Introduction to Robotics

CSCI/ATRI 4530/6530

Dr. Ramviyas Nattanmai Parasuraman

Assistant Professor, Computer Science
University of Georgia

email: ramviyas@uga.edu
web: http://cs.uga.edu/~ramviyas/

Department of Computer Science
Franklin College of Arts and Sciences
UNIVERSITY OF GEORGIA

Table of contents

What is this course?

Course Syllabus

We will broadly cover the following topics:

- Overview of Robotics

Course Syllabus

We will broadly cover the following topics:

- Overview of Robotics
- Sensing and Perception

Course Syllabus

We will broadly cover the following topics:

- Overview of Robotics
- Sensing and Perception
- Locomotion of a robot

Course Syllabus

We will broadly cover the following topics:

- Overview of Robotics
- Sensing and Perception
- Locomotion of a robot
- Localization

Course Syllabus

We will broadly cover the following topics:

- Overview of Robotics
- Sensing and Perception
- Locomotion of a robot
- Localization
- Mapping

Course Syllabus

We will broadly cover the following topics:

- Overview of Robotics
- Sensing and Perception
- Locomotion of a robot
- Localization
- Mapping
- Applications - through the project assignments

Course Syllabus

Overview of Robotics

- Introduction: history, state-of-the-art, and future
- Robot hardware: sensors and actuators
- Robotic software architectures
- Probability theory
- Field applications

Course Syllabus

Sensing and Perception

- Range Finders: Beam models, Likelihood fields
- Cameras: Feature-based measurement models

Course Syllabus

Robot locomotion

- Kinematics
- Velocity motion model
- Odometry motion model
- Motion and maps

Course Syllabus

Localization

- State estimation under uncertainty
- Filters: Bayes, Kalman, extended Kalman, and Monte Carlo
- Taxonomy of localization problems
- Markov localization
- Extended Kalman filter localization
- Grid localization
- Monte Carlo localization

Course Syllabus

Mapping

- Occupancy grid mapping
- Learning inverse measurement model
- Simultaneous localization and mapping (SLAM)
- SLAM with extended Kalman filter
- Particle filter based localization and mapping

Course textbook

Textbook

Introduction to Autonomous Mobile Robots, 2nd Edition (2011), MIT Press. ISBN: 9780262015356

Roland Siegwart, Illah Reza Nourbakhsh, and Davide Scaramuzza

Recommended additional book(s)

Probabilistic Robotics (2005). Sebastian Thrun, Wolfram Burgard and Dieter Fox, MIT Press. ISBN: 9780262201629

Learning ROS for Robotics Programming. E. Fernandez, L.S. Crespo and A. Mahtani, 2nd Edition

Course materials - available online

Online lecture notes from Prof. Siegwart

`http://www.asl.ethz.ch/education/lectures/autonomous_mobile_robots/spring-2018.html`

Online MOOC course

EdX - Autonomous Mobile Robots (AMRx)

`https://www.edx.org/course/autonomous-mobile-robots`

I will use the slides from this online course in our class

Course format

Lectures + Practicum + Assignments

Lectures - theory and basics (will upload all lecture slides and additional materials in eLC after every class)

Practicum - **Robot Operating Systems (ROS)** - programming (C++/Python)

Evaluation:

- Assignments (45%) - both theoretical and practical exercises
- Exams - one midterm (20%) and one final (30%)
- Attendance and participation in class (5%)

Undergraduate and graduate students will be assessed separately. Final letter grade will depend on class standing.

Academic integrity and honesty - strictly enforced

Who is your teacher?

Your Teacher - Short Bio

Experience

- Research Associate - Purdue University
- Researcher - KTH Royal Institute of Technology, Sweden
- Marie-Curie Fellow - CERN European Organization for Nuclear Research, Switzerland
- Software Developer - Oracle Corp., India

Academic preparation

- Ph.D. - Technical University of Madrid, Spain
- M.Tech - Indian Institute of Technology Delhi, India

For more information on my research and interests, please visit
`http://cs.uga.edu/~ramviyas`

Office hours

Tuesday and Thursday 2 - 3 pm (no need to email me before)

OR by prior email appointment

Email: ramviyas@uga.edu

Office: 519 Boyd GSRC

Expectations

Expectations from teacher

- Be attentive and actively participate in class
- Be honest with he assignments and exams
- Meet the deadlines
- Ask questions (no question is silly to me)
- Learn from you!

Expectations from students

- Take into account each student's background
- Easy to follow lectures
- Assignments with reasonable difficulty
- Learn something useful from the course!

Lecture for today

Introduction to Mobile Robots

- What is a robot?

Introduction to Mobile Robots

- What is a robot?
- Dictionary definition - A robot is a machine capable of carrying out a ~~complex~~ series of actions automatically, especially one programmable by a computer.

Introduction to Mobile Robots

- What is a robot?
- Dictionary definition - A robot is a machine capable of carrying out a ~~complex~~ series of actions automatically, especially one programmable by a computer.
- What are the components for a robot?

Introduction to Mobile Robots

- What is a robot?
- Dictionary definition - A robot is a machine capable of carrying out a ~~complex~~ series of actions automatically, especially one programmable by a computer.
- What are the components for a robot?
- Sensors - vision (RGB-D cameras, IR), GPS, Inertial Measurement Unit (IMU), Laser range finders, ultrasonic scanners, microphones, and other application dependent sensors such as radiation probes, thermal cameras, etc.

Introduction to Mobile Robots

- What is a robot?
- Dictionary definition - A robot is a machine capable of carrying out a ~~complex~~ series of actions automatically, especially one programmable by a computer.
- What are the components for a robot?
- Sensors - vision (RGB-D cameras, IR), GPS, Inertial Measurement Unit (IMU), Laser range finders, ultrasonic scanners, microphones, and other application dependent sensors such as radiation probes, thermal cameras, etc.
- Actuators - motors for base locomotion, robot arm for manipulation, etc. along with their hardware controllers/drivers.

Introduction to Mobile Robots

- What is a robot?
- Dictionary definition - A robot is a machine capable of carrying out a ~~complex~~ series of actions automatically, especially one programmable by a computer.
- What are the components for a robot?
- Sensors - vision (RGB-D cameras, IR), GPS, Inertial Measurement Unit (IMU), Laser range finders, ultrasonic scanners, microphones, and other application dependent sensors such as radiation probes, thermal cameras, etc.
- Actuators - motors for base locomotion, robot arm for manipulation, etc. along with their hardware controllers/drivers.
- Communication - wireless devices Wi-Fi, Zigbee, Bluetooth, LTE/4G, etc.

Introduction to Mobile Robots

- What is a robot?
- Dictionary definition - A robot is a machine capable of carrying out a ~~complex~~ series of actions automatically, especially one programmable by a computer.
- What are the components for a robot?
- Sensors - vision (RGB-D cameras, IR), GPS, Inertial Measurement Unit (IMU), Laser range finders, ultrasonic scanners, microphones, and other application dependent sensors such as radiation probes, thermal cameras, etc.
- Actuators - motors for base locomotion, robot arm for manipulation, etc. along with their hardware controllers/drivers.
- Communication - wireless devices Wi-Fi, Zigbee, Bluetooth, LTE/4G, etc.
- Battery and power management boards

See the attached slides from EdX.