Design and implementation of a data acquisition system for the study of dynamics signals in the time Domain.

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Abstract. The purpose of this research was to design and implement a data acquisition system for the study of dynamic signals in the time in order of nanoseconds, through the use of electronic instrumentation to obtain the temporal profiles of light signals, such as pulses of light from a laser or fluorescent light signals. To carry out the design and implementation of the data acquisition system proposed, we used a rapid response transducer and a data acquisition card of high speed. As well, it was developed a graphical user interface for visualization, analysis and study of the data acquired. Thus, it was possible to perform the digitization of a pulse on the order of nanoseconds, as well as the acquisition of fluorescence signals of different wavelengths, from which to obtain theoretical and experimental valuable knowledge based on the physics of spectroscopy.

1. Introduction

Some of the most important aspects in the characterization of new compounds for the development of tunable pulsed laser are their temporal profile of laser emission pulse [1,2], the dynamics of fluorescence compounds of interest in optical spectroscopy, the information on dynamics fluoresce induced in human and bacterial cells, with purposes of implementing diagnostic techniques based on these dynamic phenomena [3]. In some of these sources, the light output changes randomly as well as its temporal profile overtime, due to various causes of physical or technological construction [4,5]. One way to get information about this changes in the power of light source is through the continuous reading of current measurements in the time [6,7].

On the other hand, nowadays at the Universidad Popular del Cesar, there is not a minimum infrastructure for undertaking research of this type, mainly based on the study of dynamic signal in the time domain. Therefore, it is considered very important a project that allowed the acquisition of these signals in the time domain to obtain measurements of light output at intervals very short in the time, such as the order of nanoseconds, with market elements in the context of the interests of the Laser and Spectroscopy Group of the Universidad Popular del Cesar.

The present research offers a solution by members of laser and spectroscopy group with the design and implementation of a data acquisition system for study dynamic signal in the nanosecond using virtual instrumentation as a real and effective alternative to overcome the lack of this device on the minimum infrastructure for undertaking research activities required in this area.
2. System Design and Implementation

The data acquisition system consists of a platform for encapsulating the light in an optical fiber, a sensor capable of converting the light signal into an electrical signal, a variable resistive adapter for conditioning the signal from the sensor, a digitizer card high speed capable of sampling at a rate of 2 GM/s, and finally a graphical interface developed in labVIEW – graphical programming language, for analysis and visualization of the signal under study [8]. Next there are descriptions of these elements:

2.1. Platform to focus the laser light in an optical fiber: As a first step for the treatment of the sign of study, it was necessary to acquire a platform for the optical fiber and this way to lead the optical signal in a lens into the fiber to do easier the management of this signal, this is carried out with the micro block of free space MBT613 (see Figure No. 1), which is a nanopositioning of states of three axes developed to meet the most stringent requirements associated with optical fiber alignment, that includes 300 µm fine adjustment with 50 nm resolution and 4mm 3-axis adjustment range.

2.2. High-Speed Detector: The DET10A Sensor was used to convert light signal to an electrical signal. This photo-detector covers the wavelength range from the UV to the mid-IR (200nm – 1100nm), with rise time of 1ns. The DET10A comes with a fast PIN photodiode, an internal bias battery packaged in a rugged aluminium housing, and has a Bias-T circuit that combines a high-frequency AC signal with a DC signal into a single output. The direct photodiode anode current is provided on a side panel BNC. This output is easily converted to a positive voltage using a terminating resistor. When using a photodiode with a reverse bias, a small photocurrent is produced when the photon is absorbed. Typically, a 50 Ω resistor is used to maximize the bandwidth. In this case, we used the VT1 Variable terminator, which offers a choice of seven discrete resistance settings which can be easily selected from the outer rotary barrel.
2.3. **High – Speed digitizers:** we used the NI PCI-5152 high – speed digitizers / PC based oscilloscopes provides 2GS/s maximum real-time sample rate, 300 MHz bandwidths and 2 channels simultaneously sampled. This card uses the PCI bus high-speed direct memory access (DMA), which is the technique implemented to move data high speeds to the computer without processing unit involved in the process central, and which can be speeds up to 100 time higher that oh the interfaces traditional instruments of there is reduced dramatically total test time.

![Figure 4. High-speed digitizers NI PCI - 5152](image)

2.4. **Graphical user interface:** The software is the key to the virtual instruments and replaces the traditional instruments, in such a way that this is an important item in the development of systems for data acquisition and control, in addition the interface get control the interaction of hardware specifications [9,10]. We used LabVIEW, which is an integral part of virtual instrumentation; this provides an environment for developing applications that is easy to use bearing in mind the needs of engineers and researchers. One of the most powerful features is that LabVIEW has a graphical programming environment, where you can design custom virtual instruments. For the design of graphical user interface in LabVIEW, the controls, buttons, menus, displays and other items needed for software design are placed first on the front panel. The purpose of these objects is to interact with the user so that it can configure the input signal and display properly study the waveform being captured [10]. The interface designed can be observed en figure 5 and 6.

![Figure 5. Graphical user interface in LabVIEW](image)
![Figure 6. Block Diagram of the user interface in LabVIEW](image)
An additional way to use a graphical user interface is to use a software application to this case, the NI Scope Soft Front Panel, which is the application software for data acquisition card NI PCI-5152 obtained for this project. Besides the advantage offered by this software application as time-saving programming interface, enables us to use, as this is an interactive program that resembles the traditional oscilloscope screen to provide easy operation with system interface. In addition to providing access to the basic functionality of all digitizer cards, the software provides real-time measurements as well as the ability to save data to a file for further processing and analysis.

![NI Scope Soft Front Panel](image)

**Figure 7.** NI Scope soft From Panel – NI PCI - 5152

3. Results and conclusions

With the design and implementation of a system of data acquisition for the study of dynamic signal resolved in time (see figure 8), it was possible to sample signals in the order nanosecond, capture fluorescence signals in the ultraviolet and obtain light pulses from a photodiode laser in the red region of the visible spectrum seen through the soft front panel program NI scope with a graphical user interface easy to use.

![System of data acquisition](image)

**Figure 8.** System of data acquisition for the study dynamic signal resolved in time
Validated the data acquisition system with the capture of a sinusoidal signal from a 48 MHz powered by a crystal DC voltage of 4 Volts, which is equivalent to 20.8ns period (see figure 9).

![Figure 9. Signal powered by a crystal obtained with the System of data acquisition for the study dynamic signal resolved in time](image)

Additionally we analyzed the signal from a nitrogen laser (see figure 10)

![Figure 10. Fluorescence signal from a Nitrogen Laser obtained with the System of data acquisition for the study dynamic signal resolved in time](image)

With the design and implementation of the data acquisition system for dynamic signals in the time, we have gained valuable experimental knowledge in the spectroscopy to characterize the temporal profiles of light signals such as pulses of laser light and bright fluorescence signals of samples of interest, based on the implementation of a data acquisition card, using the electronic instrumentation and laser physics for the contribution of electronic engineers to the infrastructure of Laser and spectroscopy Group in the Universidad popular del Cesar
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