Realtime Processing in Machine Learning

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Duration: 18 weeks

Course Description

Computing devices that are "embedded" within other real world devices are ubiquitous. Such embedded devices range from the household digital devices to industrial machineries and robots. Nowadays Machine Learning Algorithms embedded in such devices with Real-Time (RT) processing capability are used to create devices with artificial inteligence. This course will introduce the basics of RT computing and Machine Learning (ML) in the embedded environments. This knowledge will be used to learn autonomous navigation, 3D preception, Simultaneous Localization and Mapping (SLAM).

The course is divided into learning of basic concepts and laboratory works. For the laboratory work, it is planned to use a working model (like a toy car or a drone) to learn the advanced concepts planned as part of the course.

Requirements: Although basic computing skills are sufficient for this course, it is advisable to have previous experience in Linux and programming with NodeMCU (or Arduino) boards. Students must have access to one such device or should be able to purchase one from the list of hardwares given below. Students are also welcome to bring any other device not foreseen here.

EVALUATION

Laboratory work:	50%
Presentation of a working model:	50%

BIBLIOGRAPHY

1. J. Valvano, Embedded Systems: Real-Time Operating Systems for Arm Cortex M Microcontrollers, 2nd Edition, 2012, CreateSpace Independent Publishing Platform, ISBN-13: 978-1466468863
2. User Manuals of Arduino/Raspberry PI3/Xilinx FPGA Kits
3. Various tutorials on embedded programming in the internet. A compilation will be made available at http://www.astro.ugto.mx /~sjk/courses/embedded/files.html

HARDWARE

For the microcontrller NodeMCU (ESP8266-12E) will be used. In addition one of the following hardware will be used for number crunching.

1. Arduino Yun
2. Beaglebone (Green or Enchanced)
3. Udoo (Neo or other boards)
4. Raspberry PI
5. NanoPi-2-Fire Single Board
6. RPI Compute Module 3
7. ChipPro (https://getchip.com/pages/chippro)

CONTENTS

1. Preparatory Work 2 week(s)
    - Instalation of required software.
    - Preparation of Hardware and working laboratory model.
    - Interfacing the sensors.
2. Embedded Systems 3 week(s)
    - Basics of Embedded Systems
    - General Structure and Components
    - Sensors/Actuators, Analog to Digital Conversion
    - Operating Systems
    - Programming with Microcontroller
3. Real Time computing in and Embedded System 3 week(s)
    - Basics of Real Time computing
    - Linux: Interrupts and Threads
4. Machine Learning 4 week(s)
    - Basics of Machine Learning
    - Convolutional Networks, RNNS, LSTM
    - Deep L-layer neural networks, Vectorization.
5. Autonomous Navigation and Obstacle Detection 3 week(s)
    - Obstacle Detection, Autonomous Navigation
6. 3D preception and SLAM 3 week(s)
    - Introduction to SLAM
    - 3D perception and Stereo Vision.
