Course Content

The course covers fundamental problems of autonomous mobile robotics including locomotion, reception, localization, planning, and navigation. In the context of locomotion, legged, wheeled, flying and swimming mobile robots will be discussed. In the reception part, various sensors that are used on mobile robots will be introduced and several sensor fusion algorithms will be presented. Localization problems will be tackled in a probabilistic framework using Markov and Kalman Filtering techniques. Simultaneous Localization and Mapping (SLAM) problem and its variations will also be introduced and discussed. Finally planning and navigation strategies will be covered.

Objectives

To teach fundamentals of autonomous mobile robotics that include locomotion, perception, localization, mapping, planning and navigation of mobile robots so that students can acquire a solid theoretical background and hands-on experience in mobile robotics.
**Recommend or Required Reading**

**Textbook**


**Readings**


**Assessment Methods and Criteria**

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<th>Percentage(%)</th>
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<tr>
<td>Quiz</td>
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**Course Outline**

Mobile robots are becoming increasingly important in many real-world applications. This course covers the fundamentals of mobile robotics including robot locomotion, motion control, perception, localization and mapping, planning, and navigation. The course will also provide hands-on experience through the lab sessions where students will conduct several experiments on Lego Mindstorms EV3 robotic platforms.
Topics to be covered:

- Introduction and Overview of the Course
- Robot Locomotion: Legged Robots, Wheeled Robots and Flying Robots
- Mobile Robot Kinematics: Kinematic Models and Constraints
- Motion Control: Positioning and trajectory tracking tasks for a differential drive robot and a quadrotor-type helicopter
- Perception: Sensors, Uncertainty Representation, Vision, Feature Extraction
- Localization and Mapping: Probabilistic Map-Based Localization (Markov and Kalman filter localizations), SLAM Problem, Visual SLAM
- Planning and Navigation: Motion Planning, Navigation Strategies

**Learning Outcomes**

After taking this course, students should be able to:

- evaluate various locomotion mechanisms including legged, wheeled, and flying locomotions.
- analyze motion kinematics of non-holonomic wheeled mobile robots
- quantify mobility and maneuverability of wheeled robots
- design feedback controllers for motion control of the wheeled mobile robots
- select appropriate sensors for perception including non-visual and visual sensors
- implement localization algorithms using Markov and Kalman filters
- implement simple SLAM algorithms using Extended Kalman filter (EKF)
- synthesize optimal paths using artificial potential functions
- demonstrate hands-on experience with Lego Mindstorm EV3 robots

**Course Policies**

- This is a physical-only course.
- Attendance to a minimum of 70% of lectures is required to be admitted to the final exam.
- More than 70% attendance earns participation points.
- Make-up will be given only for official excuses.