WWW REMOTE CONTROL OF THE UNDERWATER ACOUSTICS TANK LABORATORY OF THE INSTITUTO DE ACÚSTICA, CSIC, IN MADRID

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SUMMARY.

The Underwater Acoustics Tank Laboratory at the Instituto de Acústica, CSIC, has been recently reshaped. The new tank framework introduces the installation of two bridges with an automatic control on the three coordinates and the angle (Ranz & Cobo, 1998). In the last months the hardware and software necessary for sequencing the signal acquisition with the bridges motion has been incorporated. While being always necessary one operator, at the laboratory, to survey the tank activities, the actual structure allows to carry the full control of the tank motion as well as the signal acquisition out by any person, at any place, through the usual www network support. This paper describes the actual installation and the facilities involved.

INTRODUCTION.

The Underwater Acoustics Tank of the Instituto de Acústica, CSIC, in Madrid, has been recently reshaped. He old bridge supporting the sound projectors and the one moving the hydrophones are completely new, (Ranz y Cobo, 1998). This step has been complemented by a second taking care of the all procedures implied in the experimentation: signal generation, motion of sensors and signal adquisition. Once the experience to be done within the laboratory tank, has been decided by the remote user (i.e., measuring the reflective/absorptive response of a material to be used as a sonar dome window), the remote control allows to manage all the experience from the beginning to the very end. Only a supervisor operator, back in the Laboratory, is needed to care for a good functioning, including communications. By remote user we understand any authorized person with access to INTERNET.

SYSTEM DESCRIPTION

Figure 1 shows the structure of the System. We have to say that the *trajectory* is the heart of the motion control. Each trajectory can be generated by an special purpose editor. Each trajectory is a sequence of instructions with the beginning and the end coordinates followed by other orders: i.e., to wait for a specific signal to arrive. The PC1 manages all the motions of the two bridges: the two sets of **x, y, z,** and α coordinates (emitter and receiver) via the control box, with the encoders and auxiliary devices that generate the electrical signals, that, on the other hand, allow the motion of the two bridges. He PC1 connects, in real time, with other PC2, via RS232. The PC2 generates the signal to be radiated, and the time sequence (on/off) to be use; PC2 also acquires the received signal . These two missions are carried out with the help of the card PCI-MIO-16E-4 by National Instruments; this card also acts as interface with the control box that is connected to the PC1 through an 8 inputs/8 outputs, and is the final step to have a perfect synchronism between sensors motions and generation and acquisition of signals.

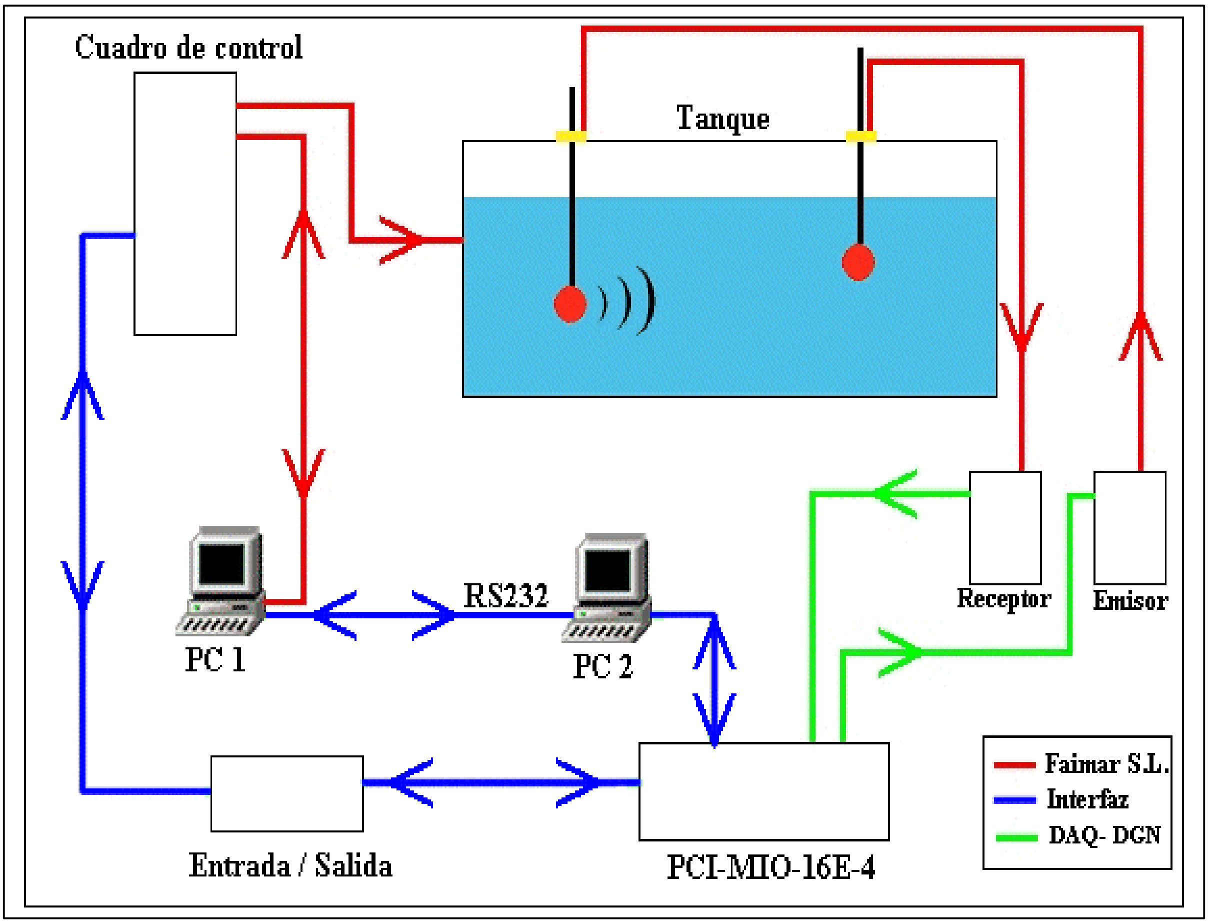

Figura 1. Esquema del Sistema de Control del Tanque Laboratorio.

The qualitative sequence is as follows:

1, The trajectories editor generates the sequence of motion steps. 2, The trajectory is activated in PC1. 3, PC1 via control box orders to both bridges to reach the next position. 4, Once this position is reached the PC1 informs to PC2 of the actual situation. 5. The acquisition card generates the acoustic signal. 6, The acquisition board detects the arrival of the received signal. 7, The board informs to PC1 that the system is ready to make a new acquisition in the next point of the trajectory. 8, PC1 via the control box orders the bridges to move to the next point. 9, At the end of the experience the results are stored in specific files. 10, the files are sent to the remote user by any required mean (encrypted if necessary). All the sequence can be carried out, by the remote user, either automatically or manually, Figure 3.

The acoustic signal is coded within a MATLAB framework, but it can be any according with the facilities of the remote user. As standard signals the laboratory has:

- Sinusoidal
- Square
- Random with a given statistics
- Pseudorandom
- FM
    - + Chirp
    - + Choip
- Personalized

The signal will be called from the user interface, figure 3.

Communication between motion and signal acquisition.

The analogic interface for the digital signals is made from a connecting box with a coupling analogic card. In this way the digital input/output conditioning between the acquisition board and the control box of the bridges, is done. He analogic card is made of 16 terminals (8 in, 8 out). The inputs accept stimulus up to 5 Volts from the board but the signal is amplified, via operational, up to 12 Volts dc. An unavoidable problem of this installation is the high level of e.l.m.noise that comes from the control box; this noise was induced through the cabling into the acquisition board. This problem was solved by means of a first order low pass filter, with 900 Hz of cutting frequency.

The coherent dialog among PC1 and PC2, is introduced by a series communication line that establishes and manages the control of the signals. The communications protocol is such that it reponds to any demand of information of the bridges actual position (x, y, z, and α), by reading the signals in the digital ports, in the acquisition board. The user interface, figure 3, collects the positions of the bridges that came in by RS-232. The positioning demand, of both bridges, always follows the same routine in such a way that the communication is only possible if the bridges are at rest.

The communication process is activated under PC1 demand sent to the acquisition control (PC2). In this process the trajectories editor plays the main role by sequencing the corresponding communications via RS-232. The experience ends under the last order.

Trajectories in the Tank. Basic trajectory components.

The motion of the bridges, in the tank, are function of the activities to be done. Most probably many experiences would locate the sensors along the acoustic axis of the tank and in one unique position (i.e. calibration). In other instances one, or both, of the bridges move carrying simple motions: turns around an axis (i.e., directivity), or straight lines to (or out) a given point. Some times the sensors are to move over a plane. The trajectory editor gives two possibilities: espiral and zigzag. When the trajectory is in 3D, is very important to decide which is the starting exploration surface. The editor provides three possibilities: paralepipedic, cylindrical and spherical surfaces. These three with a companion correction factor can approximate any other surface.

The positioning system allows one last option. Any trajectory can be edited “step by step”. This solution would, eventually, be useful only when the trajectory is so complicated that can not be solved, or approximated, by any basic trajectory. This solution, will be the last option because the internal structure of the editor implies to enter 13 instructions for each elementary motion. It is clear that even very simple trajectories, require a highly tedious process of entering orders. The external text file including all the automatic control instructions, that goes into the memory of PC1 is structured as follows:

- **Coordinates.** Coordinate position and angle where each bridge ends.
- **Velocity.** Velocity at which each bridge moves in % of maximun: 3m/min.
- **Accuracy.** Accuracy of the position in % of maximun: ± 1 mm, ± 0.5º.
- **Waiting time.** The system stops during a preset time, in miliseconds.
- **Input.** No action will be done before a given digital signal is entered.
- **Output.** A digital signal is activated in any of the outputs of the control box.

The limited dimensions of the Tank restrict the amplitude of the trajectories. The

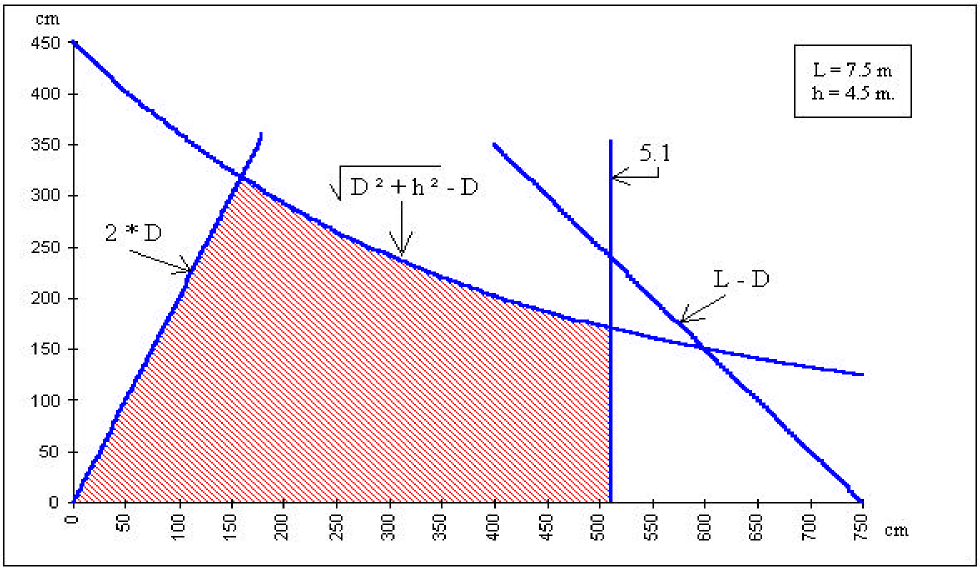

Figura 2. Zona óptima de trabajo en el Tanque considerando todas las posibles limitaciones.Eje abcisas: Separación longitudinal de transductores. Eje ordenadas: Longitud del impulso en cm.

separation distance between sensors is a function of their dimensions, also of their intrinsic properties (i.e., their Q factor), the working frequency range and the tank dimensions. It is important to be in the far field of the emitters and at the same time to have direct signals discriminated against the reflections in the boundary surfaces, figure 2.

In figure 2, D is the separation between transducers, h is the depth of the tank, and L its length. Due to the existence of some “security zones” the actual length of the tank becomes reduced to 5.1 m. In figure 2 the sensors are located along the tank axis. If the type of experience and the specific shape of the sensors are taken into account other criteria intervenes (Ranz, C. 1969). When two or more criteria exist, the most restrictive shall be chosen.

User Interface.

Figure 3 shows, the user interface. This screen informs and allows to act. Through it, the user has full control of the tank. In the upper left the RS-232 control exhibits the actual coordinates of each bridge. At the right hand, three circles inform (when turn to the red color) about the working status of the system: a) arrival to the measuring point, b) emission of the acoustic signal, and c) end of the experience. Under these parts the date and the laboratory clock appear. In the lower left side some parameters of the emitted signal and its sequencing are given: number of pulses per second, manual or automatic control, waiting time between acquisitions, pretrigger time, trigger level, and time span of the presentation in the right hand screens. The sampling frequency has been selected in a previous step. In the lower part of the user interface are the commands: initiate/continue of the generation/acquisition of the signal, the number of the acquisition (if greater than one), and the activation of the “start” and “end” of the experience.

Remote control via Internet.

Today the technological evolution facilitates to share many of our resources with other

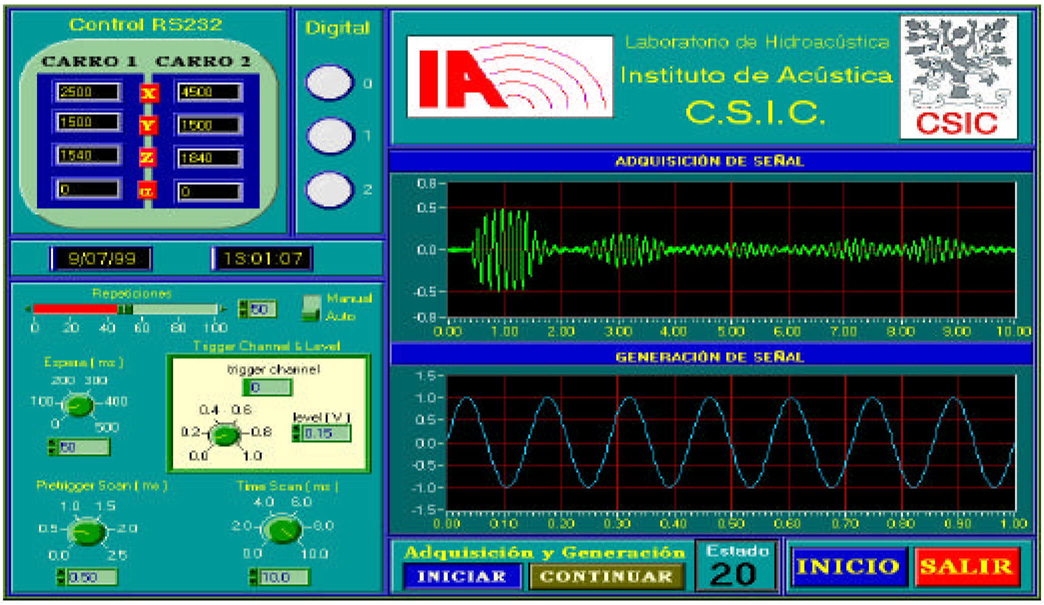

Figura 3. Pantalla de control de generación/movimiento/adquisición de señal.

scientific bodies. Internet has made possible an important increase in making the communications more easy. Profiting from the facilities that actually offers the WWW, the Instituto de Acústica has put forward the necessary framework to facilitate any person, in the world, to work with our Tank Laboratory.

The working method is highly simple. The remote user will have the technological capabilities as he could have if being in our laboratory. The remote user, through the WWW laboratory address, has the mechanism to contact with the laboratory personnel to settle the required information in order to make the experiences properly. This can be a way to palliate the lack of installations of this kind, and so to cover the gap between the primary steps and the experimentation in real medium under controlled conditions and boundaries.

The system offers two different ways to access to the control of the tank.

Remote experimentation without interactivity. The remote user ask for a given experience without any knowledge or control of it. The laboratory personnel will be in charge of making the work. The results will be sent back to the user, (e-mail, FTP or ordinary mail).

Remote experimentation with interactivity. Two different ways are possible: a) *Monitoring of the experience:* The remote user describes the experience he wants to make telling that he will monitor the development of the experiment. The laboratory personnel and the user will agree on the day and time. The remote user will watch at the video picture of the tank bridges (real time), and by TCP/IP will have the user interface (figure 3), telling about all the parameters of the experience. From the user is only required to have a software able to facilitate video conferences as it can be the MS Net-Meeting, that it is offered free. In this case the actual control would be in the hands of the hidroacoustic laboratory. B) *Full control by the remote user:* as it was referred above, the user will decide the type of experience to be done. The difference lies in that, in this instance, the remote user has the whole control of the experience; he acts through the user interface, having at his hands the possibility of modifying (in real time) any of the parameters included in the user interface and making the full experience with complete confidence, if he wants so. It is clear that in this case, the user needs to be very well acquainted with the use and possibilities of the Hydroacoustics laboratory. The remote user needs to have an adequate connection to Internet able to support the transmission/reception data velocities equivalent to videoconferences, as well as the software needed for an IP connection. The laboratory has a high speed Internet connection, which affords a fluent possibility of handling large amount of information, also has a video-camera that gives audio and video in real time with a maximun resolution (for video) of 352 x 288 pixels.

CONCLUSIONS

The experimental structure of the Underwater Acoustics Laboratory of the Instituto de Acústica, CSIC, has been greatly increased. All the procedures involved in the sensors motions as well as the corresponding generation and acquisitions of signals have been established. The introduction of the tank in the WWW, to be controlled by any user anywhere, is perhaps a novelty for this type of installations.

REFERENCES.

Ranz, C., y Cobo, P., "*Underwater facility for automated experimentation and measurement*". J.A.S.A., 103, 5, Pt. 2, pp: 2755. 1998.

Ranz, C.,"*Características Físicas de un Tanque de Experimentación en Acústica Submarina*".Electrónica y Física Aplicada, XII, 45, 1969, 1-5.

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