Embedded Perception Systems

Inbyggda perceptionssystem
6 credits

Programme course

TSBB18

Valid from: 2025 Spring semester

Determined by	**Main field of study**	
Board of Studies for Industrial Engineering and Logistics	Computer Science and Engineering	
Date determined	**Course level**	**Progressive specialisation**
2024-08-28	First cycle	G2F
Revised by	**Disciplinary domain**	
	Technology	
Revision date	**Subject group**	
	Computer Technology	
Offered first time	**Offered for the last time**	
Spring semester 2019		
Department	**Replaced by**	
Institutionen för systemteknik		

Course offered for

- Master of Science in Industrial Engineering and Management - International
- Master of Science in Industrial Engineering and Management
- Master's Programme in Data Science and Information Engineering

Prerequisites

Programming, Signals and Systems, Digital Circuits, Computer Systems.

Intended learning outcomes

After the course, the student is able to:

Goal 1: Implement a lego sorting robot based on resource constrained hard- and software.

Goal 2: Be able to explain and solve central problems in robotics, such as camera calibration, hand-eye-calibration, and forward and inverse kinematics.

Goal 3: Apply basic operations on images and video, such as reading, thresholding, and morphological operations.

Goal 4: Apply and explain important themes in prototype development, such as virtual environments and digital twins.

Course content

The course introduces automatic image processing, sensor calibration and inverse kinematics for robot control.

In a design and development project, consisting of 3 sub-projects, each group of 2-3 students will implement an automatic sorting robot. This will be done with the help of a Raspberry Pi, a camera, an Arduino and a robotic arm with grip claw. The camera is used to provide digital images of a number of lego pieces. These should be detected and their respective positions shall be related to the coordinate system of the robot, which picks up and sorts them by color. In the three sub-projects, the overall system is gradually built up. How these sub-assignments are solved is up to the students and the training in independent problem solving is a central sub-objective of the course.

Teaching and working methods

The working method of the course is very much related to prototype development where the students, from a concrete problem formulation, build a system that solves the problem with the help of available components and their documentation. The course has a somewhat PBL (problem-based learning) style, where students are expected to encounter sub-problems where they need to acquire new knowledge in order to solve the problem.

The students have support in the form of expert supervisors, who are available to discuss problems and recommend study material. The course starts with a lecture that introduces course objectives and working methods and gives an introduction to the area of computer vision with a focus on digital images, the imaging forming process for real cameras, image processing, homographies, hand-eye calibration and the open source libraries that are popular for image processing. The second lecture introduces inverse kinematics and how this problem can be solved. Furthermore, subject relevant seminars on e.g. system building, Linux and numerical optimisation can be held on demand.

Examination

PRA2	Projects	6 credits	U, G

Each subproject is examined in the form of a common demonstration that shows that the subproject is solved. This tests the "implement" part of goal 1, the "solve" part of goal 2, and the "apply" parts in goals 3-4. Each student must be able to explain each part of each subproject, which is tested through questions during the demonstrations. These questions, together with a brief (maximum one A4-page) summary of subprojects two and three, test the "explain" part of goals 2 and 4.

Grades for examination modules are decided in accordance with the assessment criteria presented at the start of the course.

Grades

Two-grade scale, U, G

Other information

Supplementary courses:

TSEA56 Electronics Engineering – Bachelor Project
TSBB09 Image Sensors,
TSBB08 Digital Image Processing,
TSBB15 Computer Vision,
TSRT08 Optimal Control,
TSBK07 Computer Graphics

About teaching and examination language

The teaching language is presented in the Overview tab for each course. The examination language relates to the teaching language as follows:

- If teaching language is “Swedish”, the course as a whole could be given in Swedish, or partly in English. Examination language is Swedish, but parts of the examination can be in English.
- If teaching language is “English”, the course as a whole is taught in English. Examination language is English.
- If teaching language is “Swedish/English”, the course as a whole will be taught in English if students without prior knowledge of the Swedish language participate. Examination language is Swedish or English depending on teaching language.

Other

The course is conducted in such a way that there are equal opportunities with regard to sex, transgender identity or expression, ethnicity, religion or other belief, disability, sexual orientation and age.

The planning and implementation of a course should correspond to the course syllabus. The course evaluation should therefore be conducted with the course syllabus as a starting point.

The course is campus-based at the location specified for the course, unless otherwise stated under “Teaching and working methods”. Please note, in a campus-based course occasional remote sessions could be included.