The Design of High Speed Acquisition and Storage System Based on Labview

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ABSTRACT: The design of high speed data acquisition and storage system is based on Labview. It can not only achieve high accuracy and high data rate but also use the software and hardware synchronization trigger to complete the multi-channel continuous real-time monitoring of the acquisition and storage periodic signal. Which is similar to the function of the oscilloscope. This system is based on high speed data acquisition card of NI company and Labview 2012 for PC software development platform. Data acquisition card is used to finish data acquisition of periodic signal through the serial port. It also collect data upload to upper computer. Upper computer collect data for storage, display and analysis to realize the real-time monitor of multi-channel analog. The design of the sampling channel is 2, the sampling rate up to 200M/s, the sampling precision is 12 bits, and the sampling depth is 2000. Lots of verification prove that the design has good compatibility, performance and stability of the collection. Data error is negligible by analyzing the data collected. More importantly, the design can be as far as possible to restore the actual signal source data without distortion. This paper provides a portable design for high speed data acquisition, which can be widely applied in the engineering of modern test and measurement technology.

1 INTRODUCTION

Nowadays, the mainstream design in the traditional data acquisition system has two ways. One of which is to utilize data acquisition card and PC system architecture design, the other is based on MCU and PC system architecture of design [1]. In this paper, aimed at the price of high speed data acquisition card is too high and the data acquisition card memory is not big enough to solve the problem of mass data storage [2]. Focus on acquisition of periodic signals, what’s more it can’t use the trigger mode to control the signal acquisition. The design in such a context is nurtured and hygiene. Based on the American company NI data acquisition card, using PC Labview system, software and hardware of the synchronous trigger can complete high speed and long time of continuous sampling of periodic signals. The design also can store the data in the form of Excel file in order to facilitate subsequent analysis. It provides a good platform for the subsequent analysis, data processing and data acquisition.

The design is based on using the second development of DLL to achieve high sampling rate [3]. The validation results show that the system has high speed sampling, continuous sampling hardware and software synchronization trigger. It is convenient for users to use the design in the data analysis and data processing. Users can continue to develop on this design to meet their different needs by system programming design.

2 System programming design

The high-speed data acquisition and storage system is based on Labview. It was composed of virtual instrument programming block diagram and front panel which correspond to programming block diagram.
Fig1: This is a high-speed data acquisition and storage system block diagram based on Labview. Firstly, the instrument initialization. It contains setting appropriate sampling rate and channel port in Labview. Secondly, Through setting the trigger mode of rising edge in data collection and setting appropriate time to collect samples of the signal data. After the parameter setting is completed, the system will collect the data when receiving the rising edge of the pulse[5]. At the same time it will collect data in a cumulative way. When the data acquisition is completed the acquisition data will be stored in the form of excel. Thirdly, when the sampling time reaches acquisition time which have been setted in program design[6]. The program will automatically determine that the process of data collection and storage is completed. At last, after completion of the data acquisition. The collected data will be displayed by waveform chart in the front panel of the system[7] . so a data sampling period is completed[8].

Figure 1. The block diagram of high speed data acquisition and storage system

Figure 2. Data acquisition and storage of the Labview program
Fig 2: The upper-left corner of the block diagram is a timing module. The function of this module is used to control the length of time in the process of data collection. User can set the appropriate sampling deadline according to their requirements. The bottom left of the block diagram is a data storage module, the role of data storage module is to store the collected data in the form of an array. It will be stored in the specified path in the folder. The middle portion is a block diagram of the structure to determine whether the conditions to collect the data, if the data is collected. Then it will be stored in the data array 2[9]. The following program is a conditional construct. It makes the collect data converted into dynamic data and the data will be accumulated in the front panel display after setting a appropriate time. More important is the design can complete dual-channel signal acquisition and data storage capabilities. The block diagram is used in the design of channel 1 for data collection and storage, Users can choose to use channel 1 or channel 2 for data collection. On the right side of the block diagram is to start, stop, and set the sample rate button[10]. Appropriate sampling time should be set before the user wants to data acquisition. time can be set according to user’s requirements.

As is shown in Fig 3: Users can according to their needs to set an appropriate sampling rate. The highest sampling rate up to 200MB/s can meet users’ different requirements. As a result, it can complete high-speed data acquisition target[11].

3 The verification of system

3.1 Frequency verification

Use the signal generator and matlab simulation software can verify the accuracy of the high-speed data acquisition and storage system. In the first, user can use signal generator to generate a 1MHZ frequency and amplitude is 1volts square wave. Then, set sampling rate 200MB/s (200MB/s correspond to 500ns/div in the front panel). Through the high-speed data acquisition and storage system. It can be seen from the front panel that waveform data has been collected (Fig 4). At last ,through matlab software we can restore the acquired waveform data (Fig 5).
By calculating, it can be seen from the image that a periodic signal contains 100 points. According to the formula, it can be calculated $T=\frac{200}{(200\text{M/s})}$, $f=\frac{1}{T}=1\text{M}$. According to fig 5, we can see that the amplitude is about 1 volts. From the diagram it can be proved that the system adopt rising edge triggered mode to collect data.

Next use signal generator to generate a 1KHZ frequency and amplitude is 1 volts square wave. Through the high-speed data acquisition and storage system. It can be seen from the front panel that waveform data has been collected (Fig 6). Through matlab software we can restore the acquired waveform data (Fig7). The sampling rate 100k/s correspond to 1ms/div in the front panel. It can be seen that a periodic signal contains 100 points, by calculation, according to the period signal $T=\frac{100}{(100\text{k/s})}$ =0.001s, $f=\frac{1}{T}=1\text{k}$.

The above calculation can complete the verification of the frequency in the design. The system is able to identify different frequency from acquiring different signal datas.
3.2 Amplitude verification

In the first, use signal generator to generate a 1KHZ frequency and amplitude is 10volts square wave. Then, set sampling rate 100k/s (100k/s correspond to 1ms/div in the front panel). Through the high-speed data acquisition and storage system. It can be seen from the front panel that waveform data has been collected (Fig 8). At last, we can restore the acquired waveform data through the matlab software (Fig9).
By calculating. It can be seen from the image that a periodic signal contains 100 points. According to the formula, periodic and frequency can be calculated $T=100/(100k/s)$, $f=1/t=1k$. According to Fig 9, we can see that the amplitude is about 10volts.

According to the analysis of the input 1KHZ 1volt square wave in the frequency verification process, we can draw the conclusion that the system can identify different amplitude from acquiring different signal datas.

### 3.3 Phase verification

Use signal generator to generate a 1KHZ 1volts sine wave. Through the high-speed data acquisition and storage system, It can be seen from the front panel that waveform data has been collected (Fig 10). Through matlab software we can restore the acquired waveform data (Fig11). The sampling rate 100k/s correspond to 1ms/div in the front panel. It be seen in the signal of a cycle is 100 points, It can be calculated according to the period signal $T=100/(100k/s)$ $=0.001s$, $f=1/t=1k$.

According to the analysis of the sine waves in the frequency verification process, we can draw the conclusion that the system can identify different phase. The validation results are summarized as Table1:
### Table 1. PLATFORM VALIDATION RESULTS

<table>
<thead>
<tr>
<th>Parameter validation</th>
<th>System verification scheme</th>
<th>System validation results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency verification</td>
<td>Input a 1KHZ 1volts square wave and 1KHZ 10volts square wave</td>
<td>The system can track the change of signal source amplitude</td>
</tr>
<tr>
<td>Amplitude verification</td>
<td>Input a 1KHZ 1volts square wave and 1MHZ 1volts square wave</td>
<td>The system can track the change of signal source frequency</td>
</tr>
<tr>
<td>Phase verification</td>
<td>Input a 1KHZ 1volts square wave and 1KHZ 1volts sine wave</td>
<td>The system can track the change of signal source phase</td>
</tr>
</tbody>
</table>

### 3.4 System usable range

Using signal generator like GWINSTEK model of SFQ-2120 to test the application of the system scope as Table 2.

#### Table 2. SYSTEM USABLE RANGE

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test signal</th>
<th>Standard deviation</th>
<th>Variance</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>amplitude</td>
<td>0.1~10V</td>
<td>2.225</td>
<td>1.5</td>
<td>96.25%</td>
</tr>
<tr>
<td>frequen cy</td>
<td>10hz~1Mhz</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td>phase</td>
<td>trian gle ,rectangle and sine and other waveform</td>
<td>0</td>
<td>0</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>500ns/DIV ——</td>
<td>200us/DIV ——</td>
<td>200MSa/S</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1us/DIV ——</td>
<td>100MSa/S</td>
<td>500us/DIV ——</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2us/DIV ——</td>
<td>50MSa/S</td>
<td>1ms/DIV ——</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5us/DIV ——</td>
<td>20MSa/S</td>
<td>2ms/DIV ——</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10us/DIV ——</td>
<td>5MSa/S</td>
<td>5ms/DIV ——</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20us/DIV ——</td>
<td>1MSa/S</td>
<td>10ms/DIV ——</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50us/DIV ——</td>
<td>2MSa/S</td>
<td>20ms/DIV ——</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100us/DIV ——</td>
<td>1MSa/S</td>
<td>50ms/DIV ——</td>
</tr>
</tbody>
</table>

### 4. Conclusion

The design of high speed data acquisition and storage system uses Labview development platform and data acquisition card based on secondary development of Labview. It can finish testing signal data in real-time, which can be shown and stored in the front panel of the design[12]. More importantly, It use the software and hardware synchronization trigger to complete the multi-channel continuous real-time monitoring of the acquisition and storage periodic signal. Experimental results show that the system maximum sampling rate of up to 200M / s. The sampling rate can meet the vast majority of user’s different requirements[13]. It is also have an effective way to realize continuous sampling for a long time without taking the memory of data acquisition card into consideration[14]. It provides a portable design for high speed data acquisition, which can be widely applied in the engineering of modern test and measurement technology.

### Appendix

Acquisition rate correspondence relation as follows

### Acknowledgements

This paper was supported by the National Natural Science Foundation of China (No. 61661050) and the major project of Kunming Forestry Information Engineering Technology Research Center (No.2015FJA02).

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