DATA ADQUISITION SYSTEM DEVELOPMENT FOR ON ROAD MEASUREMENTS IN HEAVY VEHICLE FRAMES

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Abstract—Many different methodologies have been used for heavy vehicle frames design, whose goal is to optimize the predicted frame behavior. On road measurements will allow to increase the precision when predicting the stress and strain on the frame.

Keeping the abovementioned information in mind, and given the importance of this process, our research group concluded it is necessary to develop a Data Acquisition System capable to carry out this task both quickly and accurately.

This paper will show the developing of the Data Acquisition System used in several on road test of a semitrailer frame at Applus IDIADA test track. This report will explain all of the possibilities that the testing offers from data capture to its processing and analysis.

Keywords—Data Acquisition System, on road, frame, vehicle

I. INTRODUCTION

THE aim of this work is to develop a Data Acquisition System (DAS) for on road measurements [1], making an easier data acquisition and processing.

The types of sensors to be used are: strain gauges, displacement and tilt transducers and accelerometers. Following, the most relevant issues of the DAS will be shown.

II. DATA ACQUISITION HARDWARE

The hardware used for the DAS, manufactured by IOTECH, is a general purpose hardware, which has been properly adapted to the magnitudes to be measured.

Following, the different parts of the DAS are described:

1. Expansion module DBK41: It is able to host up to ten DBK cards inside.
2. Four DBK13 cards: Multiplexor analogic cards with 16 inputs. The inputs can be differential or simple. They are connected in the slots of the DBK41 module.
3. DaqBok 200: Supports up to 256 analogic channels with a 16 bits resolution and a maximum sampling rate of 100 kHz. It communicates with the PC with an LPT1 port.

Fig. 2 shows the DAS. In the upper part shows, the PC. The DaqBok 200 is placed below. Then the DBK41 is shown and finally the DBK cards can be seen.

Regarding to the signal conditioning, in order to measure the strain, a series of Wheatstone bridges where made.

Fig. 1 shows a Wheatstone bridge [2]. It is formed by two resistance branches, plugged between the input voltage and the ground. One of these resistances is the strain gauge, and the output voltage is measured between both branches. If the bridge is balanced and the strain gauge is not stressed, the output voltage should be 0V [3].

There are three mounting types: with one, two and four strain gauges [4]. The measurement is done by getting the voltage on the bridge terminals.

A total of four cards with a capacity to host eight channels were designed. The strain gauge connection set up is quarter bridge, that means that only one strain gauge per bridge is connected. Once it was checked that the temperature influence is negligible [5], the quarter bridge configuration was chosen for simplicity reasons, as the

other configurations would require more than one strain gauge per bridge, what would require a higher test conditioning work .
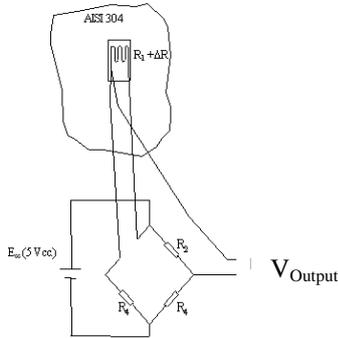

Fig. 1. Wheatstone bridge scheme.

A three cable connection to the strain gauge has been used to reduce the cable length influence. The Wheatstone bridges are supplied with a 5V voltage.

Fig. 3 shows the Wheatstone bridge design.
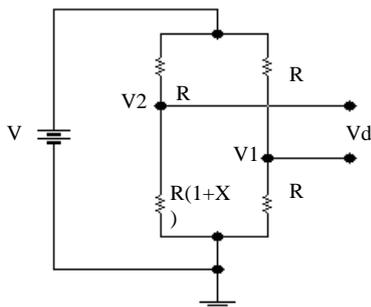

Fig. 2. Data Acquistion System components

Fig. 3. Quarter wheatstone bridge.

Fig. 4. Shows the final DAS design, with the Wheatstone bridge rack.

Fig. 4. Data Acquisition System.

III. DATA ACQUISITION SOFTWARE

The computer program used to control the DAS was developed using Labview, which is a computer tool designed to monitor, control, automatize and analyze analogical and digital signals acquired from serial ports, data acquisition cards and GPIB´s (General-Purpose Instrumentation Bus) [6]

The program task flow first gets the data from a portable DAQ (DAQBOOK/200) and sends it to a computer. Then this data is processed by the program returning the data for later analysis. The program controls not only the data type but also the way they are acquired, processed and stored.

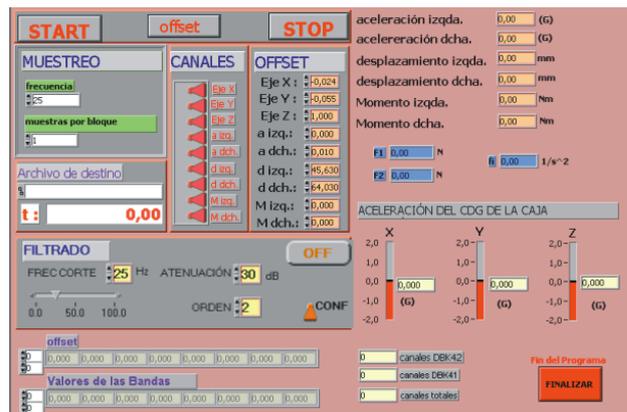Fig. 5 shows the IT application control panel:

Fig. 5. Control panel of the DAS IT application.

The control panel clearly shows two sections. The first one, on the upper left of the screen, contains all the user controls to start and stop the DAS, to select the channels to be recorded, etc…

The second one, on the on the lower right and left of the screen, shows the most relevant data in real time.

The upper left part of the screen is divided in the following panels: sampling, channels, offset, destination file and filter.

Fig. 6 shows the sampling control. It allows setting up the data acquisition frequency, which will change with the test type.

It can also let setting up a block sampling as when using high sampling frequencies it allows to save them in the DaqBook, avoiding data leaks.

Fig. 6. Sampling control panel

. Fig. 7 shows the channel control panel for the wheel axle. It allows selecting the channels to be stored.
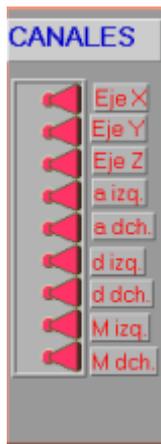

Fig, 7. Channel control panel for the wheel axle.

. Fig. 8 shows the offset control panel, which allows making the offset of any of the channels to be measured. This function corrects the offset error for each transducer and only runs when they are plugged.
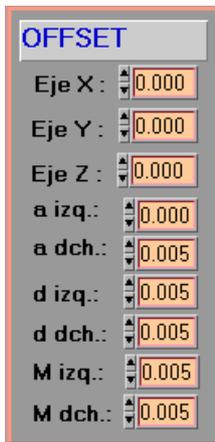

Fig, 8. Offset control panel for the wheel axle.

. Fig. 9 shows the filename and path where the acquired data will be saved, prior to the measuring. In the lower part, it can be seen the elapsed time since the START button is pressed.

Fig, 9. Filename control panel

Fig. 10 shows the filter control panel. It can be activated when clicking the on/off button. When the filter is on, the measured data will be filtered and then stored. The filter type is a Low Pass Chebyshev, and the parameters to be applied: the cut-off frequency, the attenuation and the filter coefficient order.
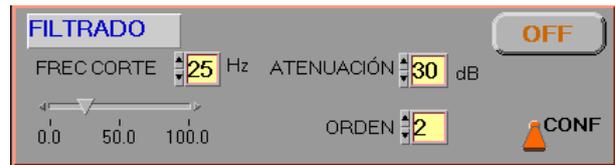

Fig, 10. Filter control panel.

The signal conditioners for the displacement sensors and accelerometers have a hardware integrated Lowpass filter, so there is no need to use the software filter and filtering should be deactivated in such channels.

Fig. 11 shows the read data for the strain gauges, placed in the semitrailer frame, in real time. The first row shows the offset for each channel. The second one the strain values, and the column on the right, the active channels during the data acquisition.
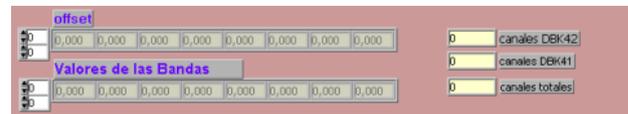

Fig, 11. Filter control panel.

Once the start button is pushed, the main screen changes. Fig. 12 shows the new screen.

The upper right section shows, on real time, the indirect measurements made by the program using predefined computations. It shows the axis angular acceleration, according to its center of gravity, or the excitation force on the frame induced by the pneumatic interaction with the road and the axis suspension [7].

Fig. 13 shows a detail of the new panels. The data on the orange background are the measured ones, while the

blue ones are the computed from one or more sensors.

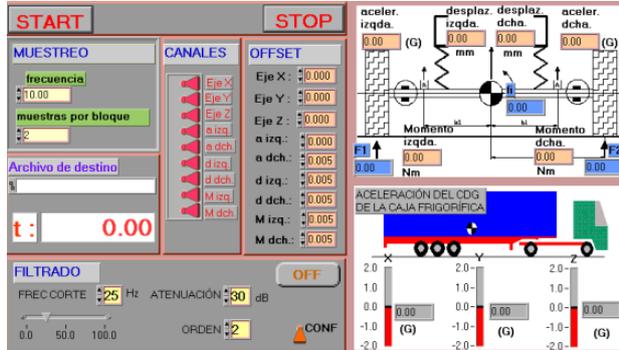Fig. 14 shows the acceleration values on the semitrailer center of gravity.

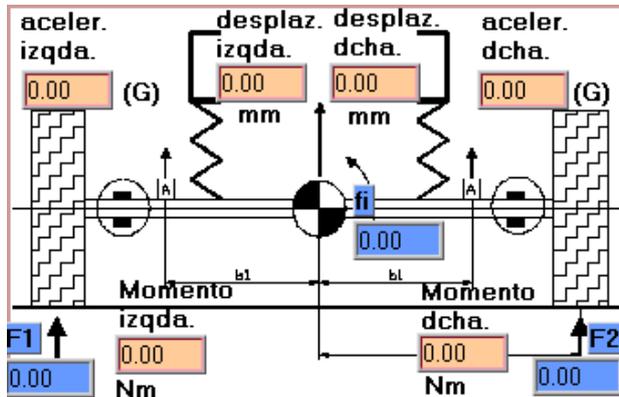Fig, 12. New screen after pressing the start button.

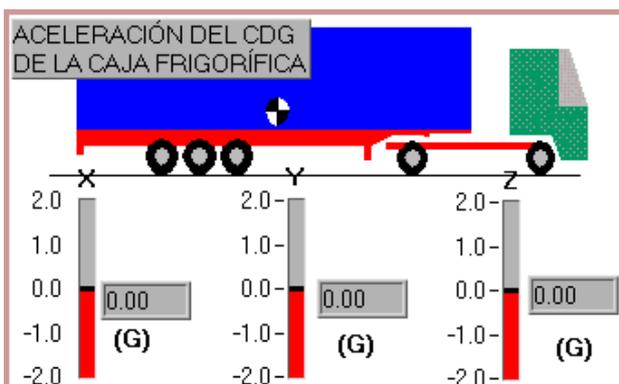Fig, 13. Computed and measured magnitudes on wheel axle.

Fig, 13. Semitrailer acceleration measurement on the center of gravity.

The software is designed to be used as a standalone program as well as to be integrated in other programs as "subvi"

IV. CONCLUSION

Once the DAS was developed, it was used in several on road tests. The results have been thoroughly satisfactory as the acquisition task was made in a simple and fast way. The test set up was done in only a few minutes and it was no need any additional data processing, simplifying significantly the essay compared to previous experiences.

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