ABET COURSE SYLLABUS

Course Number And Title: ECE 4340 Building Intelligent Robots	**Credit Hours:** 4
Required Or Elective: Elective	**Prerequisites:** ECE 2210, CS 2050

Textbooks And Required Materials: Introduction to Autonomous Mobile Robots, R. Siegwart, I.R. Nourbakhsh, MIT Press, 2004

Catalog Course Description: Covers the design and development of intelligent machines, emphasizing topics related to sensor-based control of mobile robots. Includes mechanics and motor control, sensor characterization, reactive behaviors and control architectures.

Class Meeting Frequency and Duration: Three 50 minute lecture sessions plus a 2-hour lab per week

Course Learning Objectives:

1. Explain the outside influences on the field of robotics and the effect developing robots has had on related disciplines.
2. Given a design and environmental context for one of Braitenberg's vehicles, draw a diagram of its motion and explain the trajectory.
3. Explain the relationship between motor torque and motor velocity, voltage, current, and gear ratio.
4. With your lab partner, use the torque relationships to design and build a small mobile robot with wheel encoders.
5. Discuss the advantages and disadvantages of the common wheel configurations for mobile robots.
6. Given the parameters and starting position for a mobile robot, compute the new position using the kinematic equations.
7. Derive the kinematic equations for your team robot. Demonstrate the implementation of the kinematics by controlling the robot in a specified trajectory pattern.
8. Describe common sensor components used in mobile robots, including the type of information returned, appropriate use of the sensor, potential problems related to sensor noise and uncertainty.
9. Characterize a specified sensor empirically by plotting the returned signal vs. a meaningful information metric. Derive an equation to express the relationship.
10. Design and implement a sensor suite for a mobile robot application, given a rough specification of number and types of sensors.
11. Calibrate the CMU camera for use on a small mobile robot and use it for color tracking. Describe the calibration process used and the parameters derived.
12. Discuss the influence of observed animal behaviors on control strategies for mobile robots. Explain the terms reflexes, taxes, fixed-action patterns, schema, affordance, and innate releasing mechanism.
13. Given an obstacle avoidance strategy and environmental context, compute the robot trajectory and draw a diagram illustrating its motion.
14. Discuss the advantages and disadvantages of the hierarchical, reactive, and hybrid robot control paradigms. Given a sample control architecture, explain which paradigm it uses and why.
15. Given an application, choose an appropriate control paradigm; design a robot sensor suite and control architecture.
16. Discuss the advantages and disadvantages of using global localization vs. local sensing for navigation.
17. With your lab partner, design and demonstrate an integrated robot, incorporating motors, sensors, and robot behaviors, including obstacle avoidance. Explain and document the design of the mobile base, control strategy, architecture, and results.
18. Demonstrate the ability to write technical reports
19. Demonstrate the ability to verbally present and defend the team design in front of a group of peers.

Course Topics:

1. History of robotics
2. Braitenberg vehicles
3. Locomotion basics for mobile robots; motors, wheels, gears, encoders, legs
4. Wheel configurations of mobile robots: differential drive, tricycle, ackerman, synchro, omnidirectional, tracked robots, walking wheels
5. Kinematics of wheeled mobile robots: differential drive, omnidirectional, tricycle; holonomic robots
6. Sensor types, characterization and sensory perception: IR, sonar, tactile, laser, compass, GPS, vision, color tracking
7. Programming in IC
8. Biological foundations
9. Robot control paradigms: hierarchical, reactive, hybrid
10. Obstacle avoidance techniques: reactive, bug algorithms, potential field, vector field histogram
11. Navigation methods: localization vs. local sensing
12. Robot control architectures: subsumption, AuRA, SFX,3T, Saphira, WAX

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