CS354

JMU
Computer Science

What Does "Robotics" Mean? (To Us)

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- NOT industrial automation
- NOT tele-operated robots

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- The focus of this class will be on programming <u>autonomous</u>, <u>mobile</u> robots.

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- We'll view robotics as a branch of AI that includes several problem areas:
    - Localization
    - Path planning
    - Mapping
    - Computer vision/perception
    - Forward/Inverse Kinematics
    - Task Planning
    - Control Architectures

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- Tools we use to address these problems:
  - Probability Theory
  - Control Theory
  - Graph Search Algorithms
  - Machine Learning
  - Signal Processing
  - ...

Why Study Robotics?

- We may, finally, be approaching a point where people routinely interact with autonomous mobile robots.*
  - Waymo Autonomous Taxis
  - Delivery Robots
  - Warehouse Automation

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  *Maybe not? We are in a time of optimism, startups, "pilots", demos, etc. There are still fundamentally hard unsolved problems.
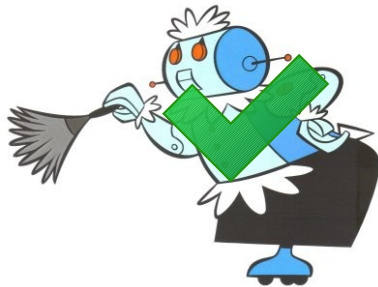
Goals For The Course

- We'll study robotics at two levels:
    - Theory: Understanding algorithms for solving robotics problems
    - Application: Writing robotics programs using ROS 2
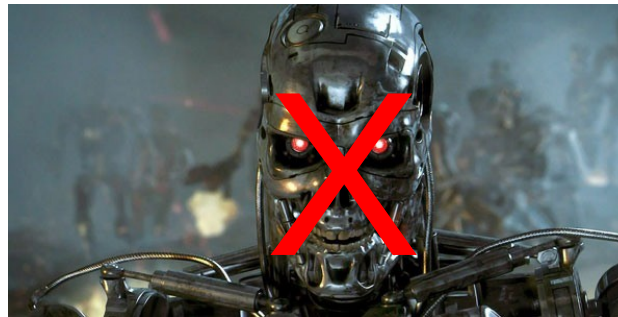
Ethical Considerations...

- In my opinion, the toughest ethical issues of this century will be related to increasing automation.
  - What would humans do if most work could be automated?
  - Who would benefit?
  - Who is responsible when robots cause harm?

Ethical Considerations...

- Let's approach this class with an eye toward improving human life:

http://www.techtimes.com/articles/
26032/20150112/mit-scientists-put-us-one-step-
closer-to-robot-maids.htm

http://www.cinemablend.com/television/Terminator-Project-May-Head-Television-60924.html

What is ROS?

"The Robot Operating System (ROS) is a flexible framework for writing robot software. It is a collection of tools, libraries, and conventions that aim to simplify the task of creating complex and robust robot behavior across a wide variety of robotic platforms."

http://www.ros.org/about-ros/

History of ROS

- 2006   Willow Garage founded

- 2007   Willow Garage formally introduces ROS

- 2010   Willow Garage begins shipping PR2 robots

"Scott Hassan founded Willow Garage in late 2006 to accelerate the development of non-military robotics and advance open source robotics software."

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- 2011   Willow Garage introduces the Turtlebot as a low-cost alternative to the PR2 (Original design used the iRobot Create base)

- 2012   Open Source Robotics Foundation (OSRF) takes over ROS development

- 2015   DARPA Robotics Challenge

- 2017   First ROS2 alpha release

- 2025   ROS1 EOL?

http://wiki.ros.org/Robots/PR2
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"Based on our observations at the competition and communications with team members, out of the 23 DRC Finals teams, we count 18 teams using ROS and 14 teams using Gazebo."

http://www.osrfoundation.org/ros-gazebo-at-the-drc-finals/

Turtlebot 3

- 2d-Lidar
- Camera
- Raspberry Pi
- Open Source Hardware
- ROS/ROS 2 compatible

http://www.robotis.us/turtlebot-3-waffle-pi

Programming in ROS 2

- Our platform:
  - ROS 2 Humble / Ubuntu 22.04 Jammy / (or Mint 21)
- Fully supported languages:
  - C++, Python3
- We'll focus on Python

ROS2 Tools

- Rviz2 - Visualization
- Gazebo – Simulation
- Many command-line utilities

Course Mechanics...

Fair Warnings

- This class is inherently challenging:
  - The 3XX number should not be interpreted to mean 25% less work than 4XX electives :)
  - Theoretical content differs from other CS courses
  - ROS 2 has a steep learning curve and spotty documentation
  - It may be difficult or impossible to install course software on your own computer
  - If you don't already know Python, you will need to learn it
  - You'll need to get comfortable using the Linux/Unix command line

QUESTIONS?