VIRTUAL PLATFORM FOR REAL MECHANICAL EXPERIMENTS ON-LINE

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1. Introduction

We stated a question if it's possible to create, by means of modern communication technologies, a system that enables scientific collaboration between researchers gathered in a distributed environment. Here collaboration means not only exchange of news and information but also covers other aspects of scientific activity, like for example conducting experiments or sharing experimental data. Very often geographical distance and inaccessible equipment are main barriers in collaboration. Use of Internet-based platforms may help breaking these barriers and reduce the cost of cooperation.

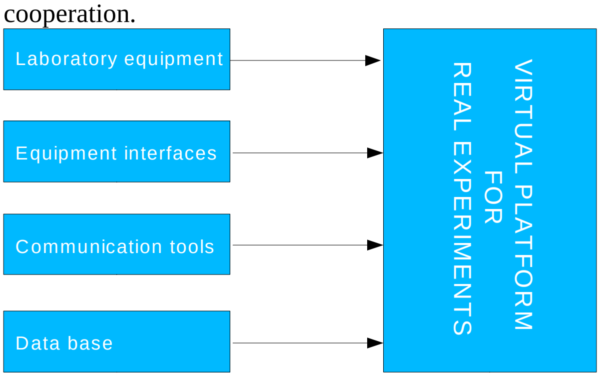

Fig. 1 Subsets of a virtual platform for real experiments

The answer for the question stated at the beginning is positive but there are several drawbacks that will be discussed further in this paper.

Presented system is called VLAB. It's an abbreviation of a term *virtual laboratory*. To distinguish between virtual laboratories available on the Internet that are just nothing more than simulations of physical phenomena, the platform maybe called *collaboratory*. This term comes from publication [1] and is a concatenation of words *laboratory* and *collaborate*.

2. Platform overview

Subsets of virtual platform are drawn on fig. 1. Underneath they'll be described more precise.

2.1 Laboratory equipment

A typical test stand utilized in a laboratory for mechanical properties examination consists of:
- hydraulic pulser (MTS),
- sensors (extensometers, thermocouples, etc.),
-- computer with data acquisition card and control software on board.

2.2 Equipment interfaces

The key component of whole platform is dynamically created website. The content of the website changes while conditions of an experiment change.

The website provides basic interface for controlling parameters of an experiment. Variables are input by forms and then passed through to control software running on a PC workstation at a test stand. In our case the software is developed in HPVEE package.

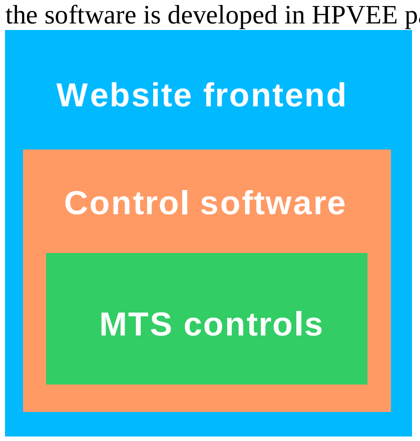

Fig. 2 Three layers of interface enabling control of a hydraulic pulser from the Internet

HPVEE application that receives variables from the website and translates them into commands that are understood for hydraulic pulser control unit (fig. 2).

Data gathered by sensors is acquired by PC workstation equipped with a dedicated measuring card. HPVEE control software visualizes data for local experimenter and sends them to the web server where they are incorporated to the website and presented to remote experimenters.

2.3 Communication tools

The website gives an access to some simple communication tools. First of all remote experimenters may observe experiment by a web camera that transmits video directly from the test stand. Free or OpenSource streaming video and audio transmission software is used (MSMediaEncoder, Darwin Streaming Server). Remote experimenters may also startup a

conversation with a local experimenter using chat application that is provided on the website.
Independently additional communication software is used. To setup a teleconference connection MSNetmeeting, available on Windows platform, maybe utilized, especially while it provides white board functionality. When cross-platform compatibility is required OpenSource MASH package is taken into an account.

2.4 Database

Very often redundant data is collected during experiments. This data may be use in other experiments later. Well-organized data base supports conducting multistage experiments where data collected in previous one are reused in next. Database should help in conducting multistage experiments in distributed environment while particular stages of an experiment are done in geographically different locations. The application of the database is not finished yet.

3. Experiments

The platform was tested on two different sets of experiments. In both cases tests were successful.

Fig. 3 Website view while experiments are on the run

3.1 Cross effects

The experiment of cross effects was realised on the virtual platform. Existence of Kelvin’s and Villarie’s phenomena in steel specimen under cyclic loads was examined. Kelvin’s phenomenon is noticed in metals during an elastic strain at adiabatic conditions. While a metal specimen is being stretched its temperature lowers and while compressed its temperature grows.
Villarie’s phenomenon is observed in metals while under loads they emit magnetic field. In the experiment a cyclic load of sinusoidal characteristic of 1Hz frequency was applied on St3 steel specimen. The strain amplitude was remotely changed from 1% up to 8% while the specimen reached the plastic state.

3.2 Characteristics identification of a magnetorheological damper

The experiment with magnetorheological damper was conducted as well as during student’s classes and conference presentations. The characteristic of the device was identified.
The working fluid of the damper belongs to functional materials group. Its parameters could be modified by change of voltage or current. Modification of fluid parameters implies change in the damper characteristics.

Changing current voltage in electromagnet coil installed inside the damper does modification of fluid parameters. The voltage was changed between 1 to 5V. Input signal applied on the damper - a sinusoidal displacement - had 1Hz frequency and amplitude changed from 1 to 9 mm. All parameters were modified remotely via Internet and experimenters involved in could observe results immediately.

4. Conclusions

1. Modern communication technologies can easily find their application in experimental mechanics.
2. It's possible to make all experiments done at described test stand available for remote experimenters as the web interface for hydraulic pulser is provided.
3. Virtual platform reduces barriers between distant collaborators and makes their collaboration much easier even in the experimental field.
4. The cost of experiments and education based on virtual laboratory is reduced.
5. Major drawbacks of a virtual laboratory in mechanical experiments are:
- the test stand requires human service,
- its not possible to remotely start experiments with own materials.

LITERATURE

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