Enhanced Data Integration for LabVIEW Laboratory Systems

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Outline

• Measurement Data Management with LabVIEW
• Case study - SYTHERM
• EquiLAB Platform Integration
• Conclusion and Future Work
Data Management in Laboratories

• Large datasets are generated in R&D facilities, testing laboratories and education “Big Data” for I&M

• Challenge: make efficient use of the data, store it and reuse it, with focus on technical universities
Associated LabVIEW Tools

- NI Diadem
- Signal Express
- Low-level built-in functions *WriteTo*...

- Unified procedure for: the same lab, across labs and sharing with external entities
## Common Data Storage Formats

<table>
<thead>
<tr>
<th></th>
<th>ASCII / LVM</th>
<th>Binary</th>
<th>XML</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchangeable</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Small disk footprint</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Inherent attributes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>High-speed streaming</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Human readable</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
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SYTHERM – Thermocouple Stand
Main Objectives

• Study the thermoelectric characteristics of various thermocouple types (J, K, E, T)
• Develop virtual instrumentation for dedicated process data acquisition modules
• Determine static and dynamic characteristics e.g. non-linearity error, step response

$$\varepsilon_{nel_i} [\%] = \frac{|T_{real_i} - T_{ref_i}|}{T_{ref_{30}} - T_{ref_i}} \cdot 100$$
Enhanced Data Integration for LabVIEW Laboratory Systems

File Logging

![Diagram of LabVIEW file logging setup]

File Description:
3-channel thermocouple measurement file configuration
File Logging (cont’d)
LVM (LabVIEW Measurement)

• Main Header

• Segment Header

• Data Channels

LabVIEW Measurement
Writer_Version 2
Reader_Version 2
Separator Tab
Decimal_Separator ,
Multi_Headings No
X_Columns One
Time_Pref Absolute
Operator Professor
Date 2013/02/06
Time 17:49:40,8399038314819335937
***End_of_Header***

Notes X values guaranteed valid only for Channel 0

Channels 3
Samples 1 1 1
Date 2013/02/06 2013/02/06 2013/02/06

Time 17:49:40,8399038314819335937
17:49:40,8399038314819335937
17:49:40,8399038314819335937

X_Dimension Time Time Time
X0 0,0000000000000000000E+0 0,0000000000000000000E+0
0,0000000000000000000E+0

Delta_X 1,000000 1,000000 1,000000
***End_of_Header***

X_Value Channel 0 Channel 1 Channel 2 Comment
0,0000000 23,400000 23,400000 23,600000
0,531250 23,400000 23,400000 23,600000
1,531250 23,400000 23,400000 23,600000
2,531250 23,400000 23,400000 23,600000
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EquiLAB Platform

- Modular, web-based, educational platform
  - Measurement System Modeling
  - e-Learning module
  - Data Integration module
Data Integration with EquiLAB
Parser Model

- Depends on equipment type and output measurement file
- LVM_PARSING_LVM for SYTHERM
- PHP implementation
Database Structure

EQUIPMENTS TABLES
- t_eqp_equipments
- t_efe_equipmentfileextension
- t_equipmentparameters
- t_prd_producers

MEASUREMENTS TABLES
- t_mea_measurements
- t_mu_measurementgroups
- t_psf_parsingfunction

PARAMETERS TABLES
- t_top_typeofparameters
- t_prg_parametergroup
- t_prt_parametertype
- t_mep_measurementparameters

USERS TABLES
- t_stu_students
- t_tea_teachers
- t_usr_users
- t_ust_usertypes
- t_utr_usertyperights

LESSONS TABLES
- t_les_lessons
- tltk_lessontasks
- t_std_studentlessons
- t_ltd_lessondetails
- t_ltb_lessontheoreticalbackground
- t_cou_courses
- t_eql_equipmentlesson

<table>
<thead>
<tr>
<th>t_psf_parsingfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>psf_number: INTEGER</td>
</tr>
<tr>
<td>psf_name: VARCHAR</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>t_eqp_equipments</th>
</tr>
</thead>
<tbody>
<tr>
<td>eqp_number: INTEGER</td>
</tr>
<tr>
<td>eqp_name: VARCHAR</td>
</tr>
<tr>
<td>eqp_description: TEXT</td>
</tr>
<tr>
<td>eqp_website: VARCHAR</td>
</tr>
<tr>
<td>eqp_photo: VARCHAR</td>
</tr>
<tr>
<td>eqp_modelphoto: VARCHAR</td>
</tr>
<tr>
<td>eqp_gmmodelphoto: VARCHAR</td>
</tr>
<tr>
<td>eqp_creationdate: DATETIME</td>
</tr>
<tr>
<td>eqp_modifieddate: DATETIME</td>
</tr>
</tbody>
</table>

G. Stamatescu
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Conclusion

- Workflow for experimental data management based on LabVIEW and dedicated information framework
  - Case study on thermocouple laboratory stand (SYTHERM)
  - EquiLAB platform based on Web 2.0 technologies: e-learning + measurement data management
Future Work

• Integrate more platforms in EquiLAB

• Parser support for efficient binary formats e.g. TDM(S)

• Moodle for data?
• Thank you!
  – Questions
  – Suggestions