CSCI 473/573
Human-Centered Robotics
Overview of Syllabus and Class Policies

• Instructor
  ▪ Hao Zhang
    • Assistant Professor
    • Division of Computer Science

  ▪ Office: BB 250
  ▪ Email: hzhang@mines.edu
  ▪ URL: http://inside.mines.edu/~hzhang
  ▪ Office Hours: 3:30 – 5:30 PM Tuesdays
    or by appointment (send email)
Overview of Syllabus and Class Policies

• Prerequisites:
  ▪ CSCI 262 (Data Structure)
    • Knowledge of fundamental concepts of computer science (e.g., data structures) and experience of programming in C++ or Python in Linux is necessary
  ▪ MATH 201 (Probability and Statistics)
    • Mathematical maturity is also needed to understand computational models

The instructor will not teach programming and will assume sufficient math knowledge
Overview of Syllabus and Class Policies

• Required Textbook:
  ▪ None
    • HCR is a new field in robotics
  ▪ The course is project-based and research-oriented
    • Based on cutting-edge concepts and techniques
    • Focusing at the system level
  ▪ Many texts, pictures, and slides we use in the lecture are grabbed from online resources
Overview of Syllabus and Class Policies

• Schedule and Assignments
  - Everything will be on the course website
    http://inside.mines.edu/~hzhang/Courses/CSCI473-573/
    Or just search “CSCI 473/573 Mines”
  - If you miss a lecture, it will be your responsibility to check the course website
    (make sure you refresh the webpages)
Overview of Syllabus and Class Policies

• Class Communication
  ▪ Assignments will be submitted to Blackboard.
  ▪ Grades will be available in Blackboard
  ▪ If you need to chat with the instructor,
    ▪ Stop by my office during office hours
      3:30 – 5:30 PM Tuesdays
    ▪ Send me an email.
Overview of Syllabus and Class Policies

• Evaluation
  ▪ Grading will be based 100% on projects
  ▪ Decisions on borderline grades will be based upon class attendance and participation
  ▪ Students in CSCI 473 will be given the same projects, as those taking CSCI 573
  • The quality and/or quantity of the work expected is higher for CSCI 573 than for CSCI 473

Final grades will be determined by overall average

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>A</td>
<td>90 – 100</td>
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<tr>
<td>B+</td>
<td>85 – 89.9</td>
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<td>B</td>
<td>80 – 84.9</td>
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<td>C+</td>
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<tr>
<td>F</td>
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</table>
Overview of Syllabus and Class Policies

• Class Attendance will be taken
  • If you have a good reason to miss class (e.g., sickness, conference travel, job interview), then it is not a problem
  • If you think you have a contagious illness, please don’t come to class. The instructor will help keep you posted on class activities
  • In any case, it is your responsibility to catch up (or keep up) with all course material and announcements covered in class
• Please participate in class discussions!!!
Overview of Syllabus and Class Policies

- **Project Assignments**
  - Projects write-ups will be posted on the course website, along with the due dates.
  - Most projects will involve programming; using C++ or Python is required.
  - Any assignments turned in more than five (5) minutes past the due date/time will receive a grade of zero.
Overview of Syllabus and Class Policies

• Exams: There will be no exams!
• Grading corrections
  • Bring any assignment grading correction requests to the instructor within 1 week of receiving the grade, or before the end of the semester, whichever comes first
  • After that, your grade will not be adjusted.
  • If you find any mistake in grading, please let the instructor know. Your grade will not be lowered.
Overview of Syllabus and Class Policies

• Using computers/phones in class
  ▪ Please be respectful of your colleagues in class, by turning off your phones and using your computers only for taking notes or keeping up with the material covered in class.
  ▪ Checking your email, working on other non-class related materials, web-surfing, etc., are not appropriate activities for class time
Overview of Syllabus and Class Policies

• Collaboration Policy
  ▪ Discussing ideas is encouraged
  ▪ Reading through the Student Honor Code and the policy existing for all CS courses in the Division of Computer Science

  ▪ Cheating will be dealt with harshly!
Before we start, I want to know what comes into your mind when you see the course title for the first time?
Time for Snapshots: Smile!!!

• Purpose: Help the instructor to remember all of you

• Procedures
  • Write down your preferred name on a write paper, bold and clear.
  • Take a snapshot with your name card
  • Take a snapshot without your name card
Modern, Traditional Robotics
BMW F30 Series Production Process

BMW F30 3-Series Production
Presented by European Auto Source
What is a ROBOT?

What image comes into your mind when you think of a robot?
Some images of robots
Applications of Robotics

- Undersea (Oberon)
- Distance driving (Stanley)
- Military (Packbot)
Applications of Robotics

- Lawn Care (Cyber Blue)
- Power Line Inspection (WireMonkey)
- Pipe inspection
What is a ROBOT?

Which of these are required characteristics of a robot?

1. Ability to move – legs, wheels, fly, burrow, swim, orbit
2. Ability to sense – eyes, ears, other inputs
3. Ability to manipulate – arms, hands, fingers
4. Ability to mimic – appearance, human tasks
5. Ability to communicate – expressions, sounds, voice, digital, analog
6. Ability to think – mechanical brain, computer, self-awareness
7. Ability to operate – remotely, semi-autonomously
8. Ability to react and respond to different situations
9. Ability to do something useful
What is a ROBOT?

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5. Ability to communicate –expressions, sounds, voice, digital, analog
6. Ability to think –mechanical brain, computer, self-awareness
7. Ability to operate –remotely, semi-autonomously
8. Ability to react and respond to different situations
9. Ability to do something useful

Can a software program be considered a robot?
- Is Siri a robot?

How about a mobile sensor?
What is a ROBOT?

Required characteristics of robots

Yes  Ability to move – legs, wheels, fly, burrow, swim, orbit
Yes  Ability to sense – eyes, ears, other inputs
Yes  Ability to manipulate – arms, hands, fingers
4. Ability to mimic – appearance, human tasks
5. Ability to communicate – expressions, sounds, voice, digital, analog
Yes  Ability to think – mechanical brain, computer, self-awareness
7. Ability to operate – remotely, semi-autonomously
Usually Ability to react and respond to different situations
9. Ability to do something useful
There is no widely accepted definition of what a ROBOT is.

And… Robots are evolving!
History of Robotics
What is a ROBOT?

• Current common notion of robot:
  - Programmable (software components)
  - Mechanically/physically capable
  - Flexible

• Our working definition of robot:

  Physical agent that generates “intelligent” connection between perception and action

That is, a system or machine which exists in the physical world, can sense its environment, reason about the information, and act on it to achieve goals
Other Definitions

• A robot a programmable mechanical device that can exert forces (MIT).

• A robot is a reprogrammable, multifunctional, manipulator designed to move material, parts, or specialized devices through variable programmed motions for the performance.

• An intelligent robot a machine able to extract information from its environment and use knowledge about its world to act safely in a meaningful and purposeful manner (Ron Arkin, 1998).

• Robotics is the intelligent connection of perception to action (M. Brady, 1985).

Our working definition in the lecture is based on the last one.
Human-Centered Robotics

'Lunch atop a Skyscraper (New York Construction Workers Lunching on a Crossbeam)' [1932] - Charles C. Ebbets
Human-Centered Robotics

Illustration by Andrew Rae
Human-Centered Robotics
Human-Centered Robotics

The use of robotic systems in human-social environments to help people live safer, easier and more independent lives.
What is a Human-Centered Robot?

Robots that can coexist with humans.
What is a Human-Centered Robot?

Robots that can coexist with humans

- **Yes**  
  Ability to move – legs, wheels, fly, burrow, swim, orbit
- **Yes**  
  Ability to sense – eyes, ears, other inputs
- **Yes**  
  Ability to manipulate – arms, hands, fingers
  4. **Yes**  
  Ability to mimic – appearance, human tasks
  5. **Yes**  
  Ability to communicate – expressions, sounds, voice, digital, analog
- **Yes**  
  Ability to think – mechanical brain, computer, self-awareness
  7. **Usually**  
  Ability to operate – remotely, semi-autonomously
- **Usually**  
  Ability to react and respond to different situations
  9. **Yes**  
  Ability to do something useful
What is a Human-Centered Robot?

Robots that can coexist with humans

- Ability to move – legs, wheels, fly, burrow, swim, orbit
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- Ability to mimic – appearance, human tasks
- Ability to communicate – expressions, sounds, voice, digital, analog
- Ability to think – mechanical brain, computer, self-awareness
- Ability to operate – remotely, semi-autonomously
- Ability to react and respond to different situations (humans & env.)
- Ability to do something useful (to be assistive)
What is a Human-Centered Robot?

Robots that can coexist with humans

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Additional characteristics?
What is a Human-Centered Robot?

Robots that can coexist with humans

Yes Ability to move – legs, wheels, fly, burrow, swim, orbit

Yes Ability to sense – eyes, ears, other inputs

Yes Ability to manipulate – arms, hands, fingers

4. Ability to mimic – appearance, human tasks

Yes Ability to communicate – expressions, sounds, voice, digital, analog

Yes Ability to think – mechanical brain, computer, self-awareness

7. Ability to operate – remotely, semi-autonomously

Yes Ability to react and respond to different situations (humans & env.)

Yes Ability to do something useful (to be assistive)

Human factors: Safety, Privacy, Satisfaction, etc.
Human-Centered Robotics

Robots that can coexist with humans

The use of robotic systems in human-social environments to help people live safer, easier and more independent lives.

Not necessary to have direct interaction with people, but necessary to coexist within a shared environment.
Applications of HCR: Security

https://www.youtube.com/watch?v=-TsgEKdGCdU
Applications of HCR: Elderly Care

https://www.youtube.com/watch?v=Z1MJPdhniXc
Applications of HCR: Daily Assistance

https://www.youtube.com/watch?v=--wEgmNzs0w
Applications of HCR: Children Education

Autism Spectrum Disorder

https://www.youtube.com/watch?v=7T7clY-Mlxc
Applications of HCR: many others!!!

Search and Rescue

Entertainment
Challenges of Robotics

None of the following is easy for a robot!

- **Yes** Ability to move – legs, wheels, fly, burrow, swim, orbit
- **Yes** Ability to sense – eyes, ears, other inputs
- **Yes** Ability to manipulate – arms, hands, fingers
- **Yes** Ability to mimic – appearance, human tasks
- **Yes** Ability to communicate – expressions, sounds, voice, digital, analog
- **Yes** Ability to think – mechanical brain, computer, self-awareness
- **Usually** Ability to operate – remotely, program control, autonomously
- **Ability to react and respond to different situations**
- **Ability to do something useful**
Challenges of HCR

Additional Challenges for HCR

- **Yes**  Ability to move – legs, wheels, fly, burrow, swim, orbit
- **Yes**  Ability to sense – eyes, ears, other inputs *(Extremely hard to sense people!)*
- **Yes**  Ability to manipulate – arms, hands, fingers
  4. **—** Ability to mimic – appearance, human tasks
- **Yes**  Ability to communicate – expressions, sounds, voice, digital, analog
- **Yes**  Ability to think – mechanical brain, computer, self-awareness
  7. **—** Ability to operate – remotely, program control, autonomously
- **Yes**  Ability to react and respond to different situations *(humans & env.)*
- **Yes**  Ability to do something useful *(to be assistive)*
Additional Challenges for HCR

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1. Ability to move – legs, wheels, fly, burrow, swim, orbit
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8. Ability to react and respond to different situations *(humans & env.)*
9. Ability to do something useful *(to be assistive)*

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Difficult to evaluate HCR performance: A working system is generally not enough; human satisfaction is also essential.

**Robot ethics and human factors!!!**
Challenging?
Challenges of HCR

Same lady?
Challenges of HCR

Locate her on New York street?
Challenges of HCR

How to make a sequence of movements?
Challenges of HCR

How can a robot navigate in this environment?
Challenges of HCR

What should a self-driving car do?
Challenges of HCR

What should a self-driving car do?
Challenges of HCR

What should a self-driving car do?
Course Objectives

• Get my students motivated!!!
• Introduce my students the state-of-the-art systems and research on human-centered robotics
• Teach my students practical techniques that are essential to build human-centered robots
• Help my students construct a working human-centered robotic system or intelligent machine
• Improve my students’ other skills, including paper writing, presentation, and team-working
Topics we’ll Cover

• 3D robotic perception
• Human representation
• Robot reasoning
• Human-robot interaction
• Several special topics:
  • DARPA challenge
  • Cloud robotics
  • Robot ethics
  • Others
Related CS courses

• Computer Vision (versus Robot Perception)
• Machine Learning (versus Robot Learning)
• Artificial Intelligence (versus Robot Reasoning)

Related to other disciplines

• Mechanical engineering (e.g., actuator, effector)
• Electrical engineering (e.g., control)

We will focus on the Computer Science aspects of Robotics
Real-Life Transformer Robot