Software for measurement systems
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Announcement

• Tuesday 12.12.2017, Project presentations 10-12 in E:1328
• Project hand-in should contain report and LabVIEW code in electronic format (see webpage for info on project presentation and report)
Structure of a measurement system

<table>
<thead>
<tr>
<th>Physical quantity</th>
<th>Measurement system</th>
<th>Presentation (and control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pressure</td>
<td>Signal conditioning</td>
<td>• Graphical programming</td>
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<tr>
<td>temperature</td>
<td>DAQ-cards</td>
<td>• LabVIEW</td>
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<tr>
<td>speed</td>
<td>Bus control of instruments</td>
<td>• Agilent VEE</td>
</tr>
<tr>
<td>angular velocity</td>
<td>• GPIB (parallel)</td>
<td>• DASYlab</td>
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<tr>
<td>luminosity</td>
<td>• RS232 (serial)</td>
<td>• Textual programming</td>
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<td>force</td>
<td>• Bus systems with integrated and standardized instruments</td>
<td>• LabWindows CVI</td>
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<td></td>
<td>• VXI/PXI</td>
<td>• Measurement Studio</td>
</tr>
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<td></td>
<td>• Real time controllers</td>
<td>• Visual Basic</td>
</tr>
<tr>
<td></td>
<td>• Field buses</td>
<td>• Visual C/C++</td>
</tr>
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<td>• Matlab</td>
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</table>

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Which is which….  

- LeCroy HDO6000 oscilloscope
- 2.5 GSa/s
- 12-bit resolution
- Intel core i5
- Windows Embedded
- Can run MATLAB
- Real time MATLAB functionality through XDEV
Dedicated SW & HW

Vibrationskontroll mjukvara nu för Windows® 7 och 8
> Ny mjukvara för 64-bits operativ system

Brüel & Kjar
creating sustainable value

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Dedicated SW & HW

PCle-DAS1602/16
16-Channel, 16-Bit, 100 kSa Multifunction PCI Express Board

Key Highlights
- 16 SESS (off analog input channels [switch-selectable])
- 16-bit resolutions
- Up to 163 kSa sampling (163 kSa max for any channel)
- Two 12-bit analog outputs
- 32-bit I/O
- Three 16-bit counters
- Connector and software compatible with the PCMI-DAS1602/16

Software
- Measurement and analysis software included for acquiring and displaying data and generating signals
- Instrument software utility for installation, calibration, and test
- ULL for NI LabVIEW™
- Compatibility with dasyLab™

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The role of SW

• Communication with the operator
  – Presentation, control, storage
• Communication with the instrument
• Communication with other applications
• Processing of measurement data

Software planning

• Programming language
  – C/C++, Java, Python, Graphical (LabVIEW, Keysight VEE)
• OS
  – Windows, Linux/Unix, MacOs
• User interface
  – What is the use? Only control, logging only, other?
• Driver availability?
  – Are there drivers available for the programming language chosen?
Programming languages

- **Text-based**
  - Eg. Visual C++, Visual Basic, LabWindows CVI, Python, Java
- **Graphical**
  - LabVIEW, Keysight VEE, DASYlab

How big is LabVIEW?

- NI : revenue of ~ 1 billion USD, ~ 7000 employees
- Mathworks: revenue of ~ 0.75 billion USD, ~3000 employees
- Keysight (was Agilent (was HP)) : revenue of ~ 3 billion, ~10000 employees
LabWindows CVI

- C for Virtual Instrumentation (CVI)
- ANSI C Integrated Development Environment (IDE)
- Build distribution for installation and use on another computer
Measurement Studio

- Measurement Studio is a suite of tools and class libraries for .NET
- Build measurement applications using Visual Studio
- Visual C# and Visual Basic .NET
DASYLab

• Data Acquisition System Laboratory
Python

PyVISA

Matlab
Software demos

DIY Measurement system

- EMG (electromyogram) acquisition board
- Computer running VC++ application
- SmartHand project
Schematic

Actual PCB
Program code for microcontroller

- IAR IDE, C-code

```c
// Function: initialize
Parameters: none
Returns: none
Description: Initializes the clocks of the AVR, waits until frequency of external crystal oscillator is stable. Sets CPU main clock = master clock = PLL out

```n

Program

- Programmed in VC++
Classification scheme

- knn-classifier (EMG data "mapped" to glove joint angles)

Video
Arduino DAQ

• Demonstration