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Portable Spectrum Analyzer Application using Android based on Software Defined Radio (RTL-SDR)

Toto Supriyanto[1]

[1]*Department of Electrical Engineering, Politeknik Negeri Jakarta (PNJ)*
Jl. Prof. Dr. G.A. Siwabessy, Kampus UI Depok. Indonesia.

Orcid : 0000-0002-9406-988X

Abstract

In this research, it is proposed to develop spectrum analyzer using RTL-SDR based on SDR Console 2. This device was then integrated with Android to do the real value calculation. The measurement results were then validated and regression was performed. The result of analysis shows that regression with linear approach has error of 4.84% second order error of 4.83%, third order error of 4.84% and fourth order error of 7.31%. Based on regression, the first order is chosen because the error value was still below 5% with the simplest equation.

Keywords: Spectrum analyzer, Android, Software Defined Radio

INTRODUCTION

SDR technology is implemented in several functions on radio systems, such as modulation/ demodulation, signal processing, programming and link-layer protocols in software. This is especially helpful when redesigning the radio software system where the parameters are often changed to get the quality which matches as expected. On a radio system that uses full hardware, it will be difficult because the parameters used are fixed, and if we want to change a parameter, the hardware must also be replaced. Radio systems built using SDR technology can be developed for applications that use different protocol links and modulation/ demodulation methods [1].

The commercial communication wireless industry is currently facing a problem because of the ever-changing standards of link-layer protocol (2.5G, 3G, 4G), where wireless network technology in different countries will hamper global roaming facilities and there is a problem with rolling-out services new due to handset limitations [2].

SDR technology overcomes this problem by implementing radio functionality as software that runs on a hardware platform. Furthermore, some software implements different standards on the radio system. This system can be applied for different purposes, in accordance with the software used. In addition, the software can implement new services by being downloaded directly from the air to the handset. This flexibility can be obtained from the SDR system. This flexibility is offered by the SDR system by solving problems related to service deployment [3].

The aim of this research is to develop Android platform application that is used in Software-Defined Radio (SDR) development, Universal Software Radio Peripheral (USRP) and PC computer for an application namely spectrum analyzer. USRP has been proven to be used for digitally analog signal (Radio Frequency) especially in the development of SDR-based systems. By implementing digital signal processing run on PC computers, whether the SDR computing platform can be developed for measurement of the frequency spectrum and the power spectrum of an analog RF signal or often called a spectrum analyzer.

SOFTWARE DEFINED RADIO

The Software Defined Radio (SDR) forum defines SDR as a radio using software for modulation, wide-band or narrow-band operation sections, communication security functions (such as hopping), and waveform requirements for current and future standards in frequency areas broad band.

In short, Software Defined Radio (SDR) is a technology where software runs on a hardware platform, namely a Digital Signal Processing (DSP) processor, and Field Programmable Gate Array (FPGA), to implement radio functions such as modulation of transmitters and demodulation processes of receiver.

SDR technology can be implemented on military and commercial radio. More extensive applications of SDR technology are for Bluetooth, WLAN, GPS, Radar, WCDMA, GPRS, CDMA, GSM, etc.

The advantage of SDR. The advantages of SDR include the following:

1. The SDR system is able to adapt to any kind of existing radio system with multiband and multi standard usage. Standard wireless commercial network is always growing, ranging from 2G to 2.5G/3G, and 4G. Each network generation has a very different link-layer

protocol standard, causing problems with customers, wireless network operators, and vendor tools.

2. Does not require hardware additions/changes. To make new radio system there is no need to add or replace hardware, it is enough with the addition of software that is loaded into the DSP. Customers are forced to buy a new handset when it has developed a new generation of a network standard. Network operators also require high equipment costs when migrating from the old generation to the new generation, because if the standards are different then the hardware used by vendors is also very different.
3. Easy and simple. The selection of the desired radio system can be done by having simple changes that simply activate the desired radio system. So is the development of new types of radio systems and services that are easy to apply.
4. Minimize size. With the application of the SDR system, it enables a more practical hardware size with sufficient capacity capability.
5. The SDR system is capable of supporting the development of more advanced radio communication systems. Different air-interfaces and link-layer protocols from different places (for example, European Wireless Networks is dominated by GSM/TDMA while in USA the wireless network is dominated by IS95 / CDMA based).

DESIGN OF SPECTRUM ANALYZER

Figure 1 below shows the architecture of a conventional super heterodyne receiver radio. A conventional wireless transceiver consists of oscillator [1], band-pass filter (BPF) [4][5][6][7], low noise amplifier (LNA) [8], and antena [9].

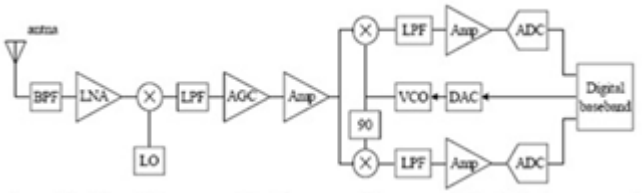


Figure 1: Block diagram of Analog Transceiver

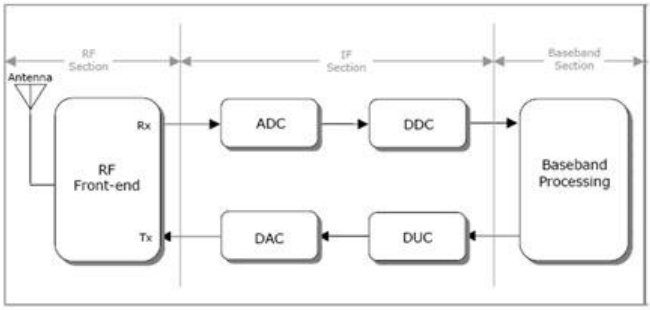


Figure 2: SDR Transceiver

A spectrum analyzer base on super heterodyne receiver radio is ineffective because it will cause the size become larger, more complicated, and more expensive. Likewise for each new standard will require the addition of the receiver circuitv[10][11][12]. It is very impractical.

Figure 3: Android spectrum analyzer with RTL-SDR (a) Front view, (b) Side view, (c) Back view

An SDR system is defined as a radio system where baseband processing and DDC/DUC are processed in software. Availability of smart antenna, wideband RF front-end, wideband ADC/DAC technology and always increased processing capacity (MIPS/Microprocessor without Interlocked Pipeline Stages) from DSP and microprocessor usage to develop multi-band, multi standard, multi-mode radio using SDR technologyv[13][14]. In SDR systems, link-layer protocols and modulation/demodulation processes are performed using software.

This study aims to develop Android platform applications that are used in Software-Defined Radio (SDR) development for spectrum analyzer applications.

The whole system test, the left shows the android smart phone along with the RTL-SDR based SDR Console 2.3. While in Figure 4 to Figure 7 shows the regression of measurement using RTL and measurement using Spectrum analyzer. The measurement spectrum analyzer used Rohde & Schwarz devices in real time.

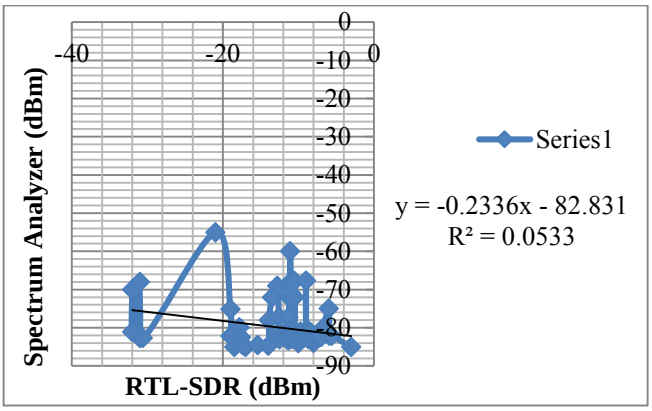


Figure 4: Linear regression between measurements using a spectrum analyzer and using android base RTL-SDR

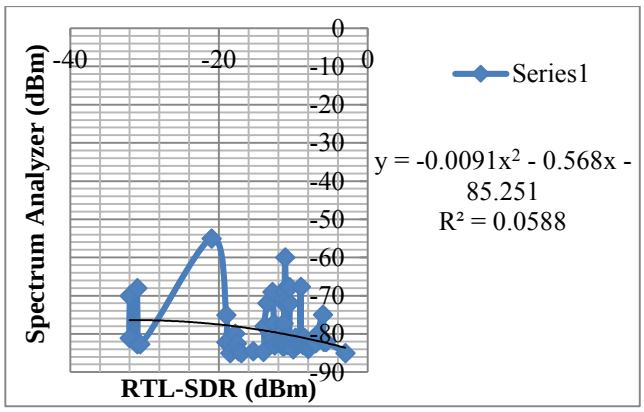


Figure 5: Second order regression between measurements using a spectrum analyzer and using android base RTL-SDR

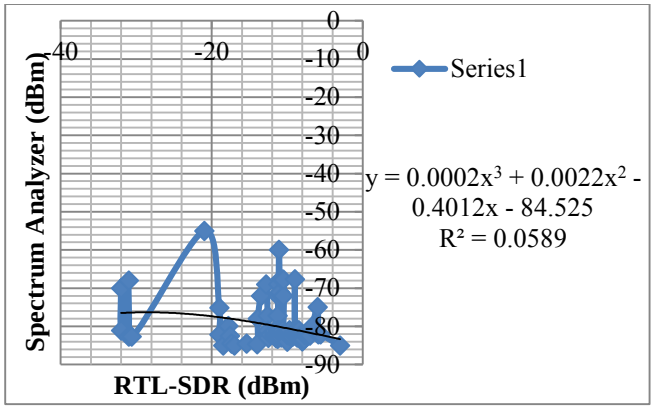
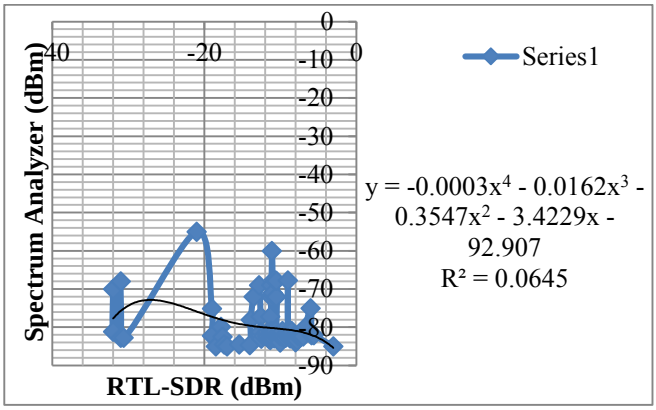


Figure 6: Third-order regression between measurements using a spectrum analyzer and using android base RTL-SDR



Gambar 7: Fourth-order regression between measurements using a spectrum analyzer and using android base RTL-SDR

After obtaining all the regression values, the equations obtained were then used to calculate the real value of the spectrum. The result of the plot is shown in Figure 8 below.

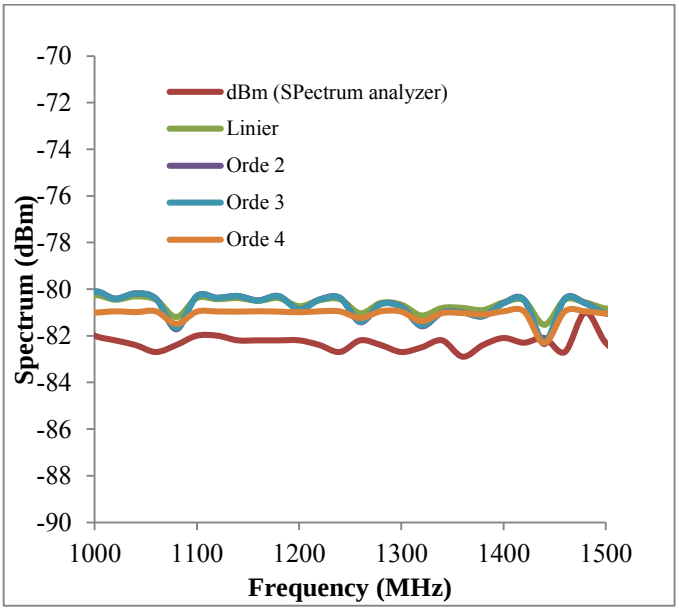


Figure 8: Comparison of spectrum plots

Figure 8 shows the plot of the spectrum value when compared to the measurement value. The measurement results show that all regression values have errors below 5%. However, considered from the equation, then the equation with linear method is the simplest of equations. So it is easier to use.

CONCLUSIONS

In this research, it was successfully designed spectrum analyzer using SDR Console 2 based RTL-SDR. This device was then integrated with Android to do the calculation of real value. The measurement results were then validated and regression was performed. The result of the analysis shows that the regression with linear approach had error of 4.84% second order error of 4.83%, 3rd order error of 4.84% and fourth order error of of 7.31%. Based on regression, the first order was chosen because the error value is still below 5% with the simplest equation.

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