LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

HYDRALAB IV – Remote Access to Experimental Facilities

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RADE - First results

27th January 2012

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LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

RADE – First Experience on Remote Access

27th January 2012

1 INTRODUCTION

The present report describes the first laboratory experience on remote access made at the COI1 flume on 27th January 2012. This experience took place in one wave flume of the maritime hydraulic installations of the Harbour and Maritime Structure Division, of the Hydraulic and Environmental Department of the National Laboratory of Civil Engineering.

This work is made on the framework of the project RADE a Joint Research Activity of HYDRALAB IV – More than Water. RADE (Remote Access to Data and Experiments) will develop a robust set of information systems to improve access to experiments and data through the innovative use of modern data management, curation and communication technologies.

Traditionally, the hydraulic research community is accustomed to exchange the results of their experiments through papers and conferences. The direct exchange of data is limited to partners cooperating in projects. The objectives of RADE are to allow research partners to access and input to laboratory experiments remotely, thereby saving on costs and the environmental impacts of long distance travel, and to make the results of our experiments more easily accessible for researchers beyond the HYDRALAB community, thus realizing synergy between different partners in Europe and world wide and creating a climate for further innovations.

The main objective of this laboratory experience is to establish a methodology to access a laboratory experience made on COI1 flume remotely.

The following sections describe the HYDRALAB IV project and in particular the RADE project. Then, the description of the experience made at the COI1 flume is presented. Final comments and future work is presented at the final section.

2 HYDRALAB IV PROJECT

HYDRALAB IV – More than Water is a FP7 project, which main objective is the improving of the integrated provision of services related to hydraulic infrastructures in regard to the following elements:

- Water & Environmental Elements (with focus on ecology and biology)
- Water & Sediment
- Water & Structures
- Water & Ice

HYDRALAB IV involves four different type of activities: Networking activities, Transnational Access Activities and four Joint Research projects (WISE, HyRES, PISCES and RADE).

The networking activities are specifically aimed at enhancing the services provided by the research infrastructures and at disseminating the results to the European user community and beyond by mutually co-ordinating the Access activities and Joint Research Activities (JRA's).

The ensemble of Transnational Access activities offers access to a coherent set of 17 research installations, suited for hydraulic research on the interaction of water with environmental elements, structures, ice and sediment. Each of the installations is unique on a European scale, but by offering them combined within HYDRALAB IV we make full use of their complementarity.

The ensemble of the Joint Research Activities (WISE, HyReS and PISCES) focuses on the development of instrumentation facilities beyond the present state-of-the-art for areas where the interaction of water with other elements (environmental elements, structures, ice and sediment) leads to a complex research problem. Depending on the present state-of-the-art in each of the research areas HYDRALAB IV takes the developments a step further. The last one project RADE (Remote Access to Data and Experiments) will develop a robust set of information systems to improve access to our experiments and data through the innovative use of modern data management, curation and communication technologies.

3 RADE PROJECT

The objectives of the research action (RA) 'Remote Access to Data and Experiments (RADE)' are to:

- Develop a robust set of information systems to improve access to experiments and data through the innovative use of modern data management, curation and communication technologies;
- Ensure that these systems are compatible with international standards and in-line with EC directives, thereby ensuring interoperability with data-management systems and structures being developed in numerical modelling and operational oceanography;
- Demonstrate the potential of these information systems by the development of a search engine for experimental databases and for participation in remote collaborative experiments.

The benefits of RADE will include remote access to experiments as they happen (increasing cooperation and reducing travel), developing a database for meta-data that is searchable from the HYDRALAB website (making the existence of experiments known) and making their meta-data consistent with international standards (improving the ability to re-use data).

Remote Access to Data and Experiments is split into the four tasks, outlined below.

<u>1 - Organisation data store experiments</u>

Through this task, the project will develop the basic data structure and procedures for sharing of information between research installations and research groups. This will lead to the development of a web interface and search engine to explore data obtained from Hydraulic infrastructures. This will be in itself a large step forward to facilitate scientific interchange between European researchers and it is a pre-requisite for subsequent access to remote experiments at the installations of research partners.

<u>2 - Access to and participation in remote experiments</u>

The development of information technology provides opportunities for on-line involvement of all stakeholders in experimental work even when not present at the experimental facility.

The development of remote access technologies tailored for hydraulic experimental installations will initially benefit the scientific community but will ultimately also impact the communication between scientists, engineers and the users of the scientific advances. The aim of this task is thus to develop and thoroughly test an appropriate and robust technological infrastructure.

This task is divided into the sub-tasks:

a) Identification of most appropriate remote access technologies; and data sharing formats/technologies. For this task full use will be made of experiences of participants in adjoining areas such as real-time forecasting and monitoring systems.

b) Adaptation/adoption of the most appropriate remote access technologies/formats to HYDRALAB. The technologies will generate meta-data in conformance with the data model, so they can be imported directly into the meta-data database. This data will then be searchable using the search and discovery mechanisms developed in Task 9.1.5;

c) Development of demonstration systems to integrate video conferencing with live data feeds of probe readings from physical laboratory projects. This will allow researchers granted Transnational Access to observe and discuss experiments while at their own institutions;

d) Development of test bed to integrate existing hardware and software with new systems to permit data integration and auto generation of searchable metadata and data records. All participants providing Transnational Access will provide example data in the appropriate form. Data from 2 experiments will be worked up more fully;

e) Development and test of interactive visualisation software for public web access to data. This will be used to scan data fields and the associated documentation within an experimental project. A common user interface will be developed to display meta-data from different participants, even though they have different internal data formats and procedures.

<u>3 - Dissemination and management of knowledge</u>

This task aims at disseminating the techniques for remote access to experiments developed through the experiments outlined above as they are happening as well as demonstrating and promoting the application of these techniques among the majority of the researchers at hydraulic laboratories within the broader partnership and networks of HYDRALAB both within Europe and worldwide.

4 - Co-ordination RADE

Coordination of RADE meetings at each of HYDRALAB workshops and the preparation of written documentation and publications.

4 OBJECTIVES

The objective of the work reported in this document is to establish a methodology to provide remote access of laboratory experiences taken at LNEC's COI1 wave flume, one of the flumes of the maritime hydraulic installations of the Harbours and Maritime Division (NPE).

The methodology is based on the use of fairly simple scheme composed of a video camera installed at the flume, which is connected to a PC computer where the software "Microsoft Expression Encoder" capture video resides and where video are images and decoded and sent to a web server. This server will then enable real-time streaming over the internet, enabling a direct, quasi-real-time, access to the video from web users.

A first experience of this setup was made on 27th January 2012.

This work involved the collaboration of FCCN (Fundação para a Computação Científica Nacional – http://www.fccn.pt), the Portuguese Foundation for the Scientific Computing. FCCN has contributed to the expansion of Internet in Portugal with the support of several national R&D universities and institutions, which includes LNEC. The main activity of FCCN is the planning, management and operation of the RCTS Network, a high-performance network for institutions with high requirements for communications, which enables an experimentation platform for applications and advanced communication services.

5 DESCRIPTION OF THE REMOTE ACCESS EXPERIENCE

5.1 COI1 flume

COI1 flume is a wave flume used for studying propagating waves over a variable bed and their interaction with a maritime structure. It is possible to construct all kind of foreshore bathymetries in this flume, both fixed bed and mobile bed foreshores, to ensure the wave behaviour in the model will be accurately reproduced according to the prototype. The flume is capable of generating both regular (periodic) and irregular (random) waves. The wave generator is equipped with a real-time active wave reflection absorption system. This means that the wave field reflected by the model structure that propagates towards the wave board is measured and the incident wave field that produced by the wave board is compensated for those unwanted reflected waves. In this way, undesired waves do not re-reflect towards the model and do not disturb the measurements. Table 1 shows the technical characteristics of COI1 flume. An overview of this flume is shown in Figure 2.

wave flume COI1
Length : 49.4 m
Width : 1.6 m
Height : 0.7 m
wave generator
Piston-type (translation) wave board
Full stroke : 22’’
Maximum velocity : 1.6 m/s
wave characteristics
Frequency range between f = 0.01 Hz - 5 Hz
Maximum regular wave height $Hmax$ = 0.4 m
Maximum significant wave height $Hm0$ = 0.25 m
features
Glass wall flume with three meter long observation window
Remote-controlled instrument carriage

Table 1- Technical data of LNEC’s COI1 wave flume.

Figure 1 - Overview of COI1.

5.2 Physical Equipment used in the remote access experience

The equipment used in the experience was, Figures 2 to 6:

- Video Camera with the following characteristics:
  - Make and model: Bosch Dinion LTC0495/51
  - Video capabilities: PAL CCIR 752 x 288, 25FPS
  - Lens: 2,8-11mm 1:1,4 Aspherical
- PC computer with the following characteristics:
  - Make and model: Toshiba Qosmio (Pentium IV, 1,8GHz, 4GB RAM)
- Video acquisition hardware
  - Conceptronics CHVIDEOCR A/D Convertor DAQ board
- BNC Cable 75 ohm , 5 m length
- 1 tripod “Joby Gorillapod SLR Zoom”

Figure 2 - COI1 flume. CATV Camera held in position using a “Joby GorillaPod® tripod” on the existing structure. Connected cable is BNC-terminated.

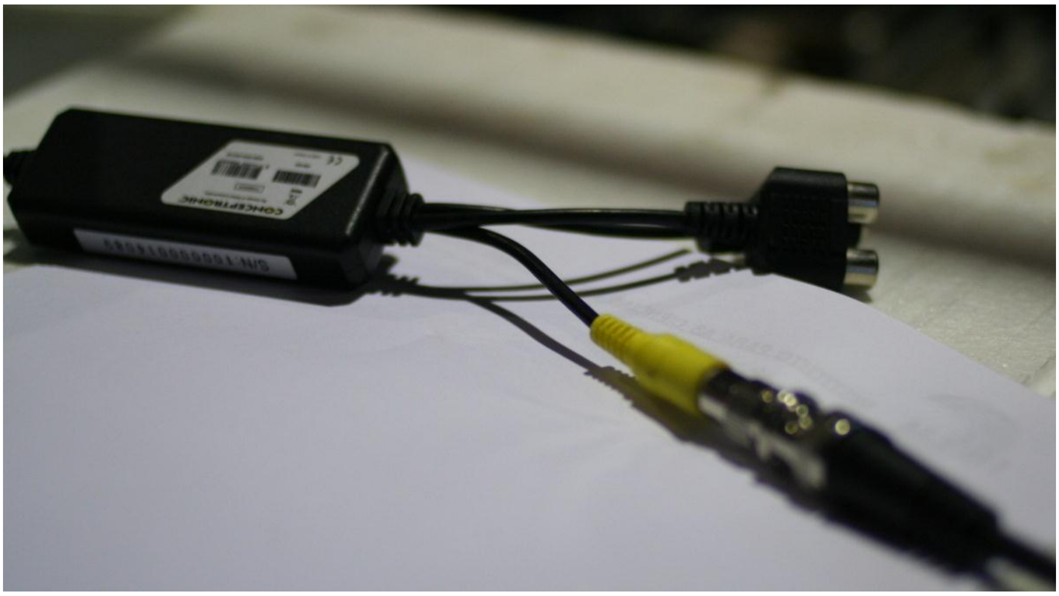

Figure 3 - COI1 flume. Cable connection (with BNC-composite video adapter) between CATV Camera and “Conceptronics A/D Convertor DAQ board”.

Figure 4 - COI1 flume. Laptop computer (Windows XP, 4 GB RAM) used to both receive conveyed video signal from A/D Convertor DAQ board (through USB interface, decode video and send decoded signals to computer server.

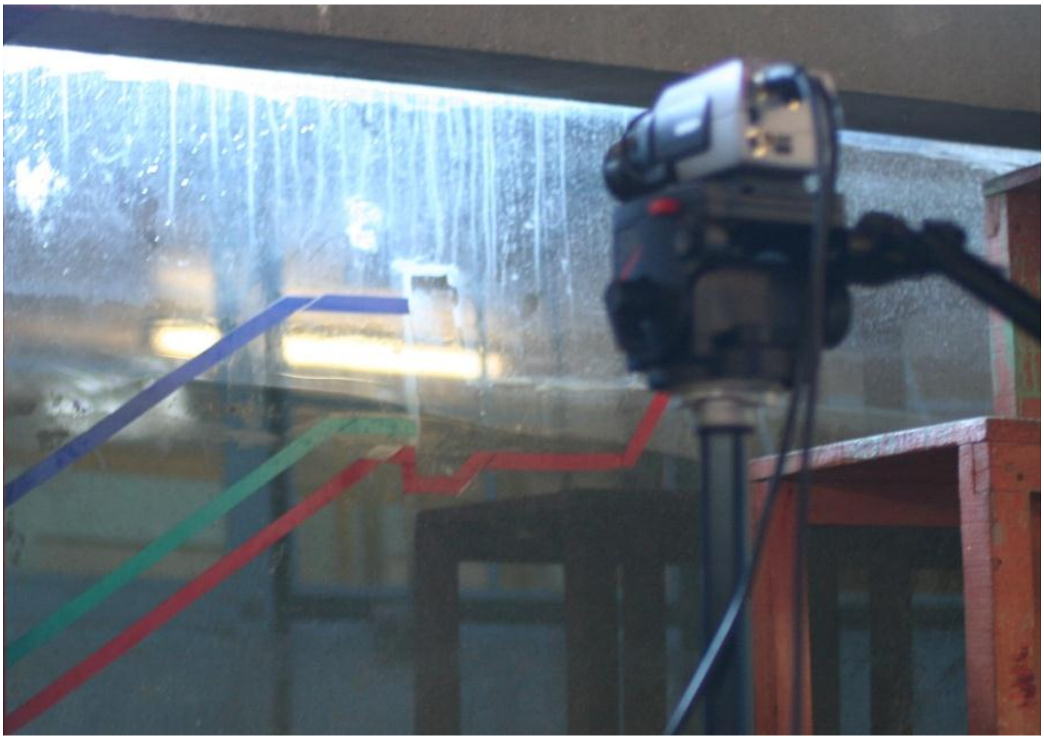

Figure 5 - COI1 flume. A side view from the installed setup. An additional tripod was used.

Figure 6 - COI1 flume. General view of test operation.

Figure 7 shows a schematic used in this experience.

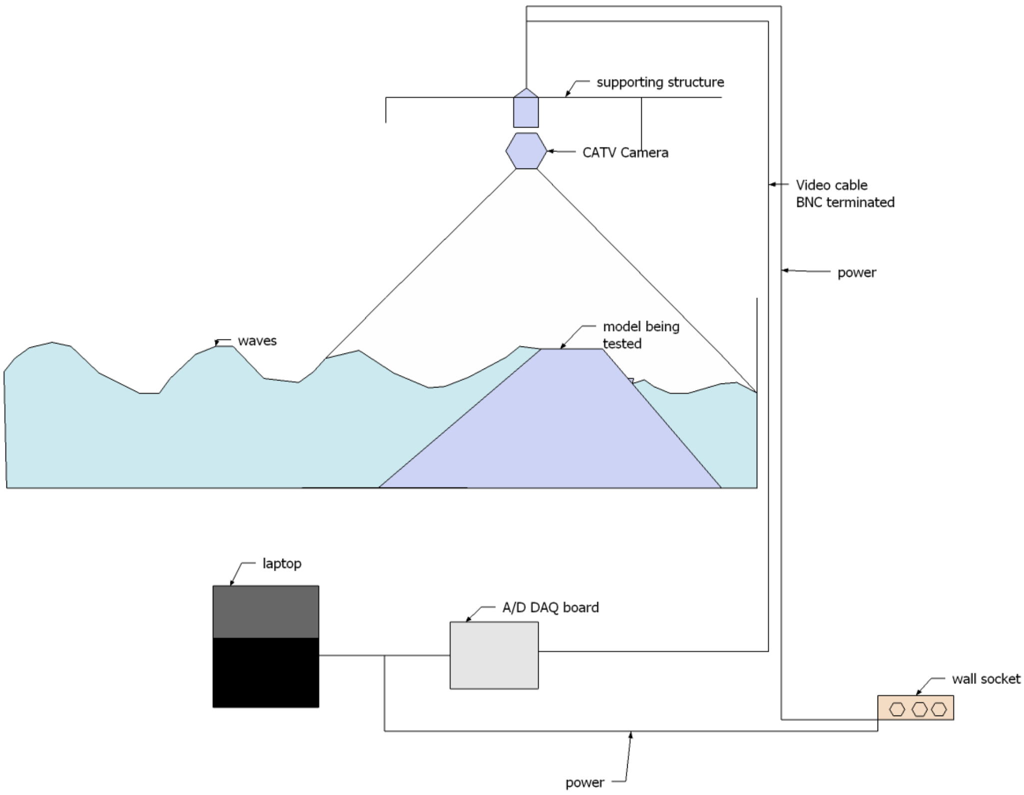

Figure 7 – COI1 flume. Schematic of the installed equipment.

5.3 Software Equipment

The software used in the video decoding and streaming was Microsoft's Expression Encoder 4 (free version). Encoding was established with the following video and audio characteristics:

- Video 25 fps, 1000 Kb/s
- Audio 128 Kb/s (2-channel 16-bit 48 kHz)

Figure 8 – Software equipment.

This is a commercial software program to encode a wide array of video file formats, stream live from webcams and camcorders or screen capture from PC's. It also enables making simple edits to video files and enhancing available media with overlays and advertising. A free version of this software was used in this first experience.

5.4 Description of the remote access experience

The experience took place at 27th January 2012. The following steps were considered in this experience:

- Installation of the equipment:

- Setup of the video camera – on the metallic structure over the flume
- BNC cable connection
- Use of a BNC-composite video adapter
- A/D Convertor DAQ board
- Laptop PC Computer – near the flume

- Use of the free version of Microsoft's® Expression Encoder 4 software (http://www.microsoft.com/ expression/products/EncoderPro_Overview.aspx);
- Activation of the wave generator at the flume to produce waves in the flume;
- Beginning the video transmission to http://wms.fccn.pt/lnec_canal;
- Accessing the web to the video images in different computers (both in the LNEC intranet network, i.e., in the offices of the harbour and maritime structure division and outside LNEC's network), by using:
    - Windows media player (WMP) through MS Internet Explorer (IE), in a PC system, or,
    - Quicktime player through Safari browser if using a Macintosh computer (OS X), provided in this case that "flip4mac" plug-in is installed.
    - Entering at the browser of choice (IE or Safari) the following web address: http://wms.fccn.pt/lnec_canal.

5.5 Results

The experience produced a video file of the whole experience. From these results one may:

- Evaluate the performance of the video transmission.
- Identify the main problems.

In the following figure one can see a snap of the transmitted video:

Figure 9 - COI1 flume. A snap of the streaming video of COI1 wave flume as seen from above.

The main problems observed were:

- **the absence of adequate illumination in the flume**. This is to be corrected by adding a number of luminary items on the flume wall. The number and characteristics of such lamps will be detailed but a starting point would be 2 fluorescent lamps 1 m length 18 W each;
- **the image freezing occurrences**. This is a typical network problem. LNEC's internal network speed should theoretically guarantee 100 Mbps but in reality, on some conditions (high traffic levels and users) a much lower throughput was sometimes available. A solution to this problem is to update existing network cables (coaxial) to optical fibre;
- **the difficulties connecting with the server.** This is a problem difficult to be fully solved. One way of diminishing this problem would be reducing the streaming bitrate but a consequence would be a loss of detail on the transmitted video;
- **the not-so-good image quality (IQ).** IQ is a parameter that works in the opposite direction of the last one, that is, if one reduces the streaming bitrate to improve the connection with the server (as advocated in last item above) a loss of detail on the

transmitted video will occur, and IQ consequently reduces. Therefore a trade-off between IQ and bitrate should be encountered;

- **the optical distortion of the camera lens.** Although the optical properties of the used camera lens are of high quality, a light distortion of the produced video frames is apparent and a geometric correction should be provided. MS Expression software does not correct such optical aberrations and therefore another software should be used.

Several experiences were made:

- Use of different illumination;
- Use of different transmission bitrates;
- Use of only one computer accessing the site;

The main conclusions were that:

  - the use of less indirect illumination (and with a more direct one with some lamps) increases the quality of the images;
  - if only one computer is accessing the site there were no image freezing occurrences;

6 Conclusions

This report describes a first experience on remote access made at the COI1 flume on 27th January 2012. This experience took place on one the maritime hydraulic installations of the Harbour and Maritime Structure Division, of the Hydraulic and Environmental Department of the National Laboratory of Civil Engineering.

The methodology used is based on the use of a video camera installed at the flume, which is connected to a PC computer where the software "Microsoft Expression" capture video resides and where video are images and decoded and sent to a server via HTTP. This server will then enable real-time streaming over the internet, enabling a direct, quasi-real-time access to the video from web users.

It was shown that the methodology is appropriate but several problems occurred that should be solved, namely:

- the absence of adequate illumination in the flume;
- the image freezing occurrences;
- the difficulties connecting with the server;
- the not-so-good image quality (IQ;
- the optical distortion of the camera lens

Use of a different illumination in the flume, a different transmission bitrate, the increase of LNEC's internal network speed and a post correction procedure of the optical lens distortion will likely solve the above problems and constitute future work.

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