



Introduction to Robotics

METR 4202: Advanced Control & **Robotics**

Dr Surya Singh -- Lecture # 1

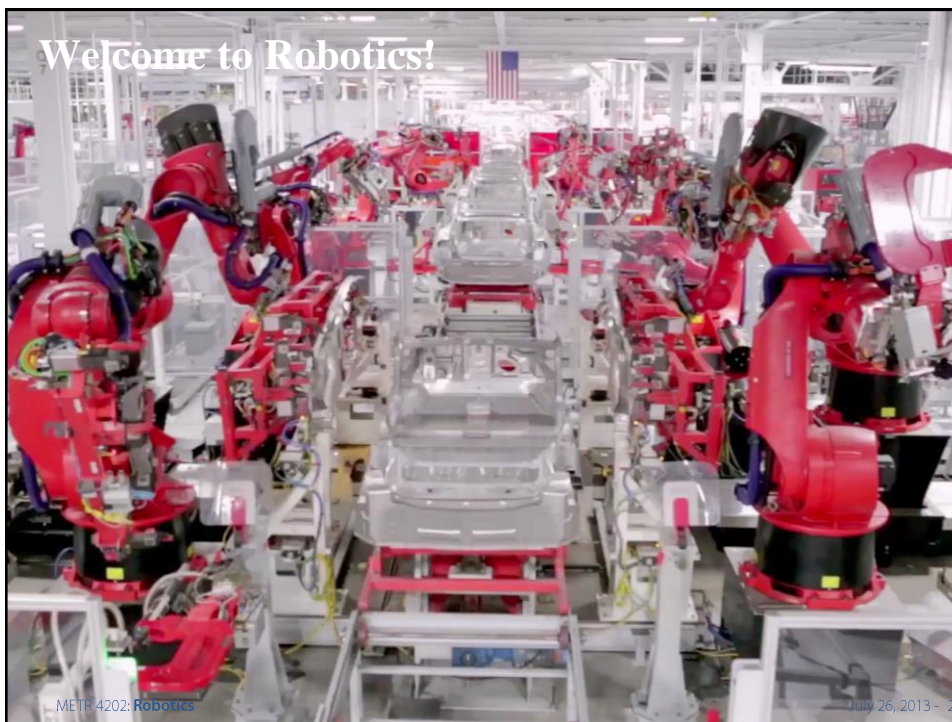
July 30, 2014

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[<http://metr4202.com>]

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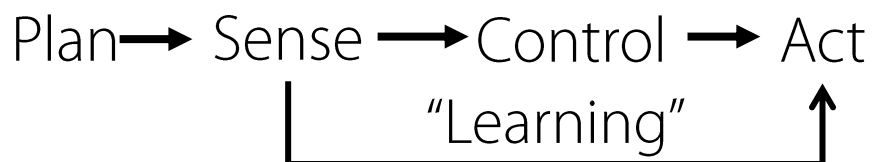






So What is a Robot ?????

- A “Smart” Machine ...
- A “General Purpose” (Adaptive) “Smart” Machine...



Robotics Definition

- Many, depends on context...

“A robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks.”
(Robotics Institute of America)

It is a machine which has some ability to interact with physical objects and to be given electronic programming to do a specific task or to do a whole range of tasks or actions.
(Wikipedia)

Programmable electro-mechanical systems that adapt to identify and leverage a **structural characteristic** of the environment
(Surya)



Types of Robotics Systems

- Manipulators



- Mobile



- Adaptive



Enabling Mathematics:

- Computational Kinematics
- Operational Space

- Behaviour based “Reflexive” control rules

- Probabilistic methods



Types of Robotics Systems → Textbooks

- Manipulators



- Roth
- Craig
- S&S
- Asada & Slotine
- Tsai

- Mobile



- Corke
- Dillman
- Choset, Thrun, *et al.*
- [SLAM]

- Adaptive



- LaValle
- Thrun
- [[Model]
Predictive
Operations]



Magicarms

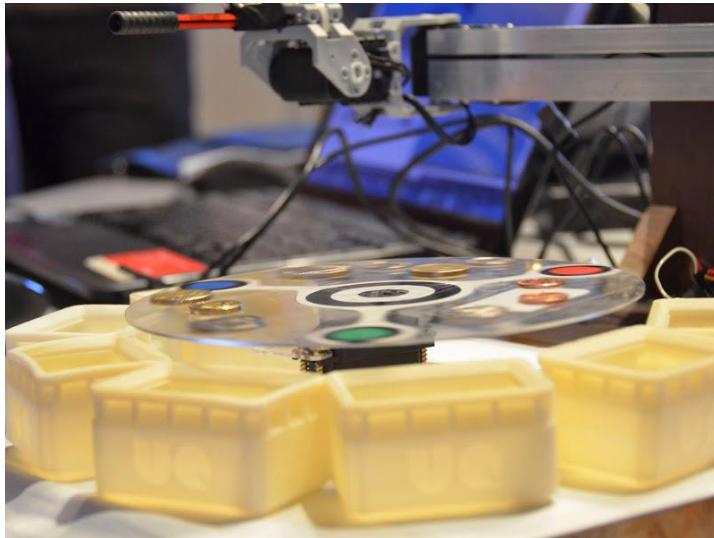




METR 4202: Robotics

July 26, 2013 - 15

Change. The Future!



METR 4202: Robotics

July 26, 2013 - 16

Schedule of Events

Week	Date	Lecture (W: 11:10-12:40, 24-402)
1	30-Jul	Introduction
2	6-Aug	Representing Position & Orientation & State (Frames, Transformation Matrices & Affine Transformations)
3	13-Aug	Robot Kinematics
4	20-Aug	Robot Dynamics & Control
5	27-Aug	Robot Trajectories & Motion
6	3-Sep	Sensors & Measurement
7	10-Sep	Perception (Computer Vision) (+ Prof. M. Srinivasan)
8	17-Sep	Motion Planning + Control
9	24-Sep	State-Space Modelling
	1-Oct	<i>Study break</i>
10	8-Oct	Shaping the Dynamic Response
11	15-Oct	Linear Observers & LQR
12	22-Oct	Localization and Navigation
13	29-Oct	Applications in Industry & Course Review



Assessment

- **Kinematics Lab (12.5%):**
 - Proprioception
 - Arm design and operation (with Lego)
- **Sensing & Control Lab (25%):**
 - Exterioception
 - Camera operation and calibration (with a Kinect)
- **Advanced Controls & Robotics Systems Lab (50%):**
 - All together!
- **Individual Take-Home Problem Set/Quiz (12.5%) ☺**



Lectures

- Wednesdays from 11:11 – 12:34 pm
- Lectures will be posted to the course website **after** the lecture (so please attend)
 - Slides are like dessert – enjoy afterwards!
- Please ask questions (preferably about the material 😊)

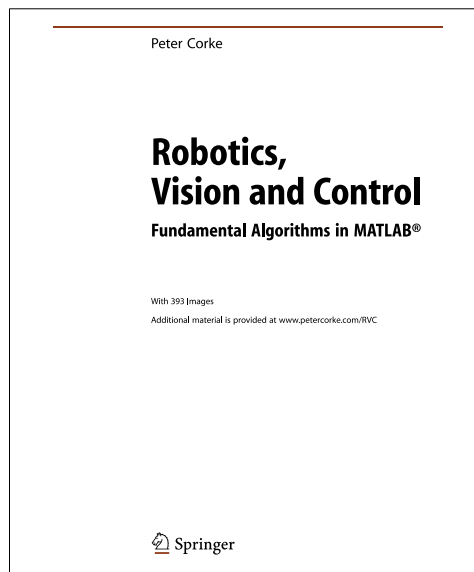


Tutorials & Labs

- Tutorials:
 - Wednesday from 5:00 – 6:00+ pm in the Axon Learning Lab (47-104)
 - Meeting Weeks 2-9 (**not this week!**)
- Labs:
 - Mondays 10:00 – 1:00 pm in the Axon Learning Lab (47-104)
 - Meeting: Weeks 2-13 (not this week either!)



Textbook



*Robotics, Vision and
Control Fundamental
Algorithms in MATLAB*

By:
Peter Corke

Available online (on
campus) via SpringerLink



E-mail & website

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<http://robotics.itee.uq.edu.au/~metr4202/>

Please use **metr4202** e-mail for class matters!



Course Objectives

1. Be familiar with sensor technologies relevant to robotic systems
2. Understand homogeneous transformations and be able to apply them to robotic systems,
3. Understand conventions used in robot kinematics and dynamics
4. Understand the dynamics of mobile robotic systems and how they are modelled
5. Understand state-space and its applications to the control of structured systems (e.g., manipulator arms)
6. Have implemented sensing and control algorithms on a practical robotic system
7. Apply a systematic approach to the design process for robotic system
8. Understand the practical application of robotic systems in to intelligent mechatronics applications (e.g., manufacturing, automobile systems and assembly systems)
9. Develop the capacity to think creatively and independently about new design problems; and,
10. Undertake independent research and analysis and to think creatively about engineering problems.



The Point of the Course

- Introduction to terminology/semantics
- An appreciation of how to frame problems in an engineering context
- Modeling and learning to trust the model
- Ability to identify critical details from the problem (separate information from trivia)



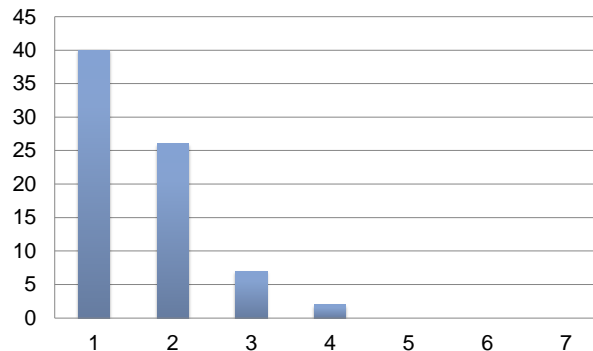
Grade Descriptors

Grade	Level	Descriptor
Fail	(<50%)	Work not of acceptable standard. Work may fail for any or all of the following reasons: unacceptable level of paraphrasing; irrelevance of content; presentation, grammar or structure so sloppy it cannot be understood; submitted very late without extension; not meeting the University's values with regards to academic honesty.
Pass	(50-64%)	Work of acceptable standard. Work meets basic requirements in terms of reading and research and demonstrates a reasonable understanding of subject matter. Able to solve relatively simple problems involving direct application of particular components of the unit of study.
Credit	(65-74%)	Competent work. Evidence of extensive reading and initiative in research, sound grasp of subject matter and appreciation of key issues and context. Engages critically and creatively with the question and attempts an analytical evaluation of material. Goes beyond solving of simple problems to seeing how material in different parts of the unit of study relate to each other by solving problems drawing on concepts and ideas from other parts of the unit of study.
Distinction	(75-84%)	Work of superior standard. Work demonstrates initiative in research, complex understanding and original analysis of subject matter and its context, both empirical and theoretical; shows critical understanding of the principles and values underlying the unit of study.
High Distinction	(85%+)	Work of exceptional standard. Work demonstrates initiative and ingenuity in research, pointed and critical analysis of material, thoroughness of design, and innovative interpretation of evidence. Demonstrates a comprehensive understanding of the unit of study material and its relevance in a wider context.



Last Year's Grade Statistics

METR4202 Grade Distribuion -- 2013



- ~ 80 % received D or HD
- Worry about **learning**, not about marks [Seriously!]
- Though a “7” might be bit more exclusive this year!



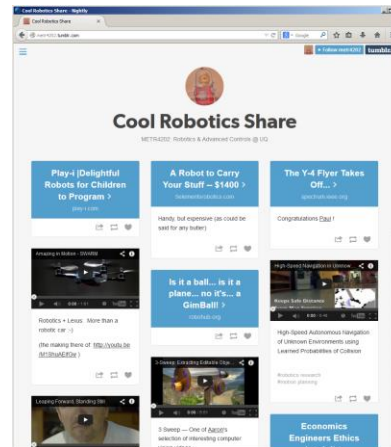
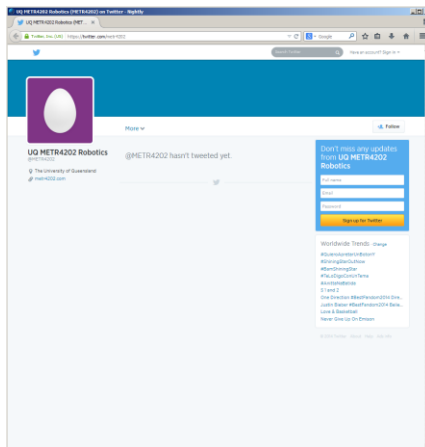
What I expect from you

- Lectures:
 - Participate - ask questions
 - Turn up (hence the attendance marks)
 - Take an interest in the material being presented
- Tutorials:
 - Work on questions before tutorials
 - Use tutorials to clarify and enhance
 - Assignments to be submitted on time



Twitter & Tumblr too!

- <https://twitter.com/metr4202>
- <http://metr4202.tumblr.com/>



Please **Robotics** Share



YouTube: 2014 RoboCup SPL Grand Final rUNSWift Vs HTWK (4:56)

- Congratulations to UNSW!
RoboCup World Champions (5:1)



What's the Magic?



Structure!

(And Some Clever Mechatronics Design)

Robotics: Exploiting the hidden structure...

- Robot working in an “unstructured” environment
- ➔ Does not have to be dirty to use “field robotics” technology ...
- ➔ Robotics is about exploiting the **structure** ...
Either by:
 - Putting it in from the design
(mechanical structure)
 - “Learning” it as the system progresses
(structure is the data!)

Summary

- An outline of the course structure – details are in the Unit of Study Outline
- Considered and presented a basic definition of a mechatronic system
- A look at the courses which will fulfil the requirements for a Mechatronic Engineering Degree
- Some examples of common mechatronic systems



This week's Tutorial ...

Remember:

- **NOT** being held this week

