Implementation of File Transfer with GNU-RADIO Tool on SDR Platform

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Abstract: The requirement for transmission systems which use software and hardware hybrid arrangement, recognized as Software Defined Radio (SDR), rises because of restricted channel capacity in wireless communication. The focus of this paper is to understand the basic methods for real time file transmission through an open source, flexible and low cost platform – Universal Software Radio Peripheral (USRP) along with GNU radio. SDR is a technology in which software is changed without varying the hardware to implement various communication applications. The GNU Radio along with USRP is a low cost, high speed SDR platform. GNU Radio is an open source software supporting SDR platform and USRP acts as the hardware for GNU Radio. The main focus of this paper is on the implementation of PSK modulator & demodulator and evaluates the working & results of a file transfer using PSK modulation technique. The real time file signal transmission and reception is performed using USRP and GNU Radio.

Keywords: PSK, GNU Radio, SDR, FPGA, USRP.

Introduction

SDR (SoftwareDefinedRadio) is a wireless system that handles the air traffic, interfaces and applications. In the SDR experimental toolkit, USRP is used as hardware set-up and GRC (GNU Radio companion) is used as software set-up.

In SDR system, GRC is used to perform different functions and modules. The GRC platform is a powerful Graphical user interface (GUI), which helps in performing SDR modules in effective way. GUI model providing practical exposure to wireless communication concepts like multiplexing, digital and considered as strongest technique in the area of wireless communication due to its ability to reduce the sideband power and provide better spectral efficiency.

This paper focuses on transmission of real time file signal through the PSK modulator and demodulator. This paper is organized as follows: Section II briefly explains the SDR system which includes USRP and GRC. Section III demonstrates the system model of this experiment i.e. real time file transmission using PSK modulation and demodulation. Section IV represents the results of the experiment. Section V presents the conclusions drawn and finally section VI is about the references.

SDR

Software Part- GNU Radio

The GNU Radio is a software that was created by the Eric Blossom under the GNU general public license. In this paper, GNU Radio [5] acts as the software part for the SDR which is used. It is an open source free software. It is a suitable software tool and can be used to implement various wireless applications. This software is compiled and run on personal computers on several operating systems, such as Window XP, Linux etc. In this paper, the operating system used is Ubuntu.

GNU Radio applications are created using Python and C++. It consists of two important parts: 'flow graph' and 'Block'. A block is a signal processing block which is used in GNU Radio. C++ has higher efficiency, because thus it is used for programming of signal processing block. There are more than 100 signal processing blocks available in GRC, like mathematical calculation, convolutional code, different filters, frequency modulations etc. Also, it is easy to add new signal processing block to GNU Radio. Therefore new blocks can be easily added according to the requirement. 'Flow graph' is the graph used to achieve the functions of different communication standards. Because of Python's easier programming and flexibility, it is used to program the 'flow graph'. There is additional type of block which is written in Python called 'hierblock' which contains some signal processing blocks. There are some complicated blocks like GMSK (Gaussian filtered Minimum Shift Keying) modulation and demodulation block.

In GNU Radio, there is a beneficial tool known as Swig (Simplified Wrapper and Interface Generator) which is used to change the C++ classes into the classes which can also be used in Python. Because of this Swig tool, GNU Radio framework is capable of putting together and exploiting the benefits of both Python and C++ [7]. The structure of the GNU Radio is shown in Figure. 1.

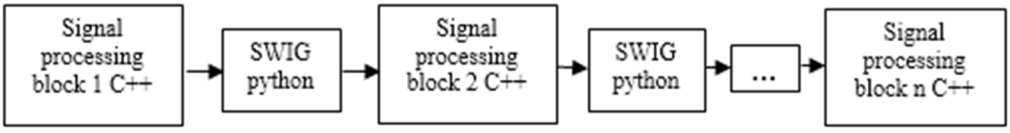

Fig. 1: Structure of GNU Radio

Hardware Part- USRP

USRP acts as hardware part for SDR. It is the most important hardware partner of GNU Radio as it provides RF front end for real time communication.It configure the software radio with the available RF environment. USRP not too expensive and users can download all design documents and circuits and the code of FPGA from the Ettus Research's website.USRP basically consist of daughterboard and one motherboard.

A USRP board is shown in Figure. 2 [6]. The motherboard converts digital signal to analog signal and vice-versa and some other functions of motherboard are digital up/down conversion, the conversion between baseband signal and intermediate frequency signal, interpolation and decimation signal processing process. It also consists of two ADCs and also has a FPGA which is important part of USRP. It implements high bandwidth mathematical calculations and reduce the speed of data so that it can be easily transmitted through USB 2.0.

USRP can be attached to the personal computer through USB 2.0. Specifically, the data streamed over the USB 2.0 interface is in the form of I/Q samples. There have been reports regarding the USB 2.0 interface supporting data rates around 32MS/s and an approximate bandwidth of about 6MHz of I/Q data and 12MHz of real data. There are four slots in one motherboard, so at the same time it can be connected to at most four daughterboard in which two are used as transmitting daughterboard and others two used as receiving daughterboards.

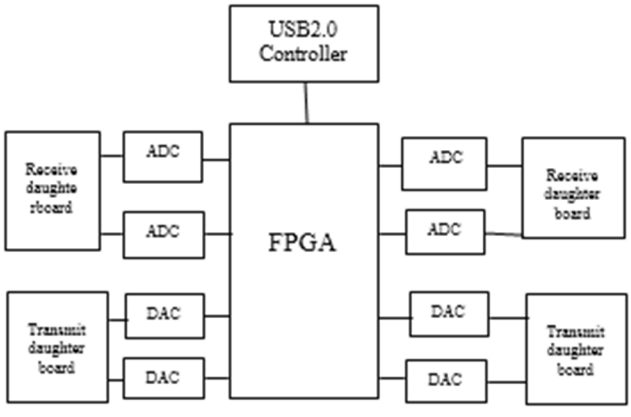

Fig. 2: USRP block diagram

Experiment Set-Ups

In this paper, system model is divided into two parts. Transmitter side implementation is the first part and second part is the receiver side implementation of the GNU Radio software. The system input is a real time file signal which is processed by the GNU Radio software. The python language is used behinds the blocks of GNU Radio. The real time file signal is transmitted wirelessly by dipole antennas. These antennas operate between 0.4 GHz to 4 GHz frequency range. At both transmitter and receiver side, these antennas are connected to the USRP device.

Transmitter side implementations

Using keyboards inputs ctrl + alt + T, open the terminal window and at the terminal prompt type: gnu radio companion. An untitled GRC window is appearing. File source, PSK modulator and other blocks are connected to each other to complete the transmitting section of the PSK modulator which is shown in Figure 3.

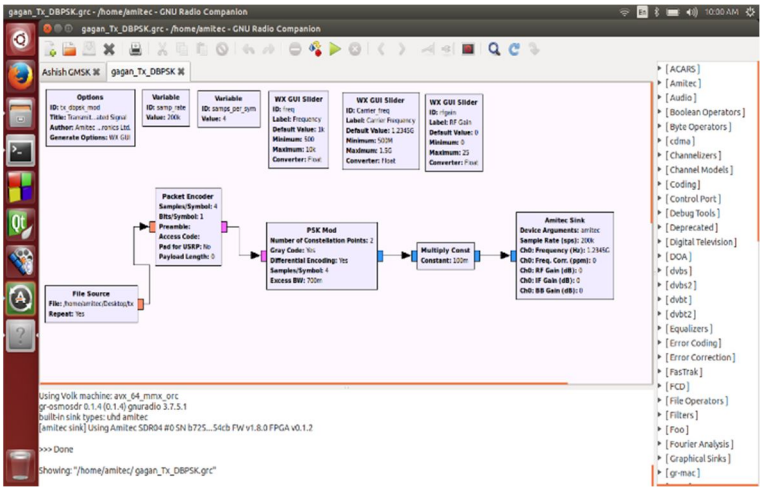

Fig. 3: PSK modulation System in GNU System

The Excess bandwidth=350m which is the bandwidth and the duration of bit period of PSK modulated signal .Samples per symbol rate = 4. Amitec sink (USRP) used 1.2345 GHZ channel frequency. The transmitted file tx shown in Figure 4.

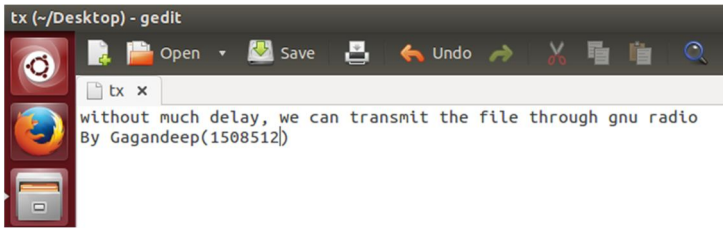

Fig. 4: Transmitted file tx

Receiver Side Implementations

Firstly, a blank file named “rx” is created at the home folder and then open the GRC window which is same as the transmitter side window. After this connect the low pass filter and PSK modulator to other blocks. The Figure 5 Show the complete flow graph of PSK demodulator.

The cut-off frequency of the low pass filter is 50 KHZ and it used the hamming window. The Amitec source which is USRP device used 1.2345 GHZ frequency.

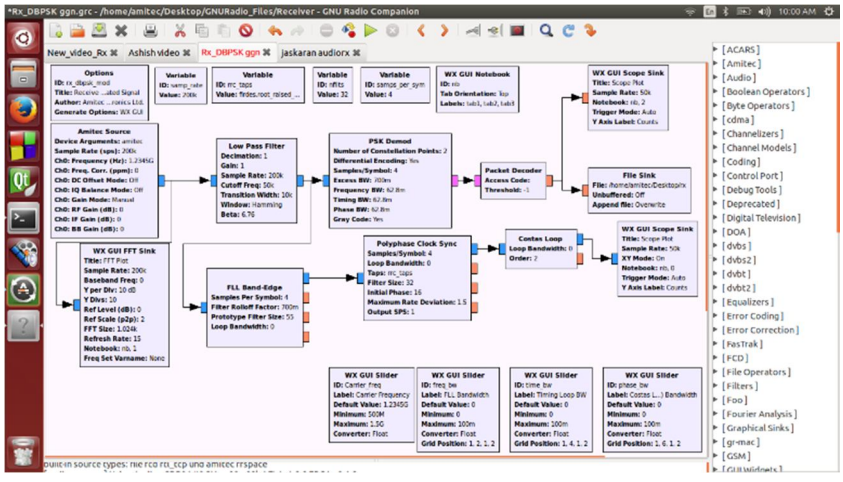

Fig. 5: PSK Demodulation system in GNU Radio

Results

In this paper PSK modulation is used to transmit real time file signal via GNU Radio and USRP. The Figure 6 shows the transmitted file signal from GNU Radio.

Fig. 6: Transmitted file signal from GNU Radio

The received file signal from GNU Radio shown in Figure 7.

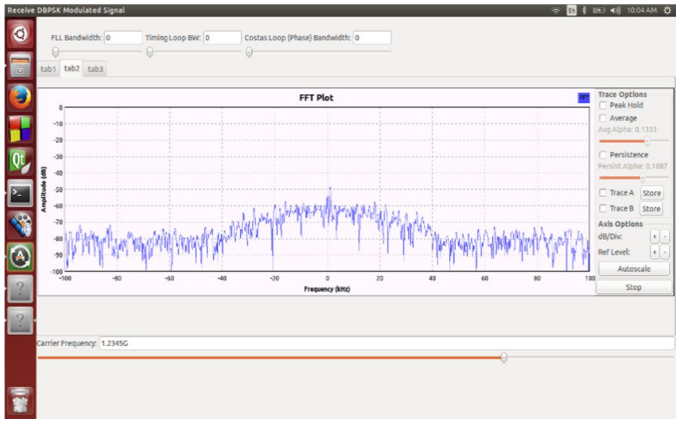

Fig. 7: Received file signal from GNU Radio

The constellation display represents the possible symbols that selected by the PSK modulation shown in Figure 8.

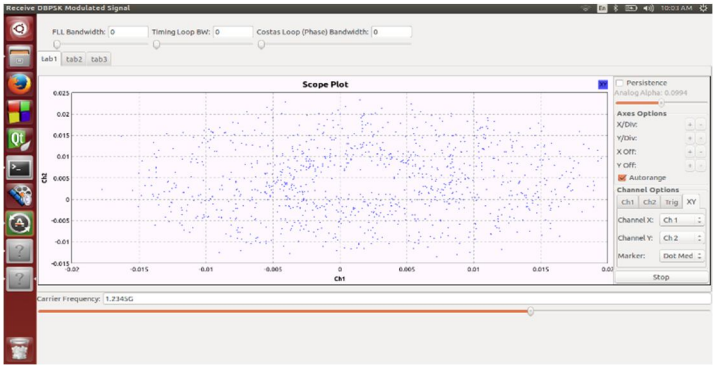

Fig. 8: Constellation display of file signal

The file signal is received by the receiving antenna which is connected to the USPR is shows in Figure 9.

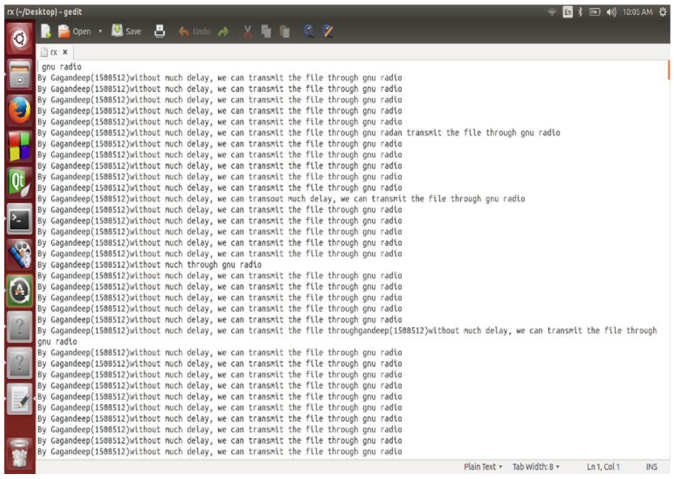

Fig. 9: Received file signal

Conclusion

In this paper, the focus is on transmittinga file by using PSK modulation scheme. GNU Radio is flexible and powerful platform to implement the real time file transmission. This paper shows how a file signal can be transmitted/received by using python blocks of GNU Radio software. It can be achieved by using high data rates at large band of frequencies. In conclusion, SDR system provides flexibility to development of file transmission using GNU radio software and USRP hardware.

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