מכון טכנולוגי חולון
Holon Institute of Technology

Department of Computer Science **המחלקה למדעי המחשב**

Software Development for an Intelligent Autonomous Vehicle

Teaching method: Lecture & Laboratory
Weekly hours: Lecture - 3h, Laboratory - 1h, Total - 4h
Credit points: 3.5
Prerequisites: Data Structures (61104); Object Oriented Programming (61307)
Note: preferably with knowledge of operating systems

General: This course will teach students concepts and principles of Autonomous vehicles and Artificial Intelligence and their application in computer science by using simulation on **RViz** (ROS 3D Robot Visualizer) environment (or 3D Gazebo simulator for use in ROS) and real – world examples with the **Hamster** robot.

The purpose of this course: students will learn the basic conceptual understanding of Intelligent Autonomous Robots, modern robot control systems and machine learning systems using object-oriented programming (C++ & Python) and open source tools (ROS & TensorFlow).

Main theoretical subjects:

1. Structure and principle operation of an Intelligent Autonomous Vehicle (mechanical, electrical, motion control)
2. Algorithms and methods for Intelligent Autonomous Robotics programming in various Navigation tasks (obstacle avoidance, mapping, localization, path planning)
3. Kinematic principles of robot movement (Direct and Reverse, Steering)
4. Intelligent Autonomous Robotics - degrees of freedom, sensors and actuators types, including Image processing
5. Off-Line programming of a robot (in Simulation)
6. Machine learning for real- time object detection

Main practical subjects:

1. Implementation principles of computer science to practical On-Line programming exercises of the Hamster robot:
2. Implementation of principles in a number of programming tools:
   a. ROS, Linux, TensorFlow
   b. C ++ & Python languages

Score components:

Current tasks and submitting mini project (intermediate project): 50%
Final project with protection: 50%

Note: Mandatory attendance at lessons and practice

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Topics taught to students (by weeks):

Laboratories and projects	Lecture topics	Week No.
Course overview ➢ Fundamentals of Robotics ➢ **Weight:** 5% of the final Score	Introduction to Robotics •	1
Laboratory No. 1: Control types ➢ Agent based modelling ➢ Theoretical paradigms ➢ Sensing ➢ **Weight:** 15% of the final Score	Architecture • Sensors •	2-4
Laboratory No. 2: Basic OpenCV for robotics ➢ Occupancy Grid Maps ➢ Steering and Maneuverability ➢ **Weight:** 15% of the final Score	Maps • Control •	5-7
Laboratory No. 3: Obstacle avoidance, detection & tracking ➢ Applied Neural Networks (Movidius) ➢ Plan - based execution ➢ **Weight:** 15% of the final Score	Decision Making • Introduction to perception in robotics •	8-10

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Laboratory No.4: Final Project Mapping & SLAM ➢ Kalman Filters ➢ Particle Filter ➢ **Weight:** 50% of the final Score	Navigation • Localization •	11-13

Score components:

The final grade will be determined according to the following criteria:

Course requirements	How to fulfill the requirements	The weight of score
Current tasks - laboratory exercises and Intermediate projects (mini-projects)	Submission of exercises during the semester and of an intermediate projects (mini-project)	50 %
Final Project	Submission of the final project with its protection	50 %

Mandatory Literature:

1. An introduction to robotics, Dr. N. Shvalb, Ariel University Press, 2009
2. Introduction to algorithms, Corman, Lyserson, Rivest Clifford Stein, Third Edition, 2010

Optional Literature:

1. ROS tutorials http://wiki.ros.org/
2. https://www.youtube.com/watch?v=aircAruvnKk
3. https://www.pyimagesearch.com/
4. “Building Machines That Learn and Think Like People” (Tenenbaum) https://arxiv.org/pdf/1604.00289.pdf