Android Based Spectrum Analyzer

Prasanna Shete, Aditya Kurude, Mayur Bhole, Tushar Khose

Abstract: The paper discusses a new concept of analyzing the signal in frequency domain using an App based on Android OS. Analog input signal is applied to hardware signal conditioning block, where it is filtered to avoid the aliasing effect, programmable gain/attenuation is provided to the signal using an programmatically selectable amplifier /attenuator. The signal is digitized using internal ADC of ds PIC. Digitized samples are then transferred to the android device serially via Bluetooth, which is controlled by dsPIC. A java based application installed on android device accepts samples, performs FFT on them and display the signal in frequency domain. The performance of the proposed embedded system (i.e. Hardware & software) is then measured against some standard spectrum analyzer parameters. Greater cost reduction and smaller size of the embedded system offer advantages over conventional instruments.

Index Terms: Android, Bluetooth, ds PIC, Eclipse, FFT, GUI, Signal Processing, Spectrum Analyzer.

1 Introduction

With the advent of recent smart computing devices and their powerful processors; developing new Apps presents a new era. At the forefront of this advancement are handheld devices that are transforming into computing platforms. Smaller size and lower power consumption of such devices offers noticeable advantages over any conventional measuring device giving us opportunities to make use of them in the field of measuring instruments. Android is one of the major players in the handheld device market, and its market share is continuously growing. Android is the first complete, open, and free mobile platform and it offers endless opportunities for mobile application developers. As with all other platforms, having a robust and flexible development environment is the key for the platform's success [1]. This paper attempts to present a new idea of analyzing the signal's spectrum using a java based app along with necessary hardware part. Section 3 of this paper discusses our proposed scheme in details.

- *Author Prasanna Shete is currently Head of E&TC dept., PVG's COET, Pune University, India. E-mail: shetepg@gmail.com*
- *Author Aditya Kurude has completed Bachelor of Engineering in Electronics and Telecommunication from Pune University, India. E-mail: adi.kurude@gmail.com*
- *Author Mayur Bhole has completed Bachelor of Engineering in Electronics and Telecommunication from Pune University, India E-mail: mayurbhole123@gmail.com*
- *Author Tushar Khose has completed Bachelor of Engineering in Electronics and Telecommunication from Pune University, India.*

2 Literature Survey

Conventional spectrum analyzers can be broadly divided in to two categories depending on their principle of working: (1) Super heterodyne based (2) Direct window based. First method offers wide frequency range of operation over increased system complexity, increased cost and size. Second method offers simplicity in design but it limits the frequency range of operation. Apart from this, any signal measuring instrument can be classified in to either Analog or Digital domain. Analog instruments offers greater accuracy but with increased cost and components size limiting its use in specialized laboratories. Digital instruments allows signal to be processed using advanced digital signal processing. We present a different approach taking in to account the portability of the handheld devices and their increased processing powers and suggest a window based digital domain spectrum analyzer.

3 Working

Referring to figure 1, proposed embedded system has four major blocks: signal conditioning block, microcontroller, Bluetooth module and Android device.

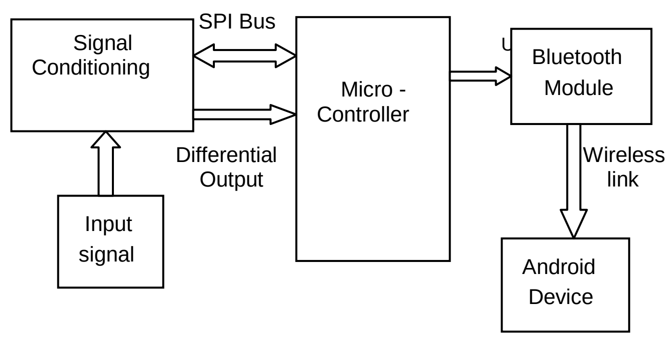

Figure 1 Shows Block Diagram of Embedded System

Signal to be measured is applied to signal conditioning block, LMP7312 programmable amplifier/attenuator is used for conditioning. It provides variable gain to the input signal and also limits its bandwidth [7]. LMP7312 is connected to the microcontroller via SPI bus. By configuring its programmable bits, signal is given appropriate gain i.e. smaller signals are amplified (1v/v, 2v/v) so as to occupy full range of ADC and signals having larger amplitude are attenuated in some predetermined steps (0.096 v/v, 0.192 v/v, 0.384 v/v, 0.768 v/v) to make it compatible with maximum input value of ADC. This signal is then sampled and digitized using inbuilt ADC of microcontroller (dsPIC33fj16gs504), also software gain is provided to these samples to compensate for the gain provided by the LMP7312 i.e. if before sampling, the signal is attenuated by gain factor 0.096, then after sampling, these samples are multiplied by (1/0.096=10.4167) and transmitted to Bluetooth device via UART. Bluetooth module LMX9838 transfers them to android device in packets of 100 samples with first byte as Data Start indication and last byte as Data End indication. Java based application installed on the android device accepts these samples by sending data request to the microcontroller, it then performs FFT on them and display the spectrum of signal. User has a choice of selecting number of FFT points, span of measurement, Run/Pause option and a curser point for measurement at specific point.

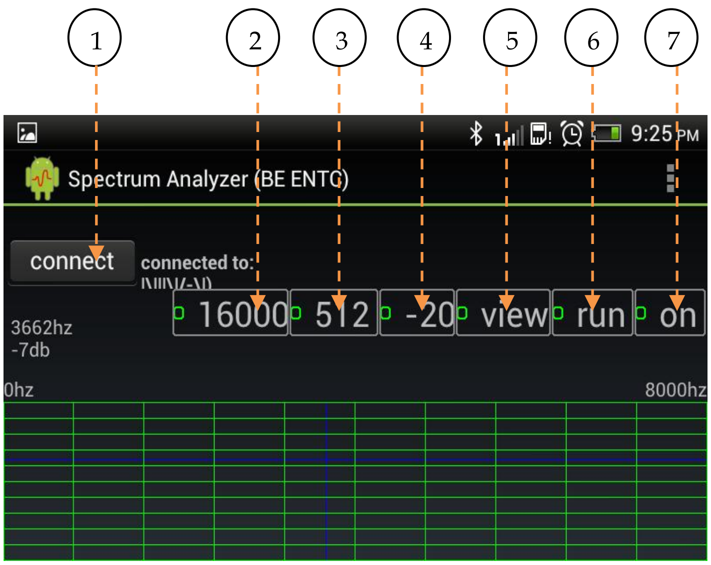

Figure 2: GUI of Android App.

Arrows (1, 2, 3, 4, 5, 6) shown in the Figure 2 indicates Buttons as follows:

1. Connect: This button establishes connection between remote hardware and android device.
2. Frequency Span select: This button selects the frequency span (E.g. 0 Hz- 8000Hz)
3. Number of FFT points select: This button allows user to vary the number of FFT points.
4. Amplitude range (dB) select: This buttons allows user to attenuate the signal.
5. View/Zoom mode: 'Zoom in' facility is also provided for distinguishing closely spaced frequencies.
6. Run/Pause: Allows user to Run or Pause as required.
7. On/Test: On mode allows user to set parameters such as number of FFT points, frequency span and in test mode actual input signal is processed.

Values shown below the connect button indicates frequency and amplitude at the current Cursor position. The intersection of horizontal and vertical blue line forms the cursor.

4 RESULT AND DISCUSSION

The calibration of designed embedded system was carried out using standard measuring instruments. Two signals with frequencies 1250 Hz and 3300 Hz were used for testing.

Table 1 Results

	Input Hz	Observed Hz	% Error
1	1250	1241	0.72
2	3300	3308	0.24
3	10000	10052	0.52
4	20000	19820	0.9
5	25000	21560	13.76

Snapshots of first two test frequencies are as shown in Figure 3 and Figure 4 respectively

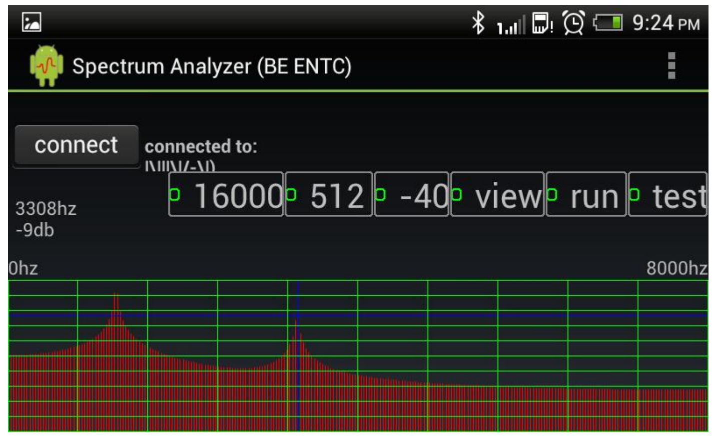

Figure 3 Snapshot for test Frequency 3300 Hz

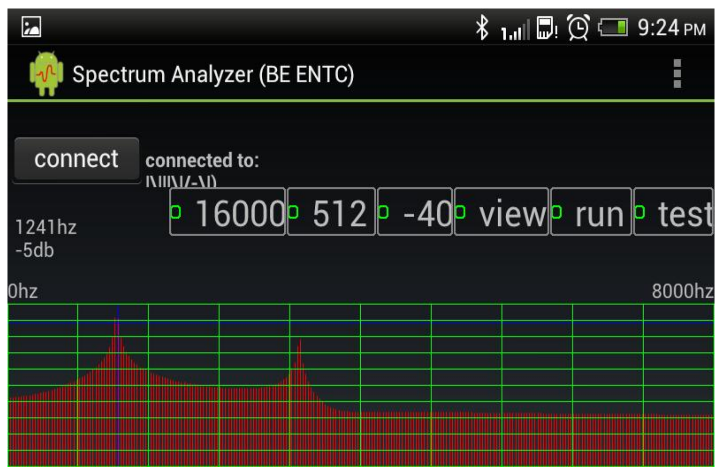

Figure 4 Snapshot for test Frequency 1250 Hz

It was observed that increase in number of FFT points increases sharpness of the spectrum by suppressing unwanted signal components, the effect is shown in the figure 5 and figure 6.

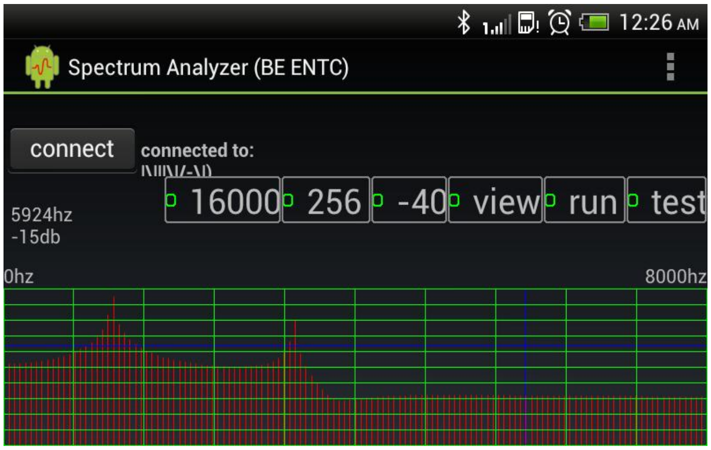

Figure 5 Snapshot showing 256 FFT points

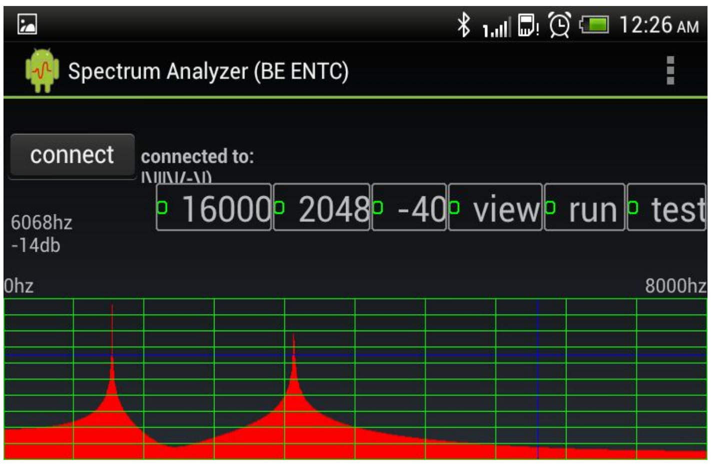

Figure 6 Snapshot showing 2048 FFT points

5 CONCLUSION

We put forward a completely new approach of analyzing signal in frequency domain. We tested the embedded system for various frequencies and found that average error was 0.594% up to 20 kHz, beyond 20 kHz error increases drastically hence suggested operating range of operation is up to 20 kHz. It was also observed that increase in number of FFT points increases the sharpness of the spectrum. Being smaller in size, it facilitates user to carry the system anywhere easily. The designed embedded system provides a good compromise between cost and accuracy.

REFERENCES

[1] Onur Cinar, “Android apps with Eclipse”.(Apress publication)

[2] Wei-Meng lee, “Beginning Android Applications Development”. (Wiley publication.Inc)

[3] Sayeed Y. Hashimi and Satya Komatineni, “Pro Android”. (Apress publication).

[4] Herbert Schildt, “Java A Beginner’s guide”. Copyright 2005 by The McGraw-Hill Companies.

[5] Ww1.microchip.com/downloads/en/devicedoc/70318.pdf.

[6] www.ti.com/lit/ds/symlink/lmx9838.pdf.

[7] www.ti.com/product/lmp7312.

[8] www.ti.com/lit/ds/symlink/lm1117-n.pdf.

[9] Christoph Rauscher (Volker Janssen, Roland Minihold),”Fundamentals of Spectrum Analysis”.

[10] National Instruments tutorial, “Zero Padding Does Not Buy Spectral Resolution”.

[11] National Instruments tutorial, “The Fundamentals of FFT-Based Signal Analysis and Measurement in LabVIEW and LabWindows/CVI”.

[12] National Instruments tutorial, “Resolution Bandwidth (RBW)”.

[13] National Instruments tutorial, “Zero Padding Does Not Buy Spectral Resolution”.

[14] National Instruments tutorial, “Resolution”.

[15] National Instruments tutorial, “Spectrum Analyzer Determined by Choice of Measurement”.