From online experiments to smart devices

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Outline

Remote experimentation timeline
Physical device constraints
From online devices to ..
........ smart devices
Concluding remarks
Remote experimentation

Motivation
- flexibility, asynchronous access, access on demand, collaborative learning
- lack of resource
- sharing of expensive resource
- live demonstration during an ex-cathedra class

Learning material
- control theory, system identification, synthesis, validation
- concepts illustrated with the help of an electrical drive

Same theoretical concepts for the last 20 years
~ 1980 - Early days

Analog signal generator
Analog controller
Signal visualization via oscilloscope

Data saving by taking pictures of the oscilloscope screen or via a plotter
1992 - Computer-based control

Replaces the analog signal generator, the analog controller and the oscilloscope with a computer and a DAQ board.

LabVIEW and associated DAQ drivers drastically speed up the controller development.
1996 - LAN access

Add a webcam + streaming software
Add a communication layer + deported GUI

Ex-cathedra demonstration
1997 - Internet access

Many clients
Online reservation and allocation system
Synchronized information streams (data + video)
2002 - Deployment

First batch of students to access the remote lab 24/7

Outside lab activities > 50 %

Integration to specific *closed* environments

Client moved LabVIEW -> Java
2005 - Other environments

Integration to open environments/clients
- Mashed-up environments

Integration with other tools
- shared space, analysis tools, video chat

Drastic student increase (40 -> 180)
- the whole class connected remotely every other week
Online device - how to

Specific device

- Full control
- Full diagnostic
- 3 + 3 sensors
- 2 + 3 actuators
- Integrated video camera
Online device - how to

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Diagram:

- Electrical drive
- Computer + DAQ
Online device - how to

Turnkey solutions

- Screen sharing *
- Controlab/WebLab (Simulink)
- Remote panel (LabVIEW)
- Dynamic web page (LabVIEW)

Pros: instantaneous
Cons: lots of bandwidth
      no video
      *too much rights granted
Online device - how to

Custom solution (client-server)

Modify the local control
- add a communication layer
- add video capture
  -> server

Create the **client** applications
- Only GUI + Communication
- Java, Flash, ActiveX, LabVIEW, etc.

Global supervision
- Dynamic allocation
- Usage statistics
Online device - how to

Integration to other environments

Client and server applications need to be adapted to get the most of collaborative environments

Client & server may require
- additional data format
- additional protocols
- authentication
Online device - how to

Integration to other environments

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Integration to other environments

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Implemented as proxy
From online to smart devices

Integration to new open environments
  Forest of proxies
  Pool information

Able to handle
  Multi protocols
  Multi data formats
  Etc.

Clients and server complexity increase
From online to smart devices

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Clients and server complexity increase

Keep the same hardware, enhance the software
Smart device

- A way of implementing functionalities (paradigm shift)
- Transfer client functionalities to smart device (server)
- Can initiate information exchange (push)
- Is seen as an agent in collaborative environments
- Ideally supports all formats/protocols or is ready to

Thomson’s¹ definition:

A smart device has communication capabilities
A smart device has sensors and actuators
A smart device is capable of “reasoning” and “learning”
A smart device has identity and kind
A smart device has memory and status tracking

¹Thompson, C. W. Smart devices and soft controllers, IEEE Internet Computing, 2005 vol. 9-1
Smart device example

Same hardware
Enhanced software

Agent in elogbook

SMS: initiate tasks

RSS feed: self diagnostic

eMail: multiple formats
Internet of things

The internet of things is the interconnection of smart devices and other intelligent objects

“Where are my Pals?”
“I’m busy at the moment,
   I’ll redirect your request to the next free device”
“3230 3435 3038 3030 3109 332E 3435 0932 2E38 3409 332E 30”
“mailto:rev2008@rev-conference.org- status OK, 3 connections>”
Concluding remarks

**Smart device is**
- The natural evolution of online device
- A new paradigm for implementing functionalities

**Smart device has**
- Sensors and actuators
- Some “intelligence”
- Identity, kind, memory, status
- Communication capabilities
- Support for “any” protocols/formats

**Smart device can**
- Initiate information exchange
- Work as an agent on the user’s behalf