Audio signal processing system design using LabVIEW

Liljana Docheva [1]

Abstract – **In this article the audio signal fundamental tone measuring with LabVIEW is given. This is necessary for audio signal analysing, in particular for speech signals processing. The LabVIEW environment gives a possibility for creating custom audio measurements applications which interact with real-world signals. Using LabVIEW software and hardware module and personal computer can be performed complex signal analysis.**

Keywords – **LabVIEW, audio system, fundamental tone measurement.**

I. Introduction

The audio signal fundamental tone measuring is important process necessary for audio signal analysing. In some cases results may be improved through the use of preprocessing of the spectrum prior to fundamental tone measuring. The most commonly used methods are: Pre-emphasis and Masking. The first method consists in equalizing the spectrum in aim to flatten it. In the second method all peaks are rejected below an inaudibility threshold which is the maximum of the threshold of hearing. The reason is that, small peaks close to much larger peaks are often masked by the auditory system. Since it is simple to extract peaks in descending magnitude order, each removed peak can be replaced by its masking pattern, which elevates the assumed inaudibility threshold [1]. Measurement of the fundamental frequency is applied in a wide range of fields [4].

In this paper the audio signal fundamental tone measuring with LabVIEW is given. Two approaches are described: the first is real time fundamental tone measuring and the second is for vowels, recorded in „wave“ format. For this aim individual vowels from man or woman spoken are used. It isn't need of preprocessing. The specifics of LabVIEW application for fundamental tone measuring are explained in the next section.

There are several ways to measure a basic tone. Commonly autocorrelation function is used. It is defined for a continuous signal by Eq. 1:

$$R(\tau) = \frac{1}{(t_{\max} - t_{\min})} \int_{t_{\min}}^{t_{\max}} s(t)s(t+\tau)dt \qquad (1)$$

Where, s(t) is the sound waveform, τ is the delay time and $[t_{min}, t_{max}]$ is the integration interval [3].

LabVIEW software provides finding fundamental tone by the highest amplitude on the signal measuring [2]. The virtual instrument that can be used is Tone Measurement Express. Other virtual instruments, which are necessary and LabVIEW block diagram are described below.

[1] Liljana Docheva is with the Faculty of Telecommunications at Technical University of Sofia, 8 Kl. Ohridski Blvd, Sofia 1000, Bulgaria, E-mail: docheva@tu-sofia.bg.

II. LabVIEW Application for Fundamental Tone Measuring

Using LabVIEW software and hardware module enables solving the problem, described above, in two ways. One of them is to record the vowels in „wave“ format, then they can be processed with aim to measure fundamental tone. LabVIEW block diagram is shown in figure 1. The LabVIEW version is 12.0f3.

Individual vowels from man or woman spoken are recorded as wave files. The required file is selected which ***svx_Get Wav List.vi*** and ***File Dialog*** virtual instruments. After reading the waveform with ***svx_Snd Read Waveform.vi*** virtual instrument the number of data elements in the waveform is calculated by ***Number of Waveform Samples*** virtual instrument. The selected file can be heard through ***Play Waveform*** virtual instrument. ***Tone Measurements Express*** virtual instrument performs audio quality measurements, which allow measuring of audio signal fundamental tone. The ***Tone Measurement Express*** virtual instrument finds the tone with the highest amplitude in the signal and calculates its amplitude and frequency. It can also to export a spectrum and additional tone analysis. For better performance, this virtual instrument can also narrow the search to a specified frequency band [2].

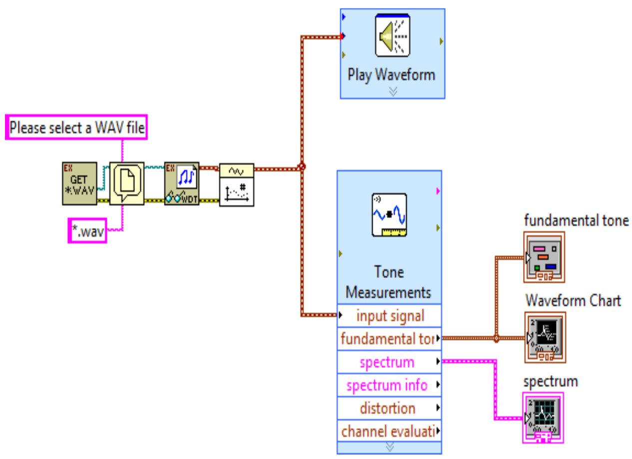

Fig. 1. LabVIEW block diagram. Fundamental tone measuring for recorded in „wave“ format vowels

The fundamental tone is found for three „wave“ format files. Figure 2 shows the LabVIEW front panel for man voice of sound „A“. There can be seen its spectrum, the fundamental tone frequency and its amplitude.

Figure 3 shows the LabVIEW front panel diagram for woman voice of sound „A“ - its spectrum, the fundamental tone frequency and its amplitude.

Figure 4 shows the LabVIEW front panel diagram for man voice of sound „I“. The fundamental tone isn’t found in real time. For real time fundamental tone measurement a different approach is needed.

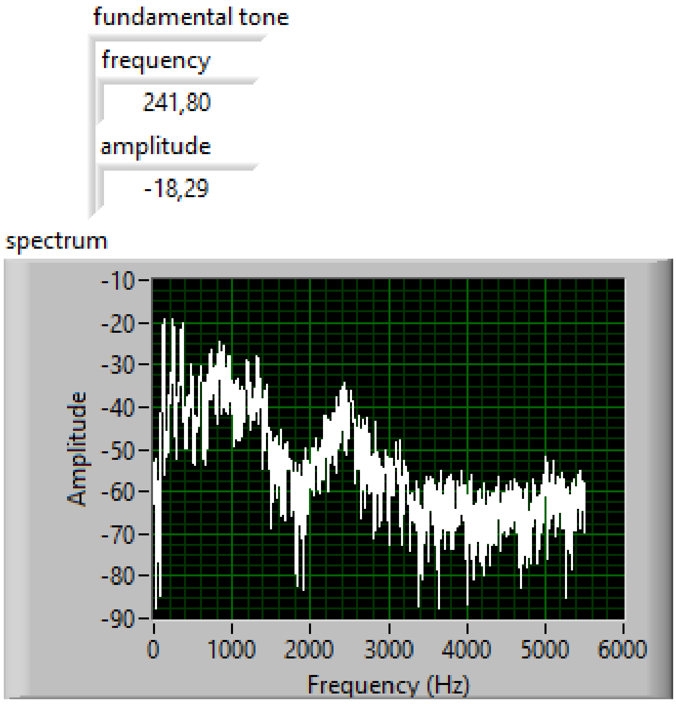

Fig. 2. LabVIEW front panel diagram for sound „A“ – male voice

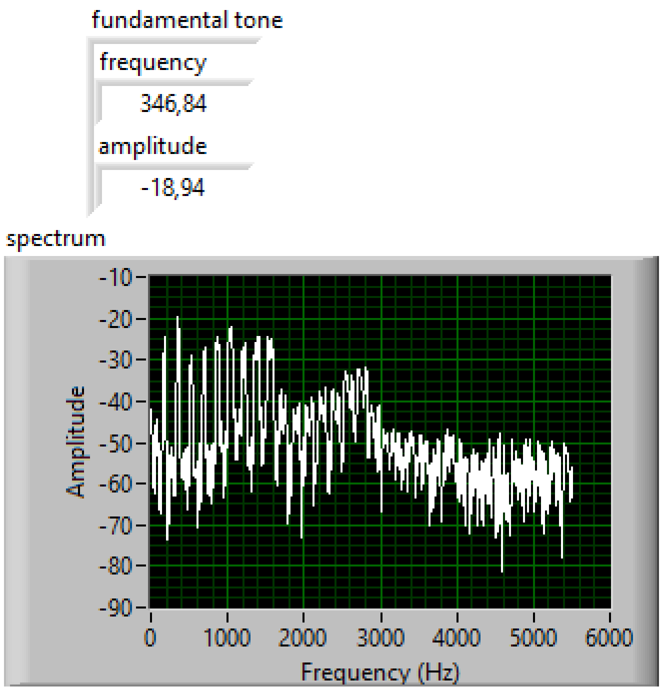

Fig. 3. LabVIEW front panel diagram for sound „A“ – female voice

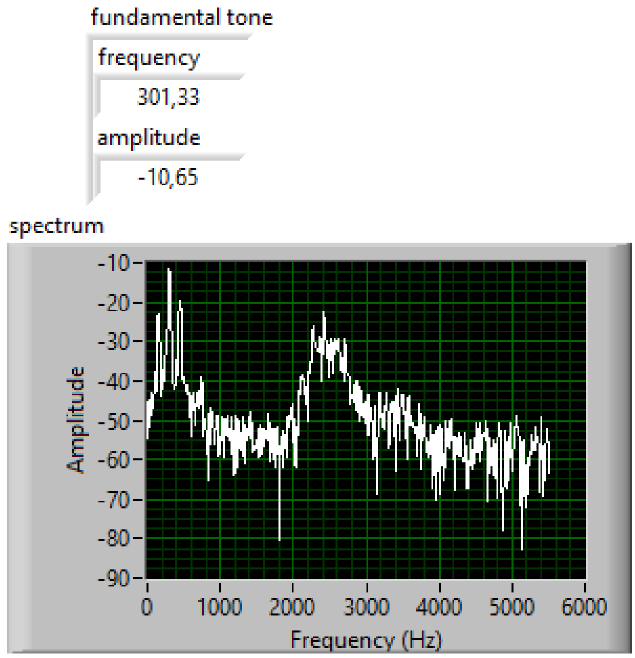

Fig. 4. LabVIEW front panel diagram for sound „I“ – male voice

The block diagram for fundamental tone measuring in real time with LabVIEW is shown in figure 5. One includes microphone, DAQ and computer. The input signal and spectrum can be presented in graphics. Current frequency and amplitude values can be indicated too.

LabVIEW block diagram for fundamental tone measuring in real time is shown in figure 6. In this case data acquisition system is necessary. The data acquisition system and ***DAQ Assistant*** virtual instrument inputs signals from the microphone to the ***Tone Measurements Express*** virtual instrument. This allows audio signal fundamental tone measuring in real time.

The LabVIEW front panel diagram for real time

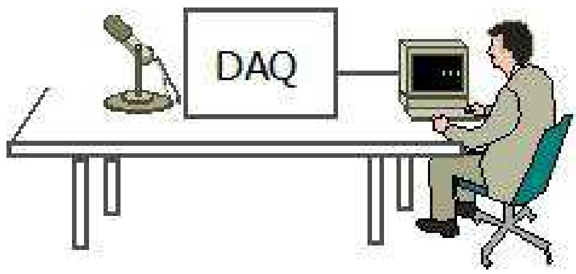

Fig. 5. Block diagram for fundamental tone measuring in real time with LabVIEW.

fundamental tone measuring is shown in figure 7 and figure 8. The vowel “A” is produced by a woman (figure 7), a child (figure 8) and a man (figure 9). The fundamental tone frequency, its amplitude, data for channel evaluation and distortion are given. Furthermore the waveform graph and signal spectral analysis are given.

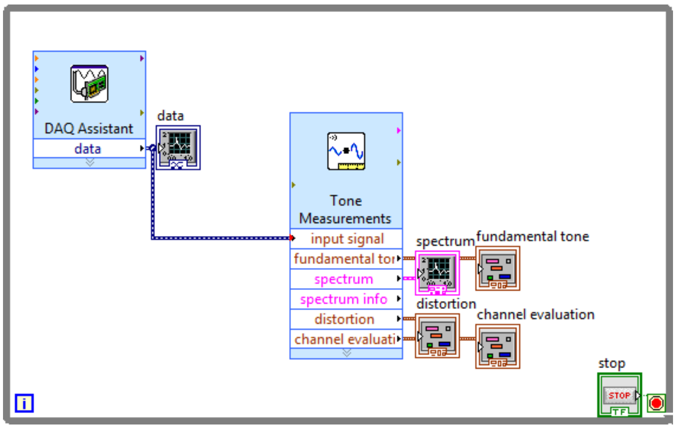

Fig. 6. LabVIEW block diagram.
Fundamental tone measuring for vowels in real time

Figure 10, figure 11 and figure 12 show the LabVIEW front panel diagram for real time fundamental tone measuring for the same woman, man and child. The vowel “I” is produced. The fundamental tone frequency and its amplitude can be seen.

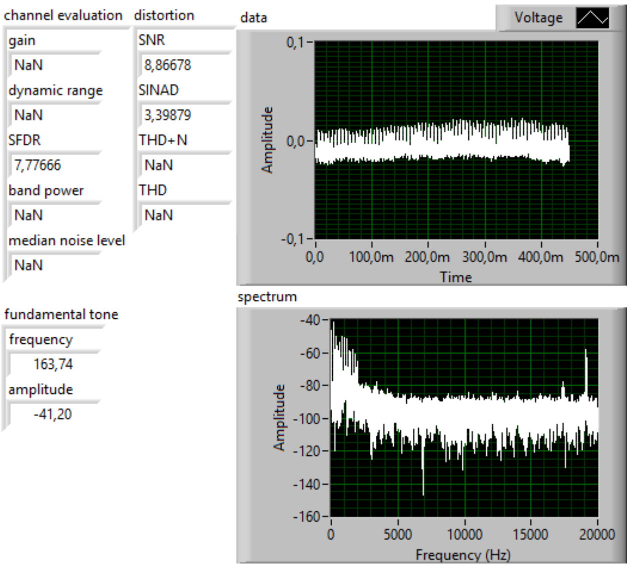

Fig. 7. LabVIEW front panel diagram for fundamental tone measuring in real time: sound „A“ – female voice

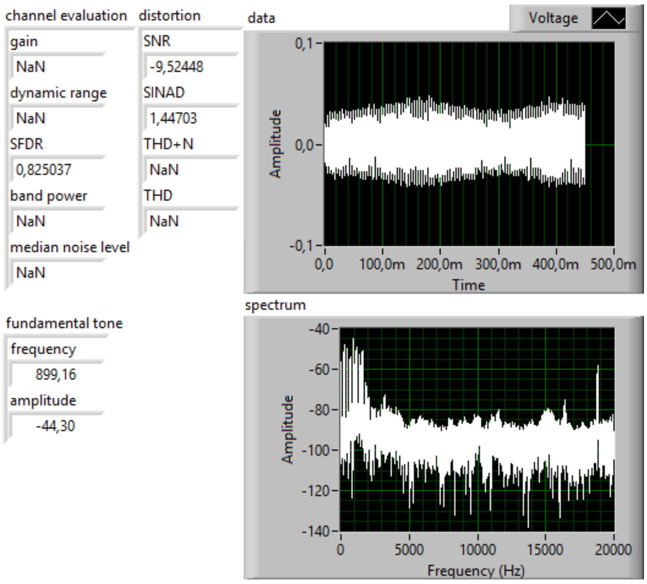

Fig. 8. LabVIEW front panel diagram for fundamental tone measuring in real time: sound „A“ – children's voice

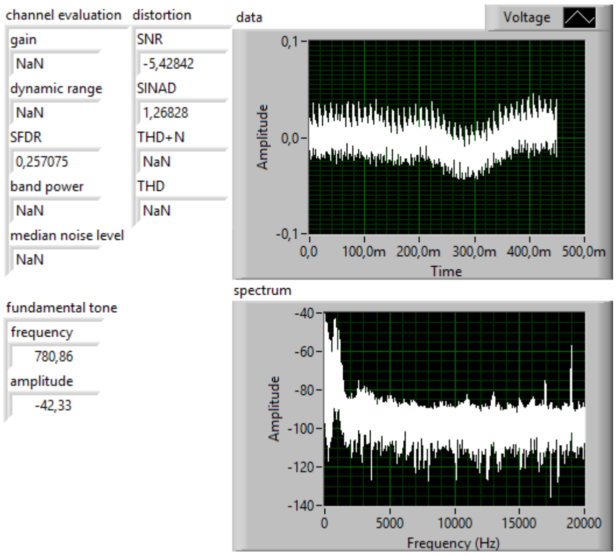

Fig. 9. LabVIEW front panel diagram for fundamental tone measuring in real time: sound „A“ – male voice

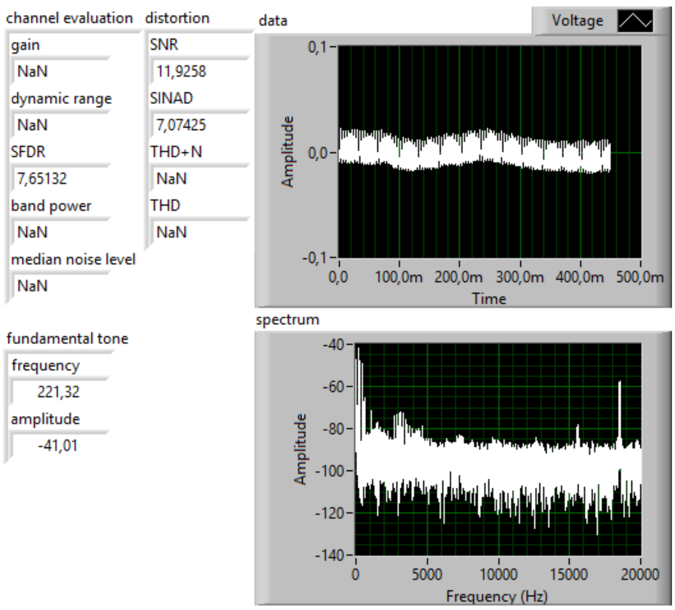

Fig. 10. LabVIEW front panel diagram for fundamental tone measuring in real time: sound „I“ – female voice

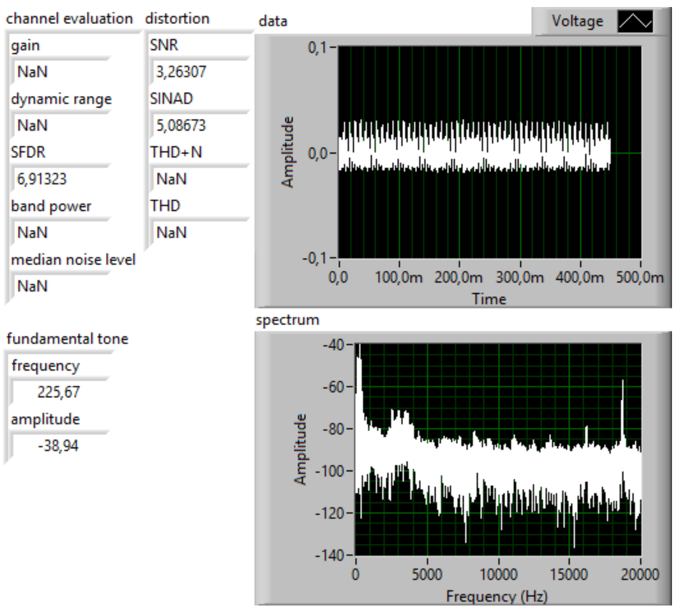

Fig. 11. LabVIEW front panel diagram for fundamental tone measuring in real time: sound „I“ – male voice

III. Conclusion

In this paper an audio signal fundamental tone measuring with LabVIEW is given. The peculiarity of LabVIEW application for fundamental tone measuring are explained.

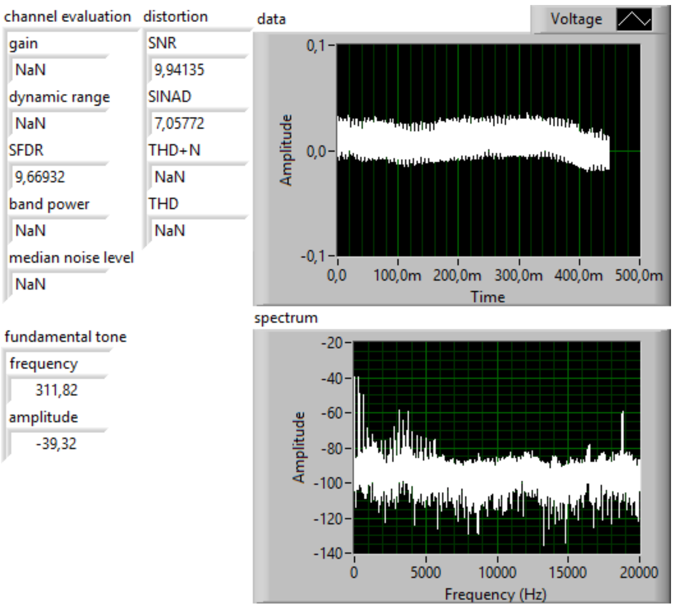

Fig. 1. LabVIEW front panel diagram for fundamental tone measuring in real time: sound „I“ – children's voice

Two approaches are described: tone measuring for vowels recorded in „wave“ format (figures 2, 3, 4) and real time fundamental tone measuring (from figure 7 to figure 12).

In both methods vowels spoken by different people have been applied to the system. Fundamental tone frequency and its amplitude are measured. The spectrum can be seen too. For the second approach - real time fundamental tone measuring - data for channel evaluation, data for distortion, waveform graph have been shown. The obtained important information will be used for further sound processing in audio systems and in education [5] which will be described in subsequent papers.

References

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