

CSE 276A

Introduction to Robotics

- Henrik I Christensen



Outline

- Welcome
- Enrollment / Waitlist
- Robot Intro
- Course Outline
- AOB

Welcome

- Lecturer / TAs
- What is a robot?
- A bit of history
- Example use-cases
- Course content

Lecturer

- Henrik I Christensen
- Distinguished Professor @ CSE
- Director of Robotics - cri.ucsd.edu
- Theme: “Real Robots for Real Applications”
- Research: Robust Robot Autonomy
- History: first autonomous vacuum cleaner, numerous robots in industry use today
- Spin-offs: Robust.AI, Robo-Global, ...
- Advisor to Temasek International, SG
- Main editor of the US National Strategy for Robotics

TAs

- Charvi Shukla cshukla@ucsd.edu
- Shiladitya Biswas s1biswas@ucsd.edu

- Office Hours (3rd floor FAH)
 - Henrik - Thursdays 12:30-1:45 PM
 - Shukla & Shiladitya - TBD

Lectures

- Tuesday & Thursday 3:30-4:50 pm
- Lectures as a podcast on Canvas
- All material on Canvas
- Discussions on Piazza

- Any and all feedback, ... is most welcome

Questions?

What is a robot?

- A goal oriented machine that can sense, plan and act

Characteristics of robots

- Consistent
- Accurate
- Reliable

- Do things that people
 - can't do
 - space, deep sea
 - won't do
 - boring, dull
 - shouldn't do
 - dangerous, unhealthy, risky

A bit of background and history

Why do we call them robots?

Robot: the word

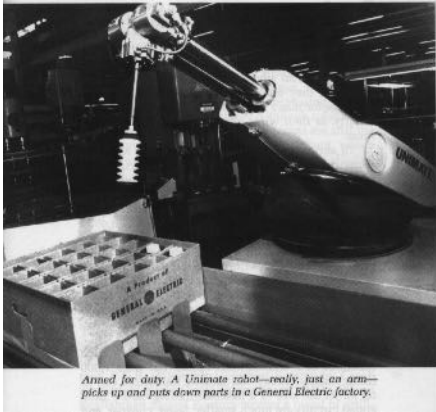


- In 1921, the Czech author Karel Čapek produced his best known work, the play *R.U.R. (Rossum's Universal Robots)*, which featured machines created to simulate human beings.
- The term "robot" was derived from the Czech word *robota*, meaning "work", "forced workers" or "slaves."
- His robots eventually rebelled against their creators, ran amok, and tried to wipe out the human race.

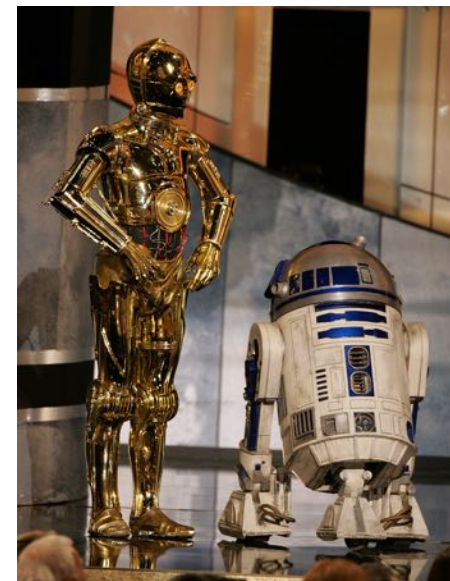
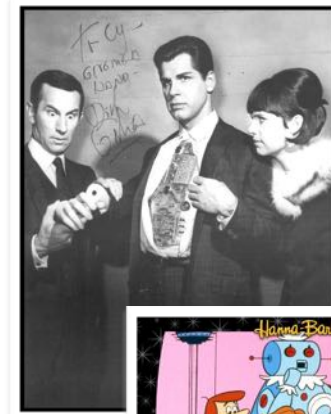
Karel Čapek

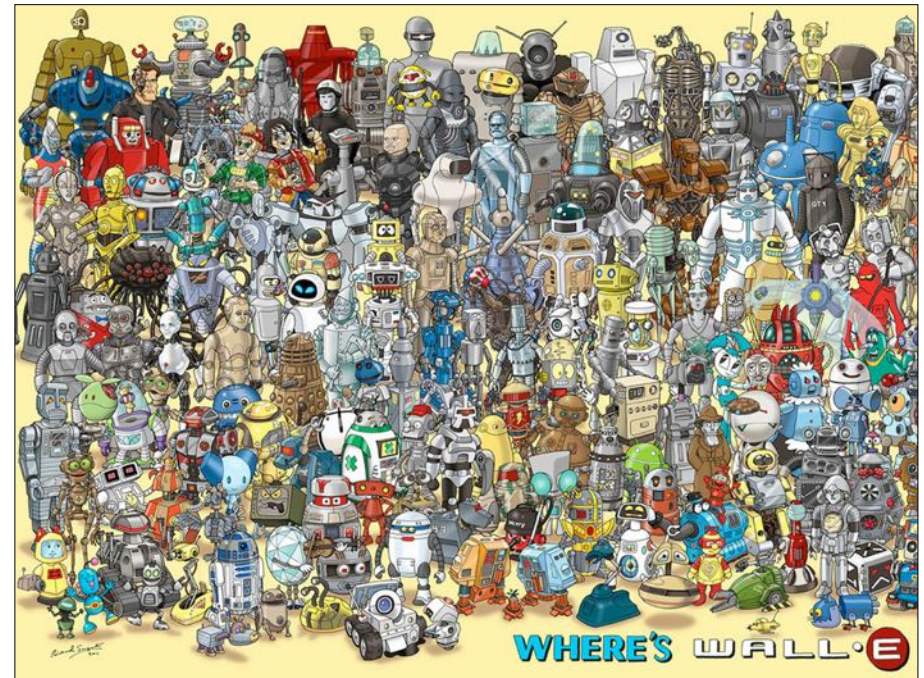
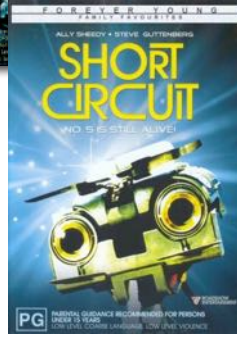
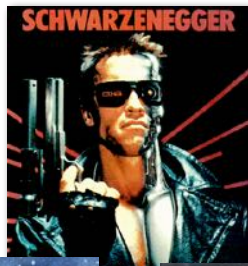
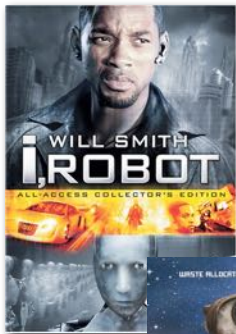
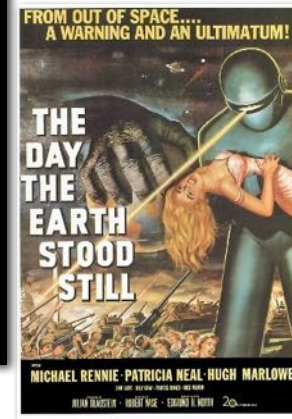
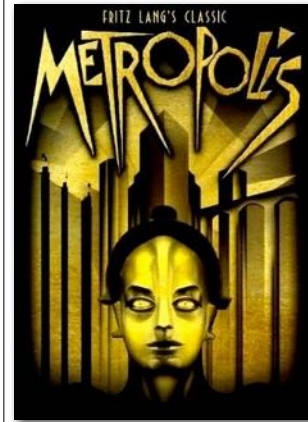


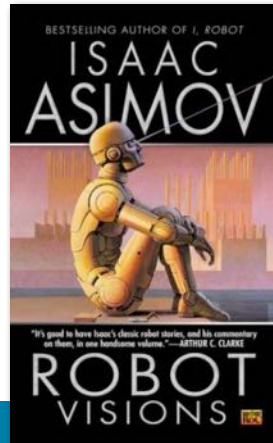
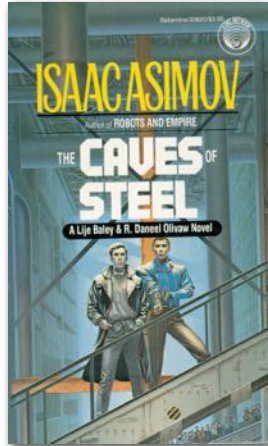
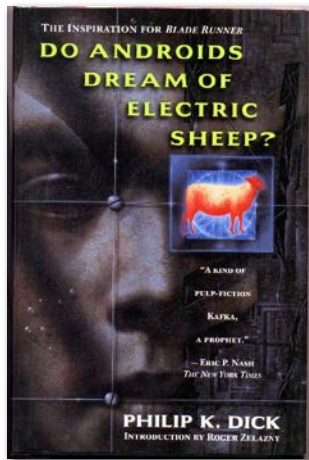
Joe Engleberger (1925-2015)



Unimation Inc. 1956

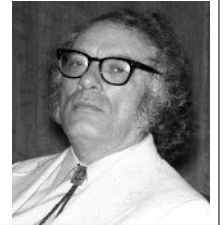
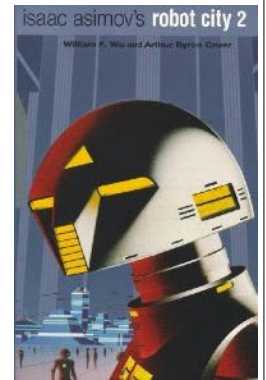




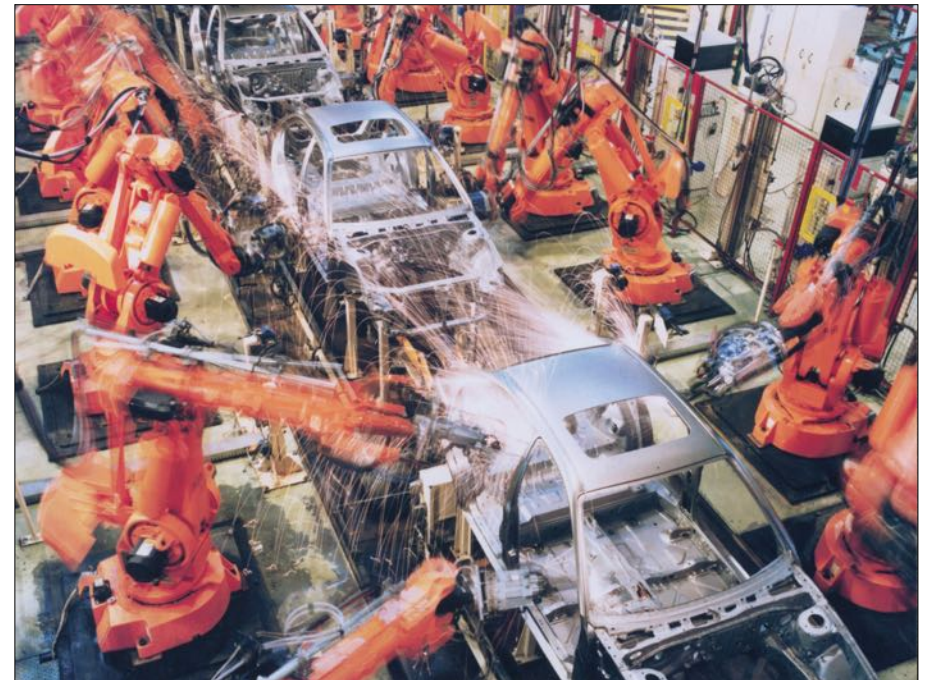


The Laws of Robotics

- **First Law:** A robot may not injure a human being, or, through inaction, allow a human being to come to harm.
- **Second Law:** A robot must obey orders given it by human beings, except where such orders would conflict with the First Law.
- **Third Law:** A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.



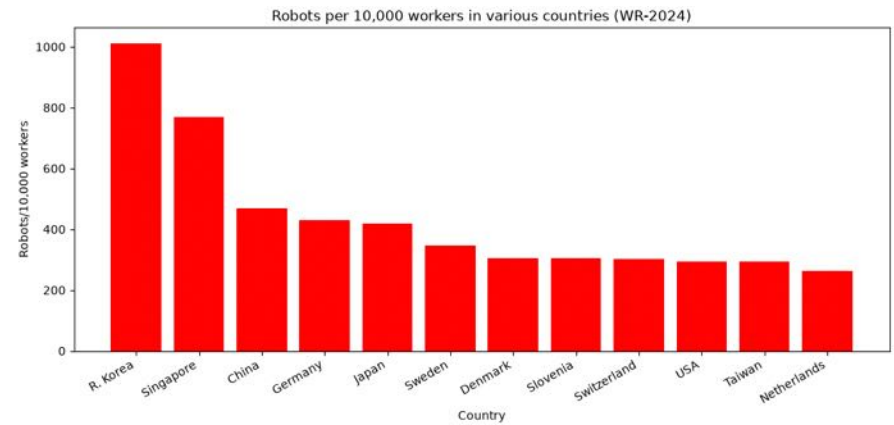
What do you think of as a robot?



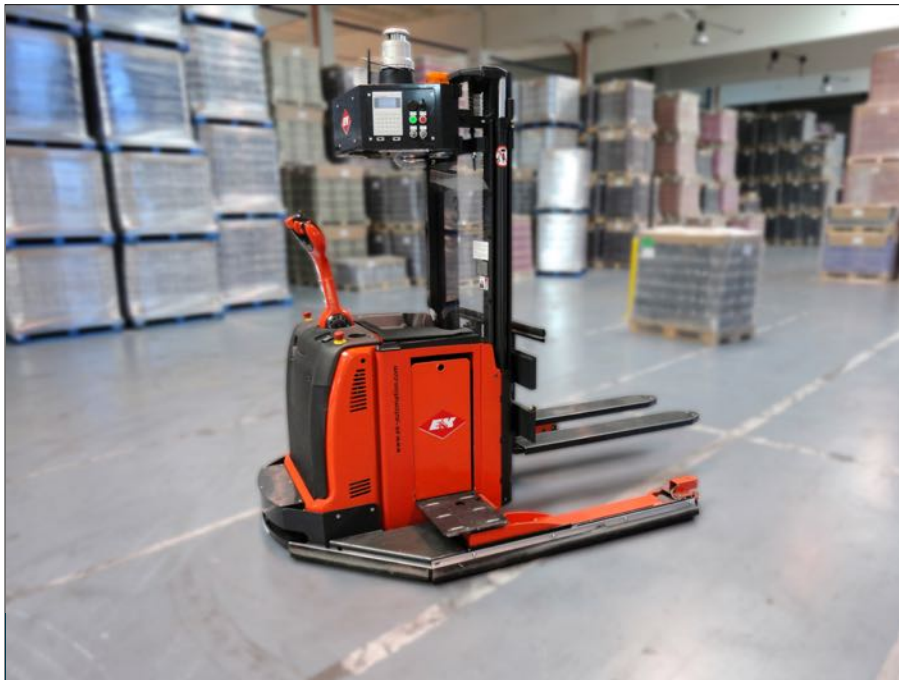
How big is the industry penetration?

- How many robots are in use in industry / worker
- Say NN robots / 10,000 workers
 - In automotive
 - In general
 - In US
 - In China?

Robot Density



SRC: World Robotics 2024, IFR, Germany

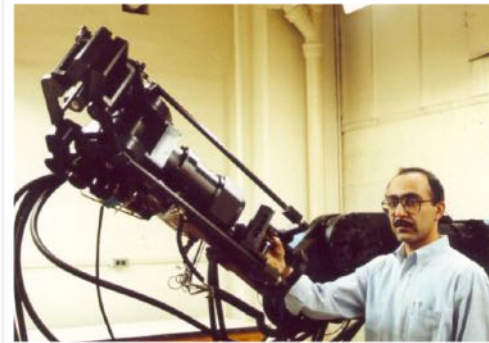


KIVA - Example



Consider robots as
extenders of human ability

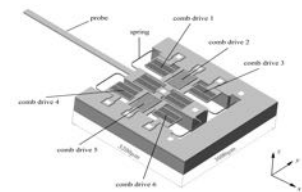
Stronger



Put us “inside” people



Let us handle tiny things



Force Feedback

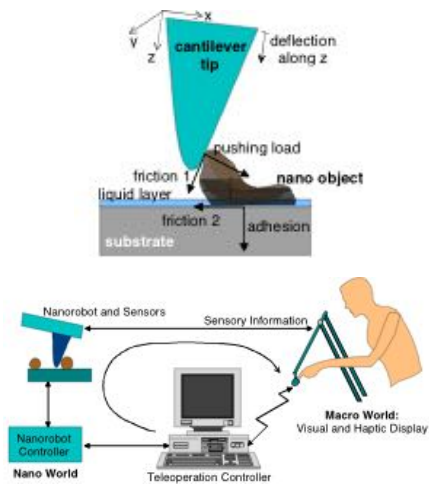
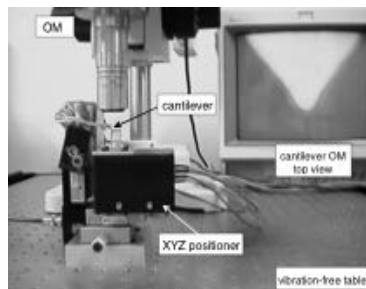
Vision Feedback



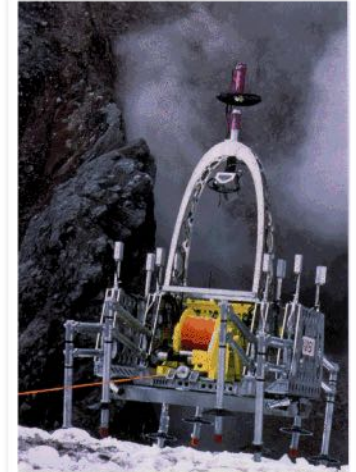
Institute of Robotics and Intelligent Systems
Swiss Federal Institute of Technology (ETH), Zürich



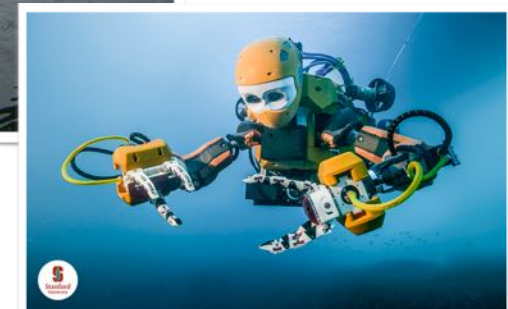
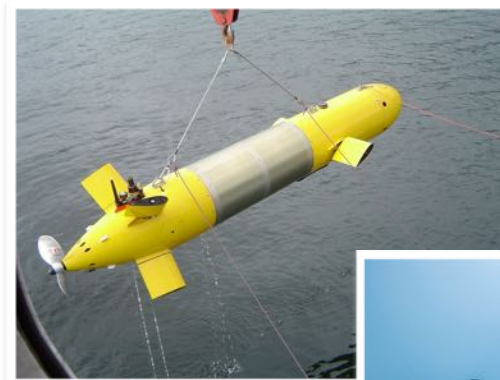
and even nano things



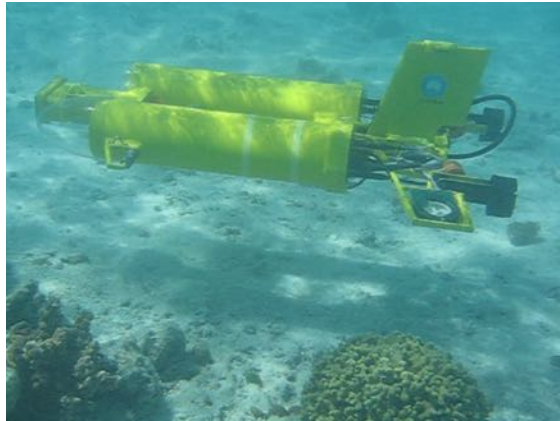
Extending our reach



Extending exploration

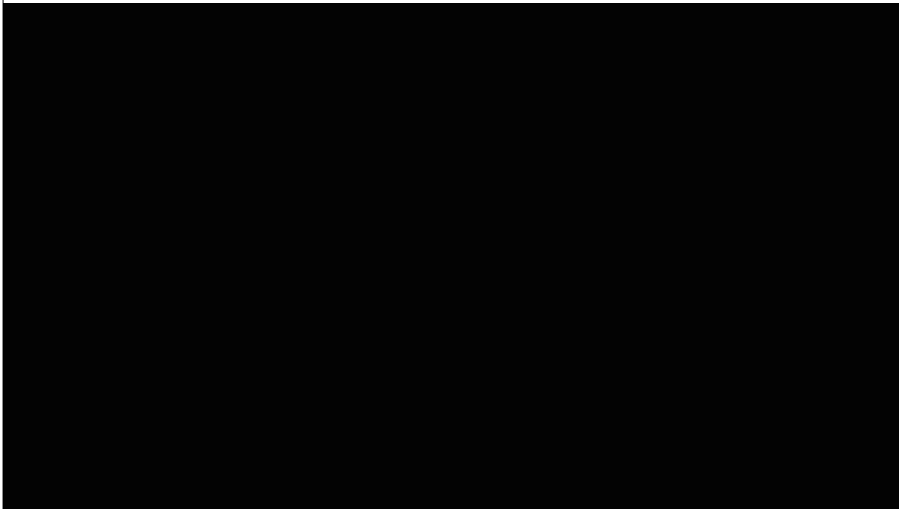


Robots underwater



Courtesy of CSIRO

Autonomous Boats - Seahunter



Courtesy of General Atomics



Mobile robots



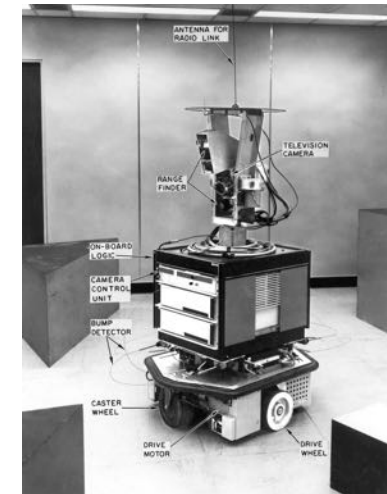
A light seeking "tortoise".

Mobility



Moravec's Stanford rover

1964

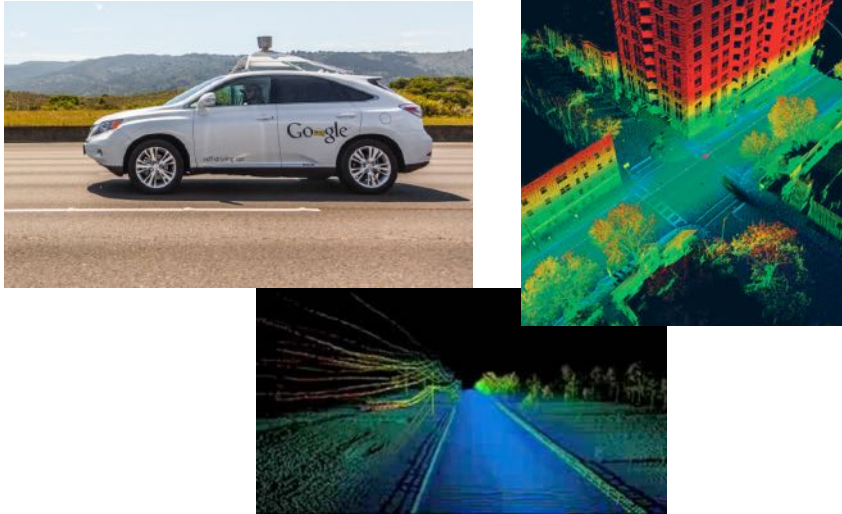


SRI's Shakey

Robots that drive



The Google car



Are we in for a revolution?



1898

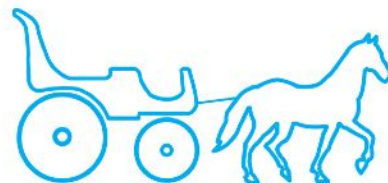


1915



11.8mph

Average speed in London 2016

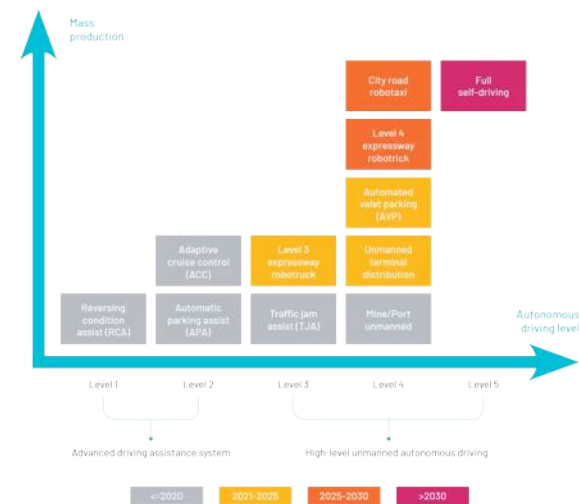


17mph

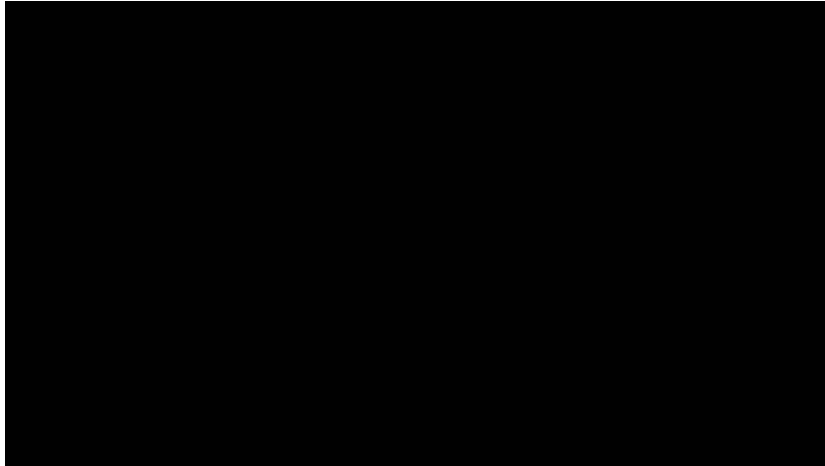
Average speed in London 1916

Driverless cars

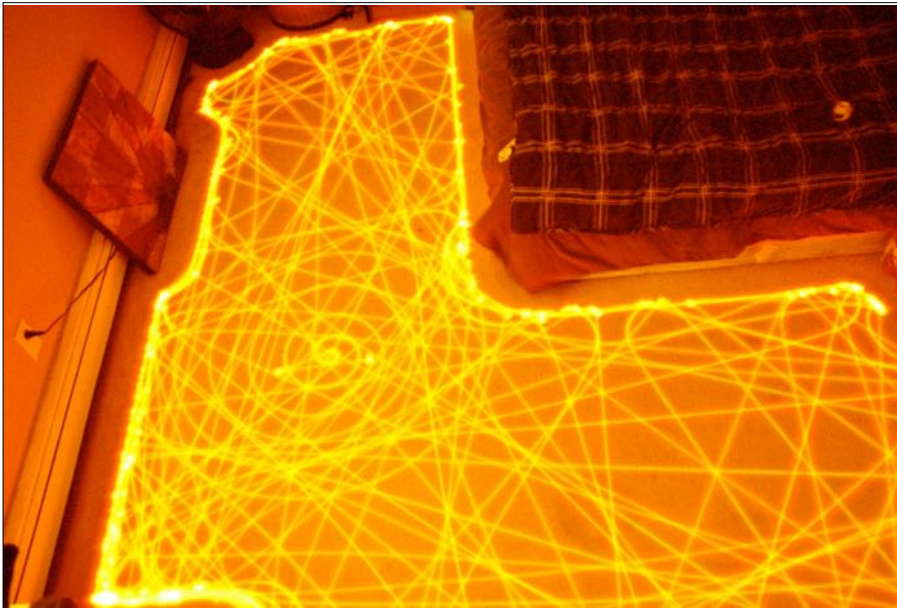
Commercial landing schedule of autonomous driving



Autonomous Driving @ UCSD



2004



Before Roomba

(Grinter & Christensen, 2009)



Two weeks after



Six months after

CERO System

- Mobile platform
- Box for deliveries
- A simple user interface
- Design is crucial

(Eklundh & Christensen, 2006)



CERO Interface



(Eklundh & Christensen, 2006)



Spot

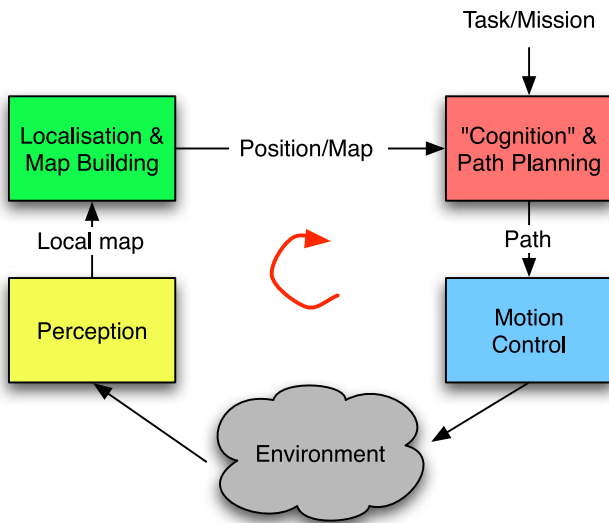
- Now a dog like commercial platform
- Very impressive performance



Questions?

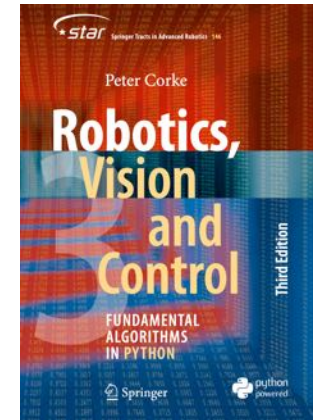
CSE276A Class Structure

- Introduction
- Kinematics / Mobile Robots
- Sensing / Estimation / GPS
- Image Processing
- Mapping
- Visual Tracking / Servoing
- Geometric Spaces / Path Planning
- Grasping and Hands
- Human Robot Interaction
- Perspective



Class Material

- Robotics, Vision and Control, P. Corke, Springer Verlag (2011, 2017, & 2023)
- Most material adopted from the book
- Will provide fairly comprehensive lecture notes / slides
- Most programming in Python / C++
- ROS - Robot Operating System 2



Class Material

- Thundercomm Rubik Pi 3
- Wondershare Rover
- Power Cell
- Robot Operating System
 - We will use ROS2
- 1-2 students / robot



Homework

- A new homework every two weeks
 1. Drive the robot to 5 way points
 2. Use vision to drive the robot to landmarks
 3. Build a map of the environments
 4. Navigate within your map
 5. Integrate to achieve a "Roomba" like system!
- THE END

Schedule

Date	Week	Topic	Corke	Quiz	Assignm
Sep 24	0	Introduction to Robotics	Chapter 1		
Sep 29	1	Robot Operating System (ROS)	Tutorial		
Oct 1	1	Space and Time			
Oct 6	2	Mobile Robotics / Test system for class	Chap 4		
Oct 8	2	Sensing / GNSS			
Oct 13	3	Images	Chaps 10 / 11		
Oct 15	3	Visual Servoing	Chap 15		A1: Basic motion
Oct 20	4	Kalman Filtering SLAM	Chapter 6		
Oct 22	4	Localization	Chapter 6		
Oct 27	5	Graphical SLAM			
Oct 29	5	KALMAN / SLAM			A2: Closed loop
Nov 3	6	Planning - Geometry / Sampling based methods			
Nov 5	6	Grasping & Hands	Chapter 8		
Nov 10	7	Human Robot Interaction			
Nov 12	7	Architectures			A3: Kalman Mapping
Nov 17	8	Robo-Ethics			
Nov 19	8	TBD			
Nov 24	9	No Lecture			A4: Robot Planning
Nov 26	9	No lecture - Thanksgiving			
Dec 1	10	Wrap-up			
Dec 3	10	No lecture			A5: Integration

Teaching team

- Lecturer:
 - Henrik I Christensen - hichristensen@ucsd.edu
- TA:
 - Charvi Shukla cshukla@ucsd.edu
 - Shiladitya Biswas s1biswas@ucsd.edu

Potential follow-on projects

- Last couple of years, Qualcomm offered special projects to some of the best CSE276A students during the winter/spring quarter
- Mentored mainly by Qualcomm engineers (and me)
- Some projects were presented at the Qualcomm annual developer forum
- All students have subsequently gotten jobs at Amazon Robotics, Qualcomm, Shield.AI, ...

Person follow robot

Demo

Navigation demo



UC San Diego

Retail Store Data Collection

Soumi Chakraborty

Rahul Salvi

Henrik I. Christensen

Qualcomm



UC San Diego

CONTEXTUAL ROBOTICS INSTITUTE

JACOB SCHOOL OF ENGINEERING
DIVISION OF SOCIAL SCIENCES

Questions?

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