UNIVERSITY OF DEBRECEN
Doctoral School of Informatics

Complex exam major subject	Embedded Systems based Cyber-Physical and IoT systems

Syllabus

Definition of the embedded systems and cyber-physical systems, their connection and applications. Specifications and modeling. Cyber-physical systems hardware issues. High complexity programmable logic devices (FPGA) characteristics'. Advanced and efficient design methods. Hardware-software codesign. IP (Intellectual Property) based design. Embedded soft processor cores. Xilinx embedded processors and bus systems. PicoBlaze and MicroBlaze soft-core processors. Zynq-7000 ARM Embedded Processors. Cyber-physical systems software issues. Case studies within sensor networks, e-health and smart environment topics.

IoT in smart cities, smart homes and industry. Relationship of IoT and M2M (Machine-to-Machine). Wired synchronous and asynchronous communication: UART, SPI, I2C, CAN protocols. Wireless, low data rate, low range, energy efficient communication: IEEE 802.15.4, 6LoWPAN, ZigBee, Bluetooth LE protocols. Transferring sensor data on the internet. Server/client and publish/ subscribe model-based communication in the IoT. CoAP (Constrained Application Protocol) and MQTT (Message Queuing Telemetry Transport) protocols. IoT and the cloud. Connecting sensors to the cloud. HTTP REST (Representational State Transfer) based communication. Connecting to various IoT platforms: ThingSpeak, DeviceHubNet. Inter-platform communication.

Intelligent embedded systems. Most popular machine learning methods such as shallow and deep neural networks, Gaussian processes, decision trees, decision forests, and k-nearest neighbors. Application possibilities of the above mentioned algorithms in the classification and regression problems.

Bibliography

1. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
2. D. Silage, Trends in Embedded Design Using Programmable Gate Arrays, Bookstand Publishing 2013, 320 oldal, ISBN 978-1-61863-541-9
3. E. A. Lee and S. A. Seshia, Introduction to Embedded Systems - A Cyber-Physical Systems Approach, Second Edition, MIT Press, 2017. ISBN: 978-0-262-53381-2
4. F. Vahid; Givargis, Tony: Embedded System Design – A Unified Hardware/Software Introduction, John Wiley & Sons, 2002, 352 oldal, ISBN 0-471-38678-2
5. P. Marwedel, Embedded Systems Foundations of Cyber-Physical Systems, and the Internet of Things, Third Edition, Springer 2017, 448 oldal, ISBN 978-3-319-56043-4
6. R. Faludi, Building wireless sensor networks: a practical guide to the ZigBee Mesh networking protocol, O'Reilly, 2011.
7. T. Noergaard, Embedded Systems Architecture, 2nd Edition, Elsevier, 2012, 768 oldal, ISBN: 9780123821966

Compulsory subjects for this major subject

1. Reconfigurable Embedded Systems based Cyber-Physical systems
2. Communication in the Internet of Things

Recommended subjects for this major subject

1. Communication Mechanisms of the Wireless Sensor Networks
2. Classification and Regression with Machine Learning