POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Embedded systems and edge computing [S2AiR2-RiSA>PO3-SW]

Course

Field of study
Automatic Control and Robotics

Year/Semester
2/3

Area of study (specialization)
Autonomous Robots and Systems

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
15

Laboratory classes
30

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

dr inż. Michał Fularz
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Lecturers

Prerequisites

Knowledge: The student should have general, undergraduate-level knowledge of mathematics - algebra, mathematical analysis, logic, and probabilistic. Furthermore, the student should have an understanding of image processing algorithms, machine learning, and deep learning methods, alongside knowledge about data representations in computer systems. Skills: The student should be able to efficiently use the personal computer and be capable of implementing algorithms and programming assignments, in particular, in the area of image processing and deep learning. Moreover, skills in problem-solving and knowledge acquisition from indicated sources are also essential.

Course objective

The objective of this course is to develop knowledge about the architecture of and methods for embedded systems used for doing computations on the edge (edge computing). In particular, this relates to image processing and deep learning algorithms on devices with limited computation capabilities..

Course-related learning outcomes

Knowledge:
The student who ends the course gains knowledge about embedded devices' architectures and methods

for edge computing in the area of control and robotics. The student will have theoretical knowledge about methods of optimizing algorithms, quantization of deep learning model weights, and choosing an appropriate model and layers. The student will also properly select the type and class of edge device for a given task.

Skills:
At the end of the course the student has practical skills related to the utilization embedded devices for edge computing, in particular in neural network inferencing in applications of automatic control and robotics. Moreover, the student will be able to put into practice topics such as weight quantization, model optimization, and neural network deployment on edge devices. Furthermore, the skills like information searching in product specification and solving mathematical, algorithmics, or programming assignments should be also developed.

Social competences:
The student understands the need and knows the possibilities of continuous education - improving professional, personal and social competences, can inspire and organize the learning process of others. The student is aware of the responsibility for his/her own work and is ready to comply with the rules of teamwork

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
•Lecture - final credit test carried out on eKursy platform.
•Laboratories - practical project at the end of semester.

Programme content

1. Computational complexity - how to measure.
2. Algorithms optimization methods.
3. Embedded systems architectures.
4. Edge computing - pros, cons, and challenges.
5. Methods of developing software for edge devices - remote access.
6. Deep learning computational complexity, choosing an appropriate model and layers. Quantization.
7. TinyML introduction - deep learning on microcontrollers.

Course topics

none

Teaching methods

•Lectures with multimedia presentations and samples of code real-time usage of software tools usful for working with embedded devices and edge computing.
•Laboratories preformed accorind to a written online instructions on PC computers on on a dedictaed hardware platforms (microcontrollers, single borad computers (SBCs), dedicated accelerators, FPGAs).

Bibliography

Basic:
1. NVIDIA Jetson Software Documentation
2. R. Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010
3. P. Warden, D. Situnayake, TinyML. Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers, O'Reilly Media, 2019
4. Supplementary material published on Moodle

Additional:
1. I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016
2. A. Koul, S. Ganju, M. Kasam, Practical Deep Learning for Cloud, Mobile, and Edge, O'Reilly Media, 2019

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00