Development of Zero Cost Digitizer based Data Acquisition System

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Introduction

Digital Signal Processing (DSP) has been the technology of choice in many contemporary nuclear spectroscopy endeavours owing to faster processing and capability of handling the ever increasing event rate from the state-of-the-art experimental facilities. Development of DSP based systems is imperative to provide an insight into the operational aspects and conclude on the recommended range of parameter values to be implemented in the actual experimental setups [1]. In this paper, we report a developmental endeavour using **open source hardware resources** and computational toolkits, readily available in the modern laboratory environment.

Experimental Details

The Analog-to-Digital conversion is the first operation carried out in a DSP based system wherein an ADC is used for the purpose. In the present work, the sound card in a computer has been used to perform the ADC operation. Since, the sound cards are equipped with a high resolution in-built ADC chip, the same provides an efficient cost-saving alternative for the conventional ADC's. However, the ADC chip in the sound card is limited by low sampling rates. Nevertheless, it is adequate for a experimental scenario with moderate event rates. Input from a pulser / detector (preamplifier) has been fed through the microphone input of the computer. The readout of the data acquired on the sound card has been carried out either using the relevant application available on the Windows XP operating system or an independent, freely available software, AUDACITY. The data files, acquired in the .WAV format, have been subjected to the filtering algorithm implemented on MATLAB®. Alternatively, a Digital Signal Oscilloscope (DSO) has also been used for the aforesaid digitization of the pulser / preamplifier pulse, for comparison.

Programming and Results

The data file acquired from the sound card is read into the MATLAB® program for processing. The raw data file is first subjected to a 4-point averaging procedure and facilitate the subsequent steps. Next, a peak detection algorithm is implemented to identify the pulses of interest. The detected peaks are then subjected to a filtering operation wherein the widely used trapezoidal shaping is used. The recursive algorithm for trapezoidal filter [2] is as follows.

$$y(n) = y(n-l)+x(n)-x(n-k)-x(n-l)+x(n-l-k) \tag{1}$$

where $x(n) = input$, $l = k+m$, $m = flat\,top$ and $k = rise\ time$.

The amplitude of the filter output is read and stored in an array for histogramming (generation of spectrum). The Fig. 1 and Fig. 3 represent various stages of the aforesaid processing. It is noteworthy to mention that the rise time and the flat top of the trapezoidal filter have to be optimized, depending on the input pulse. Efforts are underway to apply the algorithms to real detector (scintillator

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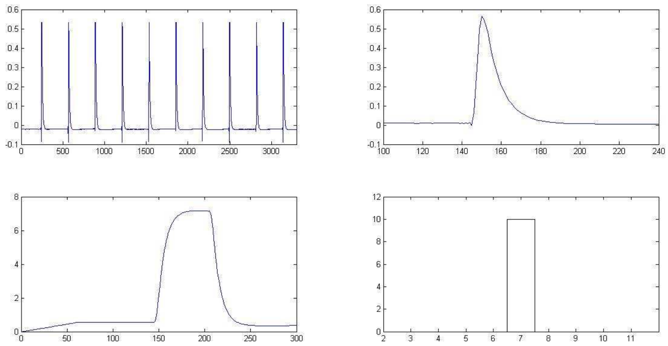

FIG. 1: (Upper left) Pulser output captured by a sound card and read in MATLAB. (Upper right) Zoom on a single pulse. (Bottom left) Filter output following trapezoidal shaping. (Bottom right) Spectrum generated from the data of 10 pulses. The pulse height (4 units) has been extracted from reading amplitude of the filter output.

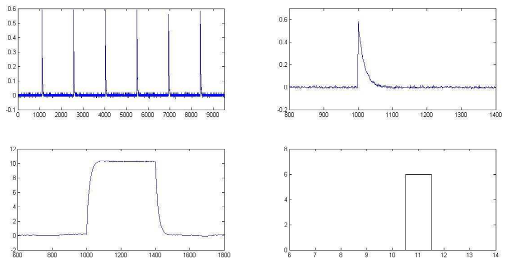

FIG. 2: Similar to Fig. 1 except that the pulser output has been captured by a DSO.

and HPGe) pulses captured through sound card / DSO. It may also be stressed that, in the absence of toolkits like MATLAB®, the same algorithm can be implemented through any programming language with graphics support from free softwares like ROOT [3] and DISLIN [4]. We have thus demonstrated the development of a modest DSP based data acquisition system that is expected to aid education and training purposes.

References

[1] A.K. Tiwari *et al.* Proc. DAE Symp. on Nucl. Phys. **57**, 944(2012).

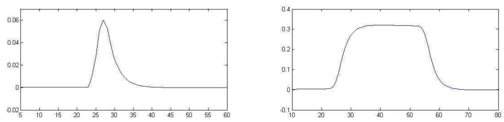

FIG. 3: (Left panel) Pulse from HPGe as captured by a sound card with AUDACITY and (Right panel) corresponding output from trapezoidal filter. The result is preliminary and being optimized.

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[3] http://root.cern.ch/drupal/
[4] https://www.mps.mpg.de/dislin/