Using remote and virtual laboratories in science and engineering in UNED
Part I and Part II

Workshop on Remote Experiments for HE
The Open University, Milton Keynes, UK

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17th April 2015
Outline

Part 1

1. Experimentation environment
2. A primer on EjsS
3. A retrospective look
4. A panoramic view of VL/RL in UNED
5. Conclusions

Part 2

UNILabs demo: http://unilabs.dia.uned.es
1. Introduction

• UNED, the Spanish University for Distance Education, is the only state-run Spanish distance-learning university and it is the largest university in Spain.

• One of the largest European Universities with around 220,000 students, most of them adult students, and near 1,500 teachers.
  - Central organization: Madrid
  - 65 study centers: All over Spain
  - 13 study centers in Europe & America

• UNED focuses mainly on distance learning and continuous education.

• It delivers degrees in most disciplines including Industrial Engineering, Computer Science, Physics, Chemistry, Mathematics, Economics, Social and Political studies, Humanities, Arts ....

• UNED’s teaching methodology incorporates intensive and extensive use of e-learning resources including interactive video lectures, remote and virtual labs, e-learning platforms, learning objects, augmented reality, mobile devices, and biometrics.
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2. Experimentation environment

A taxonomy
2. Experimentation environment

A taxonomy

NATURE OF THE RESOURCE

Real

Simulated
2. Experimentation environment

A taxonomy

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3. A primer on Ejs

**Easy Java/Javascript Simulations (EjsS)**

- EjsS is a free open-source tool developed in Java/Javascript designed for the creation of computer simulations.

- EJsS has grown to help in creating web-accessible (virtual and remote) laboratories:
  - Connections with external applications.
  - New features for 3D modeling.
  - New libraries and plug-ins to improve the development of VRLs.
  - New experiment languages.
  - Etc,…

- developed by Prof Francisco Esquembre, Murcia University (Spain)

- [http://fem.um.es/Ejs](http://fem.um.es/Ejs)
3. A primer on EjsS

**Easy Java/Javascript Simulations (EjsS)**

EjsS provides a simplified implementation of the Model-Control-View paradigm.

1. The **model**, which describes the phenomenon under study
2. The **control**, which defines certain actions that a user can perform on the simulation
3. The **view**, which shows a graphical representation of the different states that the phenomenon can have.

\[ \dot{x} = f(x,u,t) \]

**Control**

**Model**

**View**
3. A primer on EjsS

A simple example: A pendulum

Basic variables: \( t, dt, x_1, x_2 \)

Visualization variables: \( x, y, v_x, v_y \)

Dynamic model

\[
\begin{align*}
\frac{dx_1}{dt} &= x_2 \\
\frac{dx_2}{dt} &= -\sin(x_1)
\end{align*}
\]

Constraints

\[
\begin{align*}
x &= \sin(x_1) & v_x &= x_2 \cos(x_1) \\
y &= -\cos(x_1) & v_y &= x_2 \sin(x_1)
\end{align*}
\]
3. A primer on EjsS

Users map of EjsS

http://fem.um.es/Ejs/
3. A primer on EjsS

Some examples of virtual labs using EjsS

- Particles collision
- Chain of oscillators
- Ball in a wedge
- 3 tanks system
- Ball and plate
- Ball and hoop
3. A primer on Ejs

A new way of teaching, learning and share experiences
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4. A retrospective look

1992  HyperAutomatica

1992 1995  Repsol Course


4. A retrospective look


DIA remote portal

FisL@bs project


AutomatL@bs project

Uned-Labs portal
4. A retrospective look

What is UNILabs?
UNILabs is a network formed by many universities that share their laboratory resources.
4. A retrospective look

The structure of a VL/RL

Servo-Motor

Documentation

- Tasks Protocol
- User Interface
- Practice Guide
- Appendix

Virtual Laboratory of the Servo Motor

Delivering My Report for the Servo Motor Virtual Laboratory

Remote Laboratory of the Servo Motor

Delivering My Report for the Servo Motor Remote Laboratory
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5. A panoramic view of VL/RL in UNED

DC motor  Three tanks  Heatflow system

virtual  virtual  virtual

remote  remote  remote

Control Engineering labs
5. A panoramic view of VL/RL in UNED

Electric drives  Quadruple tanks  Ball and hoop

virtual  virtual  virtual

remote  remote  remote

Control Engineering labs
5. A panoramic view of VL/RL in UNED

Ball and beam  Ball and plate  Flexible arm

virtual  virtual  virtual

remote  remote  remote

Control Engineering labs
5. A panoramic view of VL/RL in UNED

Furuta pendulum  Inverted pendulum  Mobiles robots

virtual  virtual  virtual

remote  remote  remote

Control Engineering labs
5. A panoramic view of VL/RL in UNED

Quadrotor

virtual

remote

Control Engineering labs
5. A panoramic view of VL/RL in UNED

Light Diffraction Photoelectric Effect  Thin Lens

virtual virtual virtual

remote remote remote Physics labs
5. A panoramic view of VL/RL in UNED

Snell’s Law

Hooke’s Law

virtual

virtual

remote

remote

Physics labs
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6. Conclusions

- Virtual/remote experimentation is a mature technology.
- Yet, it is not easy to transform a traditional lab into a web-based lab.
- More research has to be done in providing new tools and new facilities.
- We have presented our approach using:
  - Easy Java Simulations to develop the interactive GUIs.
  - LabView and Matlab to develop the real-time control loop at the server-side.
  - Moodle to deploy the web-based/remote labs.
- Last course was the fourteenth year of real experience.
6. Conclusions

New challenge in remote labs

Controller in the client side
Thank you for your attention