A GENERAL SYSTEM DESIGN & IMPLEMENTATION OF SOFTWARE DEFINED RADIO SYSTEM

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ABSTRACT : *this paper presents a software-defined radio (SDR) system with reconfigurable architecture for wireless Communications. Modifying radio devices easily and cost-effectively has become business critical. Recently, new frequency bands, modes, and services to wireless communications are increased significantly, mainly due to the increasing popularity of internet and wireless use and the associated increased demand data bandwidth. In this paper, Software Radio System was designed, implemented and the effects of potential channel disturbances were analyzed and compensated.*

KEYWORDS: Software-defined radio, reconfigurable architecture, Wireless communication.

1. INTRODUCTION

A Software Radio system is a transmitter and receiver system that uses digital signal processing for coding, decoding, modulating and demodulation the data. This paper focus on using the IEEE 802.11a specification to create a software radio. The feasibility of using Math works' Simulink library. A radio is any kind of device that wirelessly transmits or receives signals in the radio frequency (RF) part of the electromagnetic spectrum to facilitate the transfer of information. In today's world, radios exist in a multitude of items such as cell phones, computers, car door openers, vehicles, and televisions. Traditional hardware based radio devices limit cross-functionality and can only be modified through physical intervention. This results in higher production costs and minimal in supporting multiple waveform standards. By contrast, software defined radio technology provides an efficient and comparatively inexpensive solution to this problem, allowing multimode, multi-band and/or multi-functional wireless devices that can be enhanced using software upgrades. SDR defines a collection of hardware and software technologies where some or all of the radio's operating functions (also referred to as physical layer processing) are implemented through modifiable software or firmware operating on programmable processing technologies. These devices include field programmable gate arrays (FPGA), digital signal processors (DSP), general purpose processors (GPP), programmable System on Chip (SoC) or other application specific programmable processors. The use of these technologies allows new wireless features and capabilities to be added to existing radio systems without requiring new hardware.

2. ARCHITECTURE OF SOFTWARE DEFINED RADIO

A. Reconfigurable Architecture

Fig. 1 depicts a SDR transmitter and receiver with a reconfigurable architecture. At the transmitter, all baseband operations inside the dashed box are software-based processing modules on a given hardware platform as depicted in Fig. 1(a). The DSP software performs source encoding, channel coding, and data stream multiplexing and modulation as needed. Different modulation requirements are implemented with different software modules, including preamble sequences and hand-shaking protocols for transmitting. Similarly, at the receiver, all reversed baseband operations, such as demultiplexing, de-modulation, channel decoding, source decoding are performed by software-based processing units on the given hardware platform as depicted in the dashed box of Fig. 1(b). Note that receiver software modules also perform the signal detection and synchronization operations in the beginning stage in order to determine the required operational modes and standards of the incoming waveforms as part of the receiving tasks.

B. Flexibility, Upgrade, and Backward Compatibility

The flexibility of DSP-based solutions in the SDR systems is due to the programmability. It provides many benefits. For example, algorithms can continually be updated and improved as computational methods advance. For standards-based modules, such as IEEE 802.11, a programmable implementation allows modules to remain compliant as the standards upgraded. A software upgrade is usually all that is needed while the backward compatibility still promised in the existing modules.

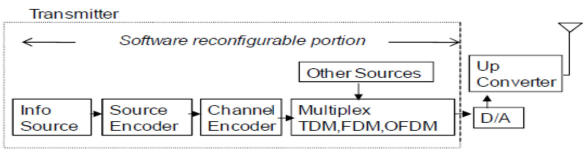

Fig.1 (a):- Software reconfigurable transmitter block diagram.

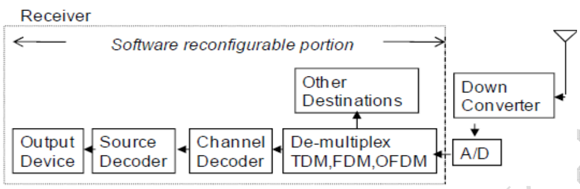

Fig.1 (b):- Software reconfigurable receiver block diagram.

3. PROPOSED SYSTEM MODEL

A software defined radio is a transmitter and receiver system that uses digital signal processing (DSP) for coding, decoding, modulation, and demodulation. This allows much more power and flexibility when choosing and designing modulation and coding techniques. The system functions are shown in Figure 2.

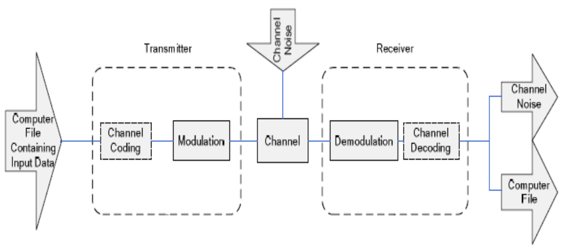

Fig.2:- I/O block diagram for transmitter and receiver radio systems

A. Inputs and Outputs

An overall block diagram for the software radio project is shown in Figure 2. The inputs to the system are a digital data source (computer file) and channel noise. The output of the system is the recovered input data. The recovered data should be received exactly as transmitted. This can be displayed on an oscilloscope coming out of the DSP evaluation board and/or stored on a computer file for further verification and analysis.

B. Modes of Operation

The input from the digital data source will be sent into the transmitter. There it will have channel coding applied to provide protection from data corruption introduced by noise. This part will not be implemented in this project. After that, the encoded digital signal will then be modulated with an appropriate modulation technique and transmitted through the channel. An appropriate model and representation for the channel also needs determined. After this, the receiver demodulates the signal and applies appropriate channel decoding. From there the reconstructed digital signal will be available for further analysis.

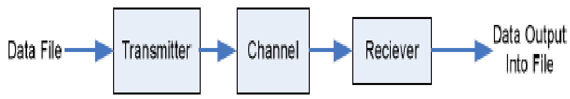

Fig 3:-System Block diagram of the Software Radio

The input to the system will be digital data in a computer file. This data will be modulated by the transmitter and sent to the channel. The channel will introduce interference to the signal in the forms of attenuation, phase delay, and noise. At the receiver side , the signal will be demodulated and reconstructed to produce the original transmitted message.

C. Transmitter

The transmitter shown in Figure 4 will generate the signal that will be transmitted through the channel. The transmitter signal is constructed using demultiplexing, quadrature amplitude modulation (QAM), orthogonal frequency division multiplexing (OFDM), and up mixing.

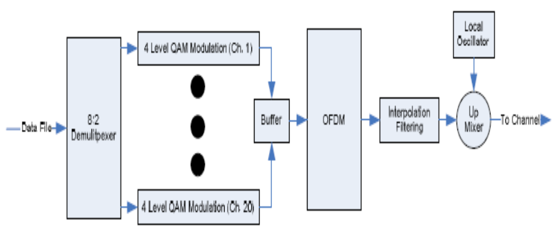

Figure 4:- Transmitter Subsystem Detailed Diagram

1) Demultiplexing & Modulation

The demultiplexing block takes a byte of binary data and then breaks the byte into four 2-bit streams. These 2-bit streams are each fed into a QAM modulation channel. Once the QAM channels have modulated the input data, a buffer collects a group of

20 QAM symbols that represent 5 bytes of data. The group of symbols is then passed into the OFDM block. The OFDM system multiplexes the QAM signals together to produce the final modulated output.

2) Interpolation

Interpolation increases the sampling rate and conditions the signal for transmission before it is modulated. This is implemented using a combination of up-sampling and filtering.

3) Up Mixer

Mixing is done to meet the bandwidth requirements of the channel. The up mixer increases the frequency of the OFDM signal by multiplying it by a greater carrier frequency. The OFDM signal is imbedded in the carrier signal that the local oscillator produces. The output of the mixer is contained in bandwidth of the channel.

D. Channel

The channel block implements a model of an actual transmission channel. Different parts of the channel model different channel effects on the transmitter output. These are channel gain, multi-path interference, and noise.

1) Channel Attenuation

The channel attenuation models the attenuation or the gain effect that the channel has on the transmitted signal. This gain can vary with time and frequency.

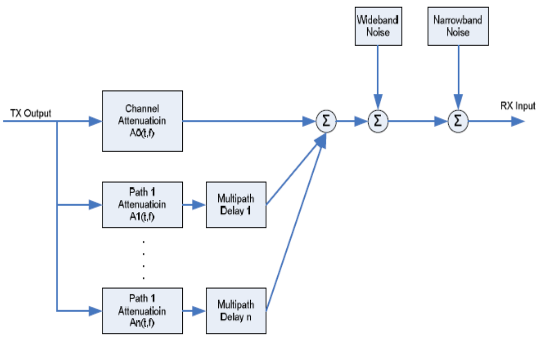

Fig 5:-Detail of Channel

2) Multi-path interference

The multi-path interference models reflections of the transmitted signal. These reflections arrive at the receiver at different times. Each one of these paths has its own attenuation that can vary with time and frequency.

3) Noise

Noise is also introduced into the signal. The noise is either specific to a limited frequency range (narrow band noise) or can affect the whole spectrum of the transmitted signal.

E. Receiver

The receiver subsystem shown in Figure 6 recovers the sent message. The receiver extracts the carrier, symbol, and frame timing from the signal. It uses this information to extract the message from the phase, frequency, and amplitude noise of the channel. The receiver is constructed of the following parts; carrier synchronization, demodulation, symbol synchronization, and frame synchronization.

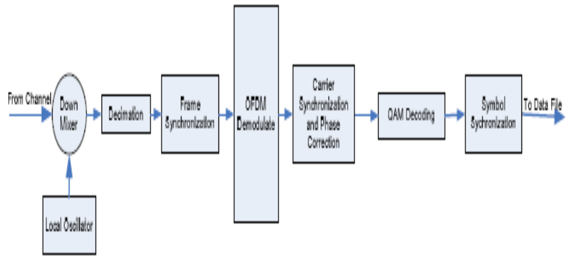

Fig. 6:-Receiver Subsystem Detail

1) Frame Synchronization

The frame synchronization synchronizes the data frames. This aligns the start time of the message so the digital data can be interpreted correctly. This allows the compute file or message to be translated back into its original form.

2) Demodulation

The demodulation system consists of two parts: OFDM demodulation and QAM demodulation. The OFDM demodulation demodulates the signal into its constituent QAM sub signals. The QAM demodulation decodes the QAM carriers back into the bytes that were originally transmitted.

3) Carrier Synchronization and Phase Correction

The carrier synchronization subsystem corrects for frequency differences between the transmitter and the receiver. It also corrects for the phase delay introduced by the channel.

4) Symbol Synchronization

The symbol synchronization determines the time to sample the pulses coming from the QAM modulation. This allows the most accurate information to be extracted from the pulse stream. The output is the digital data that was originally sent into the system.

4. RESULTS & DISCUSSION

Simulink

After completing the simulink model for software radio, it is tested by transmitting a test image through the transmitter model and received successfully. The test image transmitted through the model is given as in Fig. 7.

Fig.7:- Test image transmitted

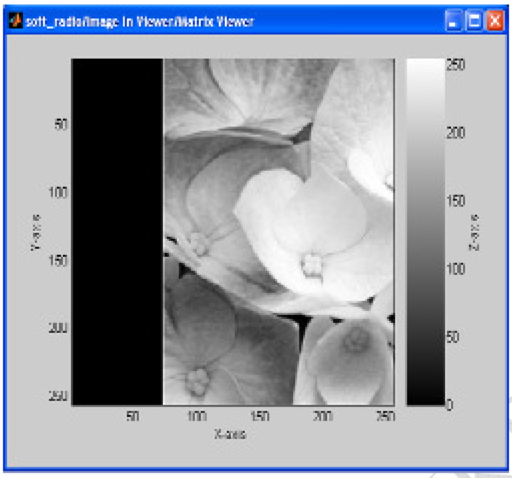

Fig. 8:-. Image out Viewer

The transmitted image is viewed before transmissionas in Fig. 8.

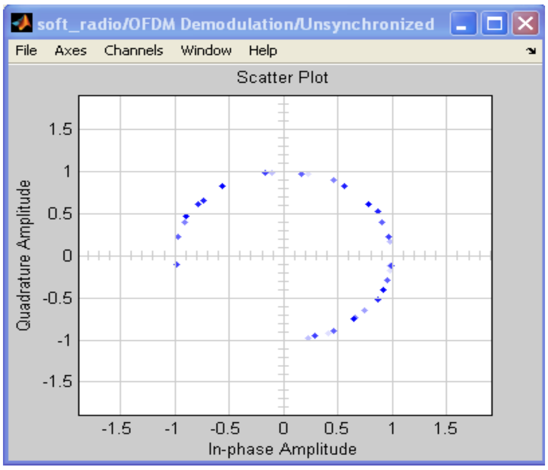

Fig.9:- Unsynchronized OFDM Demodulation Plot

Fig.9. Describes unsynchronized OFDM Demodulation plot for the developed software model.

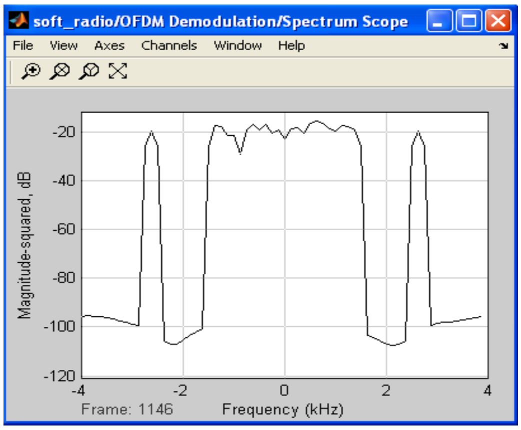

Fig.10:- OFDM Demodulation spectrum

Fig. 10 defines the OFDM Demodulation spectrum for the developed Software radio model.

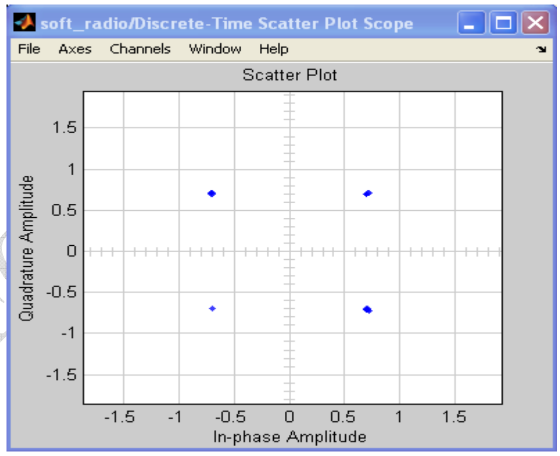

Fig. 11:- Discrete time scatter plot scope

Fig.11. explains that the discrete time scatter plot scope obtained for the developed Software radio model.

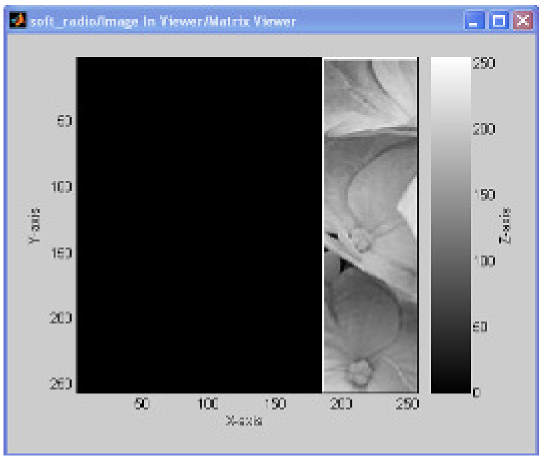

Fig. 12:- Test image while transmitting

Fig.12. Shown above defines that the picture is viewed while the image transmission occurs.

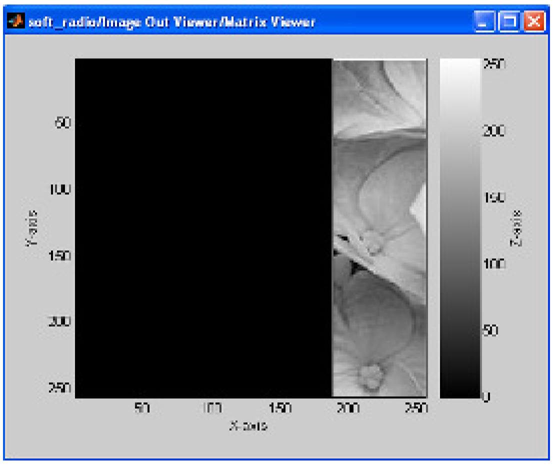

Fig. 13:- Test image while reception

Fig.13. shows the picture that is viewed at the time of reception.

Above all results for the case for perfect channel. We take other results for different cases of channel like to much frequency offset, Hz frequency offset, etc by changing the different parameters of channel. Implementation of this Model on DSK6713 dsp model kit.

5. CONCLUSIONS

Software-defined radio (SDR) system with reconfigurable architecture for wireless communications. In the past, multiple digital signal processors (DSPs) were required to implement the baseband operation in a single transceiver. However, with the rapid increase in transistor density, it has become feasible to keep the functionality entirely in the programmable DSP engines. The combination of advances in semiconductor technology in hardware devices such as field-programmable gate arrays (FPGAs) and DSPs, and the need for rapid upgrades (software) has transformed wireless transceivers into programmable devices, allowing quick upgrades and backward compatibility with old standards. In other words, significant amounts of computations are done by software in a DSP. Such a SDR system design produces a radio that can receive and transmit widely different radio communications (sometimes referred to as a waveforms) based solely on the standard employed.

The model developed for verifying the transmissions of a text or jpeg image are,

- QAM encoder
- OFDM modulator
- QAM decoder
- OFDM demodulator
- OFDM spectrum
- Soft Radio Scatter Plot

Figuring out the simulink diagram optimization so that the radio speed could be increased to run on the board. Implement Coding on the radio to reduce the error rate due to additive white Gaussian noise. Looking into implementing RF hardware to simulate Radio's performance under real world conditions. Investigate Multilevel QAM and AGC in order to increase radio's data rate. The rest of the carriers of OFDM frame could also be utilized to increase this.

6. REFERENCES

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