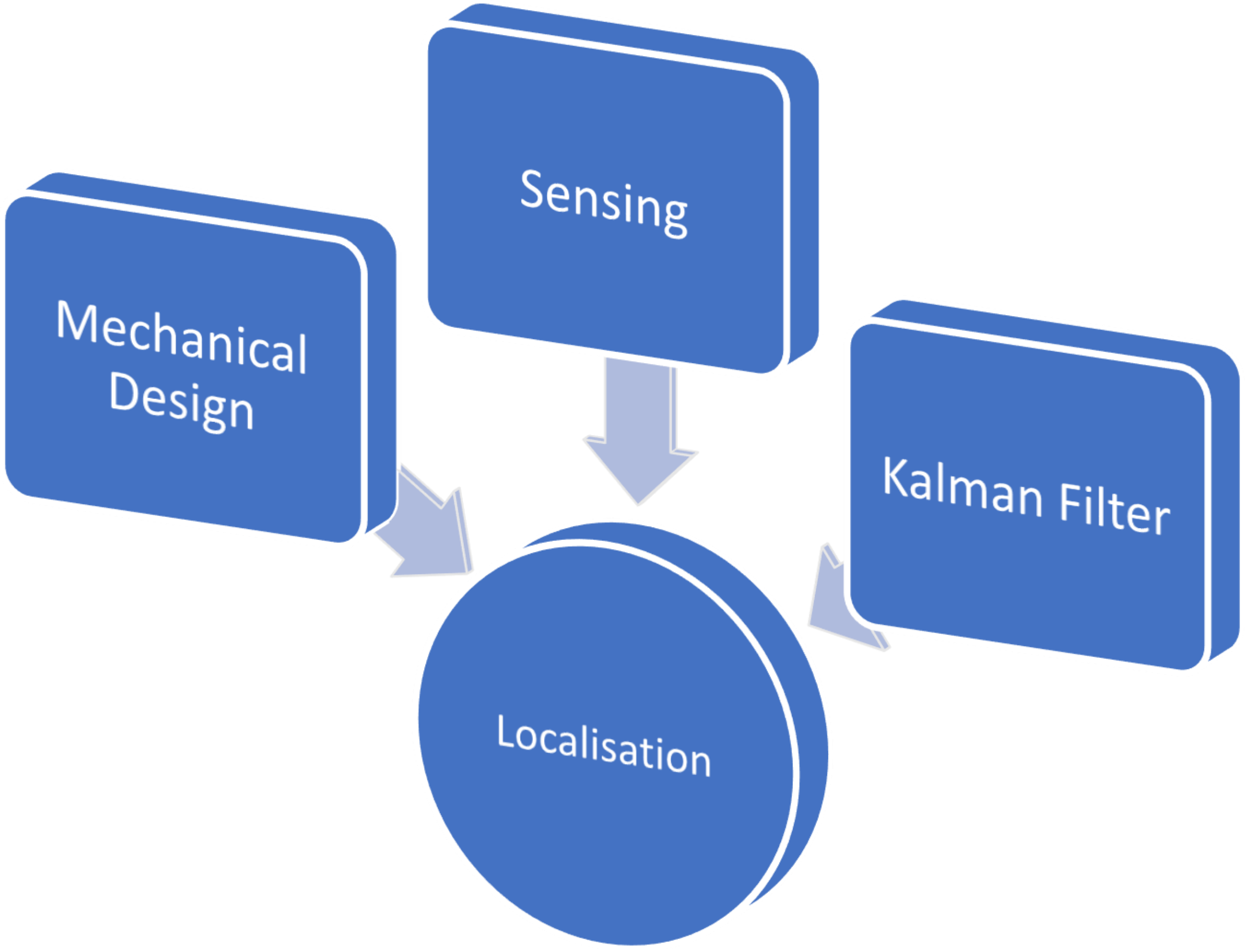
iii. ^ Controlled descent; soft vertical ocean touchdown; no recovery

https://en.wikipedia.org/wiki/List_of_Falcon_9_and_Falcon_Heavy_launches

Collaboration

Robotics – An interdisciplinary area of engineering and science





To collaborate or not to collaborate

"One monk will shoulder two buckets of water,
two monks will share the load,
but add a third and no one will want to fetch water."

-An ancient Chinese proverb

Collaborative behaviours

Assignment Phase B Forum > **Student Shared Map and Path Examples**

Name	Modified	Modified By
~~Leo~~	~~June 24~~	~~Leo Wu~~
Neeraj's share	July 5	Neeraj Gopikrishnan
Rang's share	June 28	Rang Lin

Assignment Phase C Forum > **Student Shared Example Images**

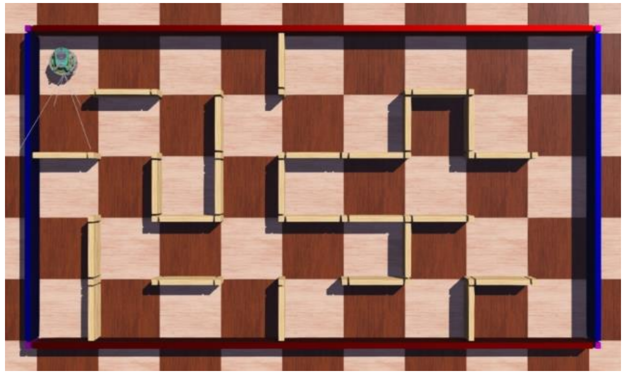
Name	Modified	Modified By
Hao Jin	5 days ago	Hao Jin
James	July 16	James Stevens
~~Leo~~	~~July 14~~	~~Leo Wu~~
Rang	6 days ago	Rang Lin

- Observation 1:
  - The teams who performed well were also the teams who collaborated well.

- Observation 2:
  - Many times, the attitude towards collaboration in the process was more important than the actual contribution incorporated in the product.

Assignment Phase D

Phase A



Driving and Perception

Week 1-3

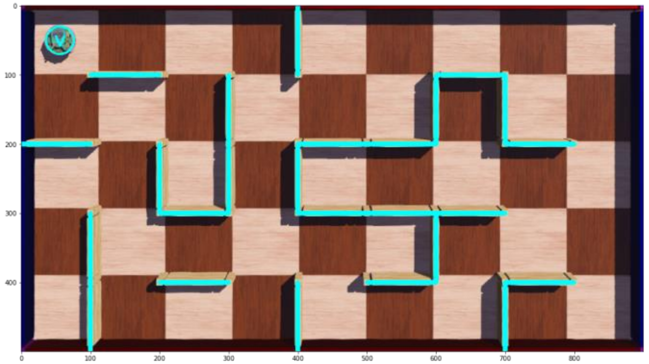
Phase B

```
Start - Find shortest path with least turns:
 --- --- --- --- --- --- --- --- ---
| v   15  14  13| 10  9   8   7   6 |
     ---                 ---
|           | 12  11    |   |    5 |
 ---             --- ---     ---
|       |   |   | 0   1   2   3   4 |
         ---     --- --- ---
|   |                   |           |
         ---         ---     ---
|   |           |           |       |
 --- --- --- --- --- --- --- --- ---
steps: 23 - 00SLFFFRFLFLFRFFFFRFFRFFFF
Done - Shortest path with least turns found!
```

Path Planning

Week 4-6

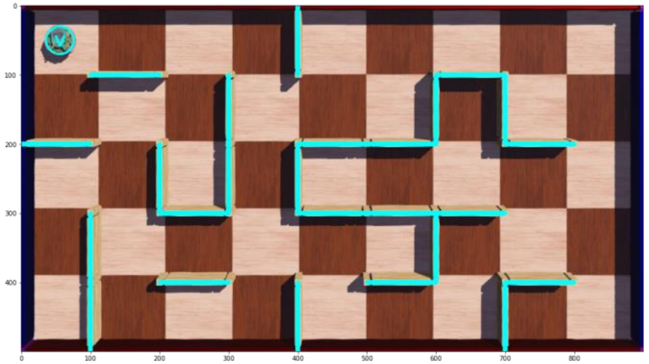
Phase C



Vision

Week 7-9

Phase C



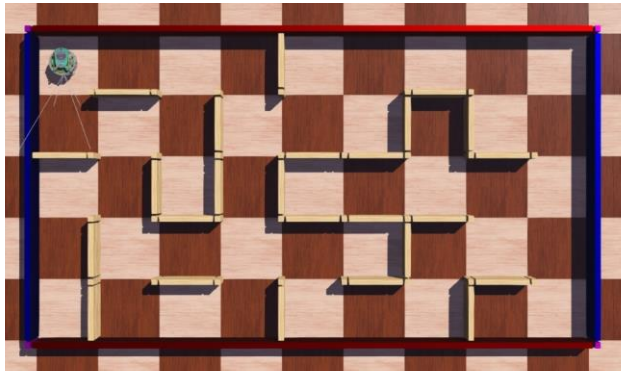
Vision

Phase B

```
Start - Find shortest path with least turns:
 --- --- --- --- --- --- --- --- ---
| v   15  14  13| 10  9   8   7   6 |
         ---                 ---
|                | 12  11    |   |    5 |
 ---                 --- ---     ---
|       |   |   | 0   1   2   3   4 |
             ---      --- --- ---
|   |                     |         |
             ---          ---     ---
|   |           |           |       |
 --- --- --- --- --- --- --- --- ---
steps: 23 - 00SLFFFRFLFLFRFFFFRFFRFFFF
Done - Shortest path with least turns found!
```

Path Planning

Phase A



Driving and Perception

Phase D

Integration and Improvement

Week 10-11

https://drive.google.com/file/d/1YFdU8UVbyGYCZqWnJRyP7CTcakhCy67d/view?usp=sharing

Competition

MicroMouse

- Micromouse is an event where small robot mice solve a 16 × 16 maze.

- It began in the late 1970s. Competitions and conferences are still run regularly.

- Search Run
  - The mouse must find their way from a predetermined starting position to the central area of the maze unaided.
  - The mouse will need to keep track of where it is, discover walls as it explores, map out the maze and detect when it has reached the goal.
  - Having reached the goal, the mouse will typically perform additional searches of the maze until it has found an optimal route from the start to the centre.

- Speed Run
  - Once the optimal route has been found, the mouse will execute that route in the shortest possible time.

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https://youtu.be/aXMcEDy-ly8
https://en.wikipedia.org/wiki/Micromouse

The faster, the better!

https://www.youtube.com/watch?v=IngelKjmecg

Let’s run a virtual competition

- The team getting the highest mark in Phase D will win the MTRN4110 2021 competition.

- In case multiple teams tie for the first place, the teaching team will vote the most impressive one as the winner.

Micro*Melomys*?

Melomys is a genus of rodents in the family Muridae. Members of this genus live in the wet habitats of northern Australia (Far North Queensland), New Guinea, Torres Strait Islands and islands of the Indonesian archipelago.

Melomys rubicola was relatively large for a mouse, with a body-length ranging from 14.8 to 16.5 centimetres (5 ⅞ to 6 ½ in) and a tail-length between 14.5 and 18.5 centimetres (5 ¾ and 7 ¼ in).

https://www.abc.net.au/triplej/programs/hack/bramble-cay-melomys-first-climate-change-mammal-extinction/10830080
https://en.wikipedia.org/wiki/Melomys
https://en.wikipedia.org/wiki/Bramble_Cay_melomys

The teaching team of MTRN4110 Robot Design 2019 congratulates

SHORT_STACK

developed by

Joel Behlevanas, Wade Hope, Daniel Dalton, and Aman Sanghvi

on winning the MicroMelomys 2019 competition!

Leo Wu

On behalf of the teaching team: Ngai Kwok, Leo Wu,
Zhihao Zhang, Annie Wang, Xiaoyi Wang, Subhan Khan, and Kasper Adermann

UNSW
SYDNEY

Engineering

The teaching team of MTRN4110 Robot Design 2019 congratulates

GUCCI BOT

developed by

Yingtao Zhang, Yibowen Zhao, Qiujie Liao, and Darien Winarso

on winning the MicroMelomys 2019 competition!

Leo Wu

On behalf of the teaching team: Ngai Kwok, Leo Wu,
Zhihao Zhang, Annie Wang, Xiaoyi Wang, Subhan Khan, and Kasper Adermann

The teaching team of MTRN4110 Robot Design 2020 congratulates

GROUP 3

composed of

Peter Bassett, Hamish Clark, and James McColl

on winning the **MicroMelomys 2020** autonomous mobile robot competition!

On behalf of the teaching team: Antonia Workman, Daniel Latimer, Jian Hu, Leigh Huang, Yuen Chan, Zhihao Zhang, and Leo Wu

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Engineering

Winner: $100/team member

Runner-up: $50/team member

The teaching team of MTRN4110 Robot Design 2021 congratulates

TEAM NAME

composed of

Student 1, Student 2, and Student 3 (Student 4)

on winning the **MicroMelomys 2021** autonomous mobile robot competition!

On behalf of the teaching team: Carlo Pane, Hikari Hashida, Jason Dam, Kenny Wong,
Leigh Huang, Matthew Chhoeu, Ming Xuan Chua, Rawan Abdo, Rowan Ramamurthy, and Leo Wu

Thank you and all the best!

- Lecturer

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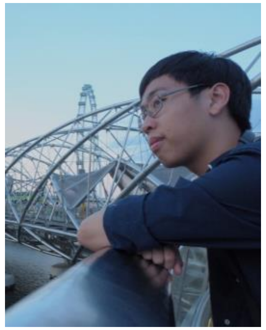

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