A. PESTER, T. KLINGER, C. MADRITSCH, W. SCHWAB CARINTHIA UNIVERSITY OF APPLIED SCIENCES

Using Pocket Labs in Engineering Education Programs I 2 April 2017 Rio de Janeiro - Brazil



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AGENDA OF THE MEETING

12.April. 2017

9:00 – 10:30 Introduction

- Platforms to use
- Case Study

10:30 – 11:00 Wrap up/ Discussions

ABOUT US

Carinthia University of Applied Sciences

- Founded in 1995
- School of Engineering & IT with 7 Bachelor degree programs, 8 Master degree programs

Andreas Pester

- Professor of Mathematics and Mathematical Modeling
- Teaching Experience: different math courses, mathematical modeling (Matlab, Maple and OpenModelica), Machine Learning (R, Python)
- Research Experience:
 - OLA, MARE, PiUELS, ECEL, OLAREX, ePragmatic, iCo-oP, eScence, MIMI, VISIR+, PILAR





MOTIVATION

Trend in Higher Education towards Maker Universities*:

- Challenge: Close connection of the experimental and theoretical part of teaching & increase interactive part in (engineering) education
- Pocket labs are one of the technological answers to that challenge.



*New Media Consortium 2014

BACHELOR DEGREE PROGRAMS

- Emphasis is on the application of theory in predefined circuits, programmes etc., hypothesis generation and practical training of technical skills.
 - "Students focus on basics and theoretical subjects: Pockets labs should support them at their learning process as smoothly as possible."
 - Bring students together with state-of-the-art technologies
- Learning methods
 - Interactive learning, collaborative learning, inverted classroom
- NI myDAQ + miniSystems, FH miniSystem, breadboards
 - C/C++, LabVIEW
 - Computer Science, Electrical Engineering, Physics





MASTER DEGREE PROGRAMS

- Focused on analysis, error- and performance evaluation and improvement of self-designed or given cyber-physical systems, software and/or hardware solutions.
 - complexity and abilities of the Pocket lab platform higher
 - students are focusing on systems and concepts
- Learning methods:
 - Inverted classroom
 - Blended learning
 - PBL



PLATFORMS TO USE

- Raspberry Pi, extension boards, breadboards, cameras, sensor/actor kits
 - C/C++, Python
 - Raspbian, Windows 10
 IoT, ...



PLATFORMS TO USE

- NI myRIO, stand-alone
 embedded real-time system,
 application processor + FPGA
 - miniSystems, FH miniSystems, breadboards, ...
 - LabVIEW, C/C++ (Linux)



PLATFORMS TO USE

- AD ADALM 1000, low-cost analog input/output device connected to a PC, a Raspberry Pi, or Mac.
 - Connected to a PC, a Raspberry Pi, or Mac.
 - Capable of measuring and sourcing of currents and voltages.
 - C/C++, Python.



CASE STUDY I

Microcontrollers Special Topics

- Components:
 - Raspberry Pi, breadboard,
 - power supply
 - Raspbian Linux, Code::Blocks
 - IDE, wxWidgets library

Tasks:

- Set-up the system
- Create and measure PWM
- signals
- Use I2C communication
- Use asynchronous and
- synchronous serial ports
- Use interrupt and DMA controller



CASE STUDY 2

Real-Time System Special Topics

- Components:
 - NI myRIO, FH miniSystem
 - LabVIEW
- Tasks:
 - Set-up the system
 - Implement the Binary output of a number
 - Apply the Producer/Consumer design pattern to acquire live data and to process it in time.
 - Make use of the FPGA to run time-critical code.





CASE STUDY 3

Electronic Engineering

- Components:
 - ADALM 1000, breadboard, PC or mini Computer (Raspberry PI)
 - Waveform Generator and Oscilloscope Application, Python or C/C++
- Tasks:
 - Measurement of a diode characteristics (1N4148)
 - Apply a sine wave voltage on the series combination of resistor and diode
 - Measure the current, ...



STUDENT PERCEPTION AND IMPACT 2015/2016

- Students were asked after each lecture about their opinion regarding organization and content; in lectures with pocket labs, the following additional questions were asked:
 - Q1: "Pocket Labs supported my understanding for the content of this lecture."
 - Q2: "The flexible time management when using Pocket Labs was ..."
 - Q3: "The use of Pocket Labs in this course makes the content more descriptive."
 - Q4: "Overall, the use of Pocket Labs in this course I consider ..."



Rating distribution of master students regarding pocket labs



Weighted results. Left – master students, right – bachelor students.

STUDENT PERCEPTION AND IMPACT 2016/2017

- Students were asked the same questions as in the previous academic year
 - QI: "The Pocket Labs supported my understanding for the contents."
 - Q2: "The flexible time management when using Pocket Labs was ..."
 - Q3: "The use of Pocket Labs in this course makes the content more descriptive."
 - Q4: "Overall, the use of Pocket Labs in this course I consider ..."



Rating distribution of master students regarding pocket labs



ONLINE LABS@CUAS



CHHOCHSCHULE KÅRNTEN OF APPLIED Course content Lab assignments **m**o Lab access Experiment delivery Lab hardware Lab Servers Single sign on Lab Management Service Broker

LESSON LEARNT

Pros

- Pocket Labs are an excellent tool to bring students very quickly in a learning situation, where they should apply their knowledge in challenging practical engineering situations;
- Pocket Labs are a lab equipment, which fosters and requires active students, social learning and the communication student- student and student-teacher;
- Pocket Labs motivate much more students to try, test and implement their own engineering ideas.
- Combination of pocket and online labs desirable

Cons

- Complexity
- Only **virtual** instruments
- Dependency from **OS**
- Applicable for simpler experiments

NEXT STEPS

Combination of online and pocket labs

- I.approach:
 - Measuring a black box, elements are analyzed with pocket labs, black box will be located online – planned for courses in electrical engineering basics and advanced courses
- 2. approach:
 - In courses of electrical engineering and mathematics students developed boards for analog computing of mathematical models in differential equations
 - Experimentation with the components on pocket labs, with the complex system on online lab platforms (e.g. VISIR), comparison of simulations based on numerics (e.g. MATLAB/Simulink) and of real component circuits (e.g. ModelSim)

EXAMPLE: PARALLEL USE OF POCKET LABS AND VISIR

- Finding the Thevenin and Norton equivalents at terminals A and B of an unknown network represented by a black box which contains a voltage divider
- Students do not know the internals of the black box
- Thevenin and Norton equivalents can only be obtained experimentally by measuring the open-circuit voltage on terminals A and B and the shortcircuit current that shows through A and B

ASSIGNMENT

- Measure the Thévenin equivalent on terminals A B of the Blackbox
- Measure the time constant of a RL Circuit



ANALOG COMPUTING WITH MYDAQ











Abbildung 3-38 Vergleich der Simulation mit dem realen Ergebnis

13 Seitenansicht des fertigen 19 Zoll Einschubes mit Analogrechnerplatine

ANALOG COMPUTING RACK AND MYDAQ PCB



OUTLOOK

For the upcoming period we will concentrate on the following:

- Integrate this technology in the teaching methodology of other key courses of the Master programes;
- Participate in the organization of an international community of practice for Pocket Labs;
- **Combine** pocket with online labs.
- Combine the use of this technology for education with the development of demo projects for industries and other areas of practical applications.



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THANK YOU FOR YOUR ATTENTION!

QUESTIONS?

OPEN DISCUSSIONS