Subject Description Form

Subject Code	ME41006
Subject Title	Perceptual Robotics
Credit Value	3
Level	4
Pre-requisite/ Co-requisite/ Exclusion	Pre-requisite: ME31002 Linear Systems and Control
Objectives	The subject aims to equip students with knowledge of: 1. Artificial robot perception 2. Perception-guided control 3. Adaptive robot behaviour 4. Perception-aided algorithms
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a) Able to mathematically model the different perceptual modalities used for robotic systems; b) Able to design perception-guided motion controls for mechanical robots c) Able to use perceptual feedback to implement adaptive robot behaviours d) Able to design perception-aided methods for learning properties about the environment e) Able to conduct experiments with perceptual and robotic systems
Subject Synopsis/ Indicative Syllabus	**Artificial robot perception.** Vision sensors (monocular perception and RGB-D sensors), thermal imaging (models and principles), touch (force and tactile imaging), proximity (different ranging methodologies), audio sensing. **Perception-guided control.** Sensor-motion coordination problem, derivation of sensorimotor models (analytical and computational), formulation of sensor servoing controls (vision-based, thermal-based, touch-based, proximity-based). **Adaptive robot behaviour.** Braitenberg machines, reactive motion paradigms (potential fields, subsumption architecture, etc.), hybrid paradigms, multi-agent systems, robot babbling, bug algorithms, sensor-based navigation. **Perception-aided algorithms.** Iterative closest point (ICP), simultaneous localisation and mapping (SLAM), sensor-based model learning, and image registration. **Practical work.** A robotic platform is assigned to a team of 2-3 students. Each chapter is delivered with a hands-on experimental session where students reinforce their knowledge in the subject.

Teaching/Learning Methodology

1. Lectures aim at providing students with fundamental knowledge required for understanding and analysing different perceptual robotic systems, including its mathematical models, controller design, and algorithms. (Outcomes a to d)
2. Tutorials aim at enhancing students' analytical and problem solving skills on robotics. Students will be able to solve real-world problems using the knowledge they acquired in the class. (Outcomes a to d)
3. The experiments/project aim to provide hands-on experience for developing perceptual robots, and reinforcing the acquired knowledge. (Outcomes a to e)

Teaching/Learning Methodology	Intended Subject Learning Outcomes to be assessed				
	a	b	c	d	e
1. Lecture	√	√	√	√	
2. Tutorial	√	√	√	√	
3. Experiments/Project	√	√	√	√	√

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)				
		a	b	c	d	e
1. Class test	10%	√	√	√	√	√
2. Coursework: includes assignments, project, experiments, lab report	40%	√	√	√	√	√
3. Final Examination	50%	√	√	√	√	
Total	100 %					

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Overall Assessment:

0.50 x End of Subject Examination + 0.50 x Continuous Assessment.

1. The continuous assessment aims at evaluating the progress of the students' study, assisting them in self-monitoring the respective learning outcomes, and applying the knowledge learnt in practical situations.
2. The examination is used to assess the knowledge acquired by the students for understanding and analysing the problems critically and independently; as well as to determine the degree of achieving the subject learning outcomes.

Student Study Effort Expected

Class contact:	
▪ Lectures	33 Hrs.
▪ Tutorials / Laboratory	6 Hrs.
Other student study effort:	

	▪ Course work	40 Hrs.
	▪ Self-learning	36 Hrs.
	Total student study effort	115 Hrs.
Reading List and References	1. Lecture Notes, Articles, and Handouts 2. Computer Vision: A Modern Approach, David A. Forsyth and Jean Ponce, latest edition. 3. Introduction to AI Robotics, Robin Murphy, MIT Press Cambridge, MA, USA, latest edition. 4. Principles of Robot Motion: Theory, Algorithms, and Implementations, Howie Choset et al, MIT, latest edition. 5. Vehicles: Experiments in Synthetic Psychology, Valentino Braitenberg, MIT Press Ltd, latest edition. 6. Robotics Modelling, Planning and Control, Bruno Siciliano at al, latest edition.	

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