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USRP 2901 Based MIMO-OFDM Transciever in Virtual and Remote Laboratory

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Abstract: OFDM has developed into a popular scheme for wideband digital communication, used in different applications such as digital television and audio broadcasting, Internet access, wireless networks and 4G mobile communications etc. SDR has become a universal platform for implementing any type of waveform in software. We use Universal Software Radio Peripheral (NI USRP-2901) as SDR to transmit and receive the OFDM signal with MIMO configuration. MIMO- OFDM Transceiver is implemented using USRP devices and data is transmitted in terms of bits as shown in the front panel output and input. The data is transmitted with the help of VERTO antennas. The VI Snippets of both transmitter and receiver are explained step by step and results are shown in the front panel in the LabVIEW software. The number of bits received and transmitted is also shown with transmitting frequency and receiving frequency in the screen shot.

***Keywords*—**OFDM, MIMO, USRP, SDR, LabVIEW.

I. INTRODUCTION

The BER of MIMO OFDM over the Rayleigh blurring channel for M-QAM Modulation. and furthermore the estimation of channel at high frequencies with customary slightest squares(LS) and Minimum Mean Square(MMSE) estimation calculations which is brought out through MATLAB reenactment. The execution of MIMO OFDM is assessed on the rudiments of Bit Error Rate (BER) and Mean square Error (MSE) level [1]. The OFDM might be joined with radio wire exhibits at the transmitter and beneficiary to build the decent variety pick up and additionally to upgrades the framework limit on time variation and recurrence particular channels, bringing about MIMO Configuration [2]. As a promising innovation for the future broadband correspondence, and the reproduction comes about demonstrate this is a promising innovation for cutting edge remote frameworks and utilized as a part of uses, for example, HYPERLAN,WLAN and DSL etc[3]. The efficient simulation for MIMO OFDM system with channel equalization. BPSK modulation is used to detect the behavior of the Rayleigh fading channels in presence of additive white Gaussian noise and performance is evaluated[4],[16].This paper demonstrates that the expansion of equalizer decreases the BER and the channel yield turns out to be more articulated [5]. This paper shows a VLSI usage [20], [19] of 2X2 MIMO OFDM handset with self ICI scratch-off plan at low power. Stage clamor and the transporter recurrence counterbalance (CFO) are the significant issues in Orthogonal Frequency Division Multiplexing (OFDM) that obliterates the shared symmetry of the sub-bearers over a given time interim. This non-symmetry between the sub-bearers causes Inter-Carrier Interference (ICI). The impacts of stage Noise and CFO in MIMO OFDM [21],[14],[15]. The SFBC coded 2X2 MIMO OFDM structure was combined in TSMC 180nm innovation utilizing Cadence NC Simulator and RTL Compiler [9], [10]. One of the major issues in building an independent robot is the recognition and recreation of its condition, which is generally accomplished with tactile frameworks that utilization camera, laser, sonar, or radar. This paper proposes the utilization of an Orthogonal Frequency Division Multiplexing (OFDM) based radio to detect the environment [18]. Our answer utilizes an OFDM remote transmitter, for example, the one from Wi-Fi, on the robot to transmit a flag which is then reflected back by snags, and the reflected flag is caught with a locally available beneficiary [11]. The recipient investigates the approaching sign for multipath deferral and edges of entry of each of these resolvable multipath segments [17], [8]. In this paper, ANN is proposed and actualizes after decoder of an OFDM framework and this approach limits the mistake [22]. This Paper presents methods for used maximum spectral efficiency from Orthogonal Frequency Division Multiplexing (OFDM) systems [23].

Section I contains the introduction of paper. Section II gives the flow chart of transmitter and receiver section using USRP device. Section III contains the architecture and essential steps in the design process, section IV describes the results and discussion, Section V concludes the research work with future directions.

II. METHODOLOGY

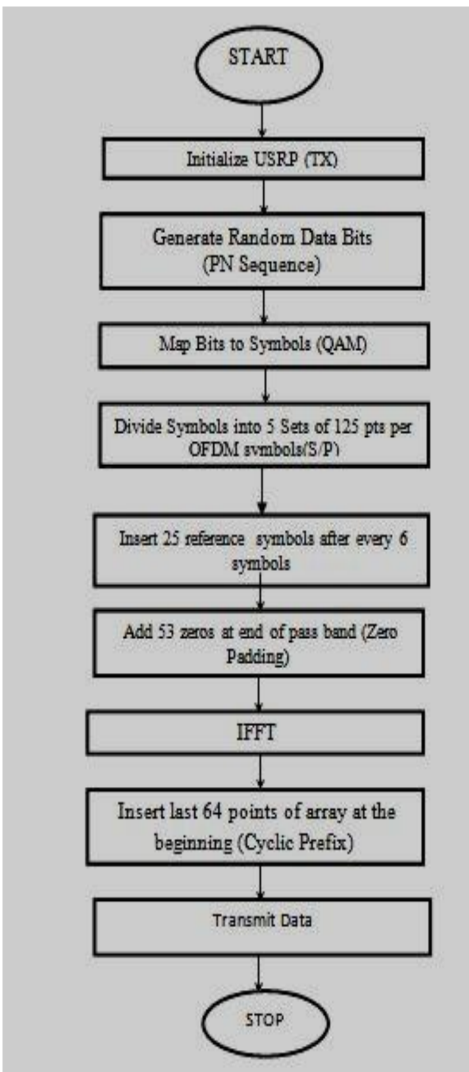

Fig 1. Flow Chart of MIMO-OFDM Transmitter

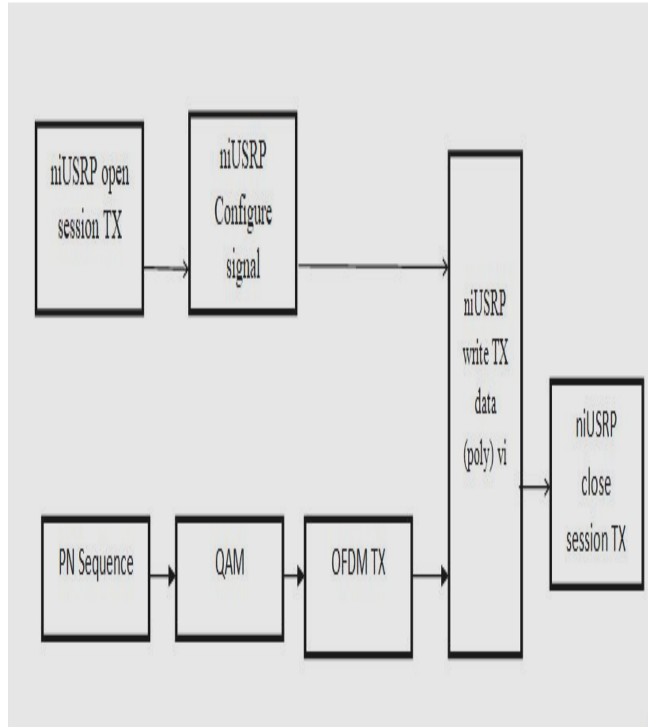

Fig 2. Block diagram of OFDM Transmitter using LabVIEW

Using a large number of parallel narrow-band subcarriers instead of a single wide-band carrier to transport information [6],[7]. Because of its high-speed data transmission and effectiveness in combating the frequency selective fading channel, OFDM technique is widely used in wireless communication nowadays [12],[13].

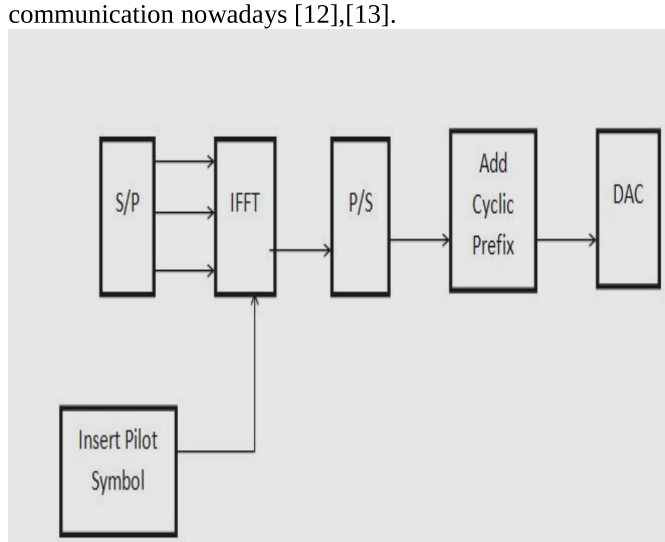

Fig 3. Internal Block diagram of OFDM Transmitter VI

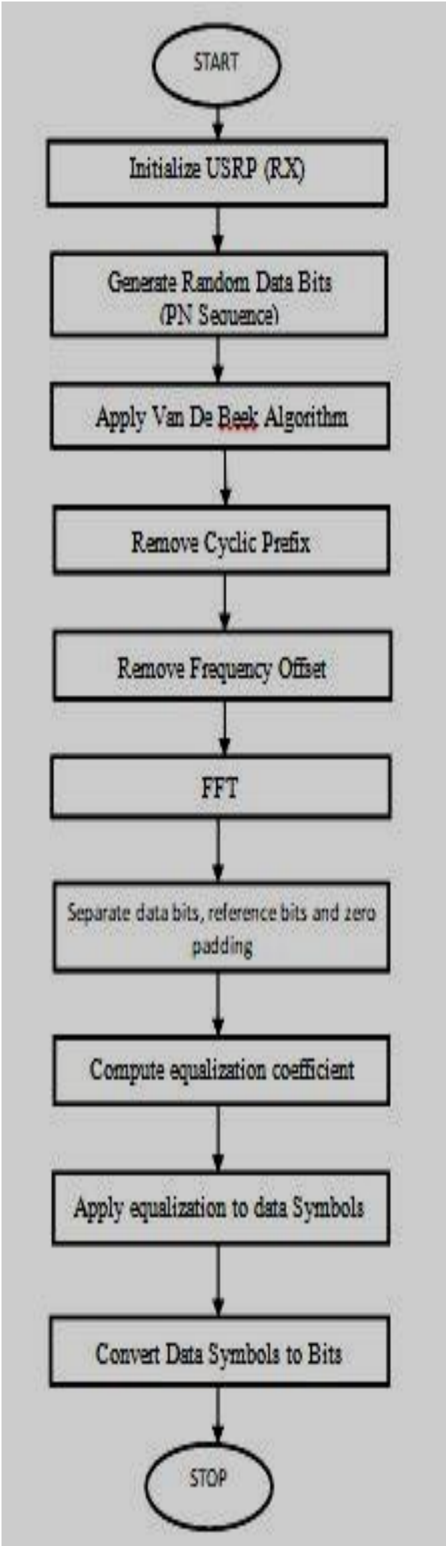

Fig 4. Flow Chart of MIMO OFDM Receiver

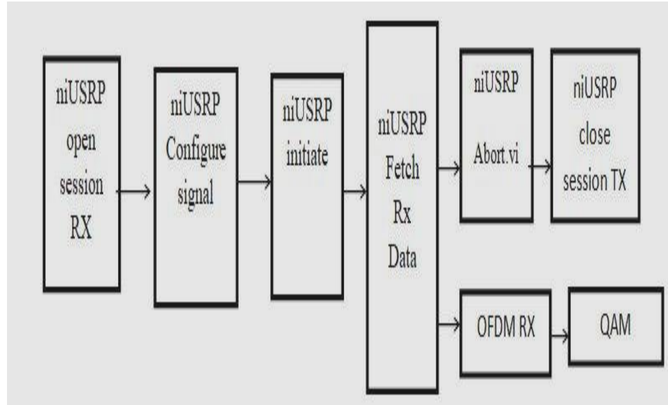

Fig 5. Block diagram of OFDM rx using labVIEW

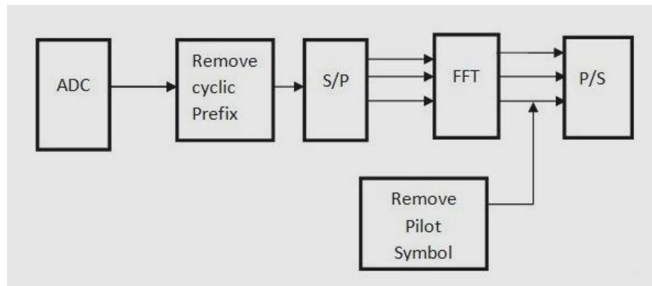

Fig 6. Internal block diagram of OFDM Rx VI

Fig 7. Hardware set up of USRP device based MIMO-OFDM Transceiver

Figure shows two niUSRP (2901) connected to computer. USRP kit is connected to PC by USB and Ac/Dc power supply

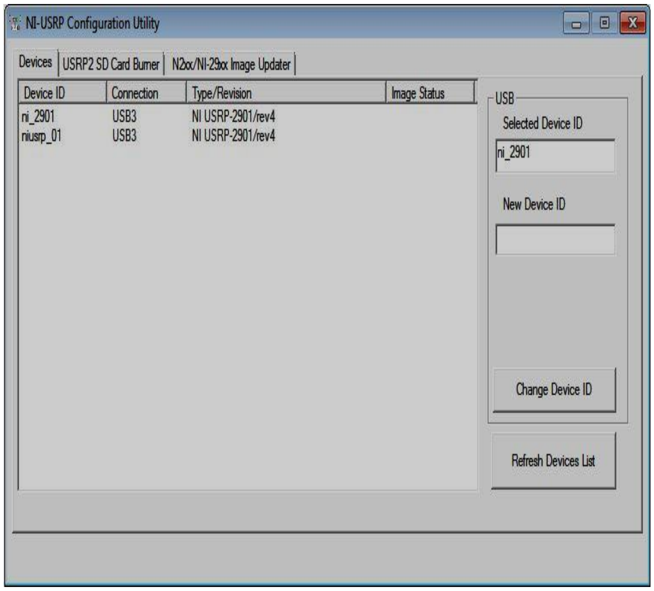

Fig 8. Screen shot of USRP device detection

Connect niUSRP device to computer using USB cable and AC/DC power supply cable. Configuration of niUSRP devices follows, Select Start» All Programs» National Instruments» NI-USRP»NI-USRP Configuration Utility to open the NI-USRP Configuration Utility. Select the Devices tab of the utility. Your device should appear in the list on the left side of the tab, similar to the following figure. If you have multiple devices, verify that you selected the correct device. The device ID of the selected device displays in the Selected Device ID textbox.

III. RESULTS AND DISCUSSIONS

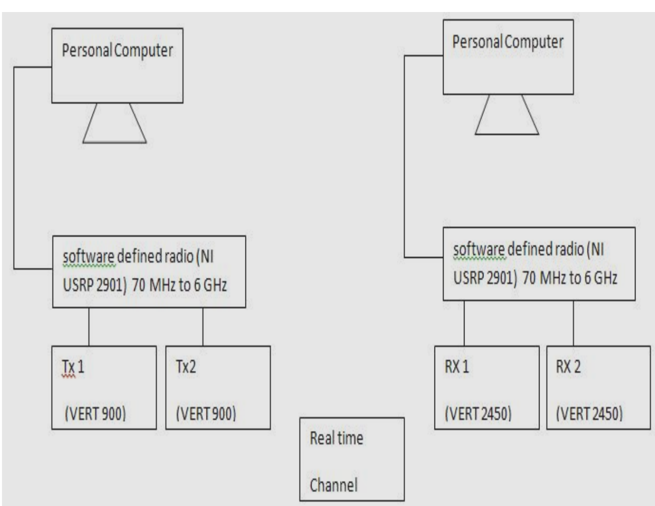

Fig 9. Schematic diagram of MIMO OFDM Tranceiver using USRP devices and VERT 900 and VERT 2450 antennas

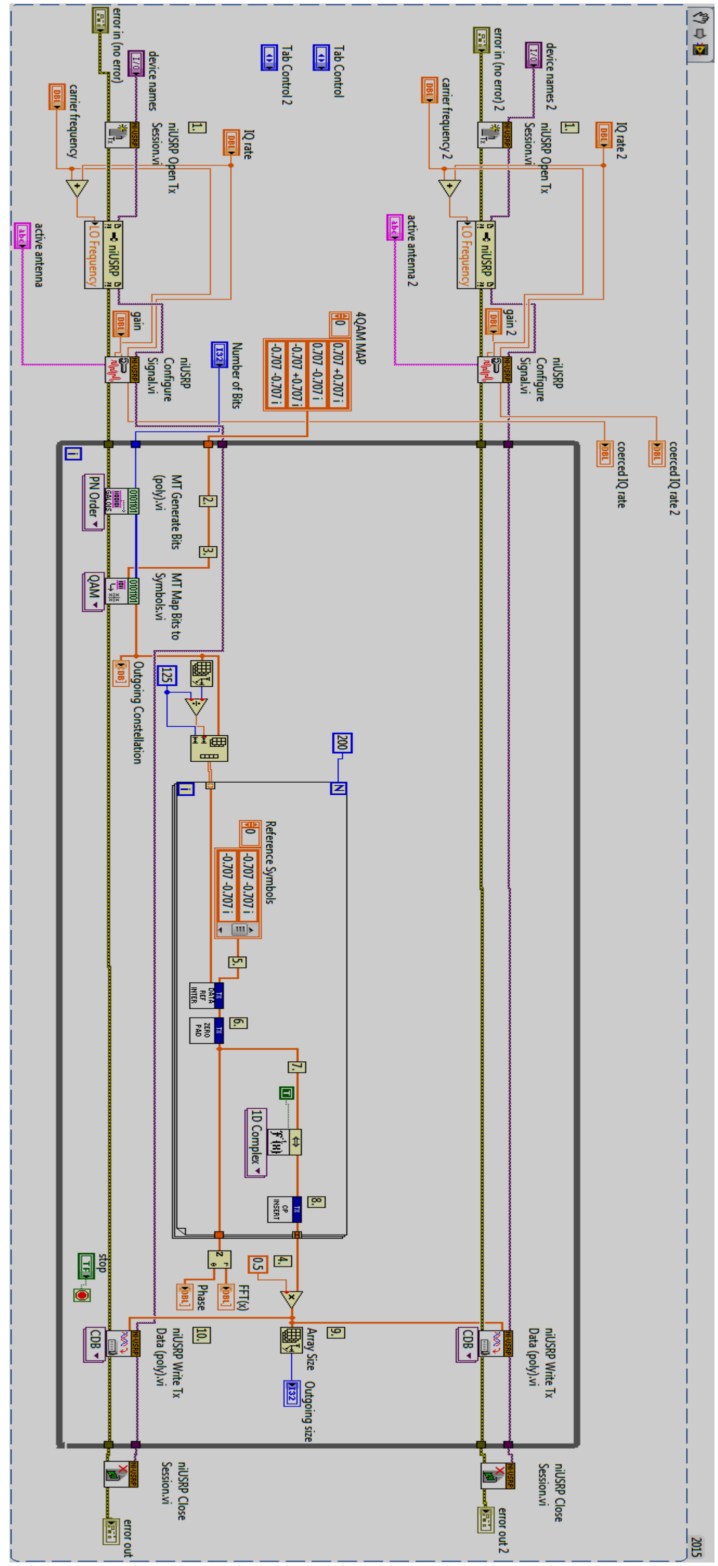

Fig 10. MIMO- OFDM Transmitter VI Snippet

niUSRP Open Transmitter Session opens a transmit session to the devices specify in the device names input and returns session handle out, which you use to identify this instrument session in all subsequent NI-USRP VI's. Device names are niusrp_01,ni_2901, niUSRP Property Node VI uses Gets or sets NI-USRP properties. The local oscillator LO Frequency adds IQ rate and carrier frequency of the signal.

NiUSRP Configure Signal VI can be used with a transmitter session. It sets the IQ rate, carrier frequency, gain, and active antenna. For multiple USRP configurations the channel list specifies a specific USRP. Not all IQ rates, frequencies and gains are valid. While Loop Repeats the code within its sub diagram until a specific condition occurs. A While Loop always executes at least one time. MT Generate Bits (poly) VI polymorphic instance generates Galois pseudo noise(PN) bit sequences. The VI repeats the selected pattern until it generates number of total bits that you specify. Use this instance to specify a PN sequence order based on which the VIs selects a primitive polynomial that returns an m-sequence. This VI is polymorphic (poly), meaning that there are several versions (instances) of the VI available to choose from depending on the data type you wish to work with. MT Map Bits to Symbols VI Maps bits to complex valued symbols for PSK, QAM, PAM, ASK and CPM modulation schemes and frequency deviations for FSK and MSK modulation schemes.

Data Reference Interleave VI Inserts knows reference symbols, Interleaves symbols. Zero Padding VI Pads beginning and end of symbols up to size N. Inverse FFT VI Computes the inverse discrete Fourier transform (IDFT) of input sequence FFT(X).You must manually select the polymorphic instance you want to use. niUSRP Write Transmitter Data (Poly) VI niUSRP Write Transmitter Data VI allows you to send IQ data to the USRP so that it may transmit that data at the carrier frequency specified by the niUSRP Configure Signal VI. This VI is polymorphic (poly), meaning that there are several versions (instances) of the VI available to choose from depending on the data type you wish to work with. niUSRP Close Session VI niUSRP Close Session VI closes the current Transmitter session and releases the memory in use by that session. After calling this VI you can no longer transmit to or receive data from the USRP until you re-open a new session.

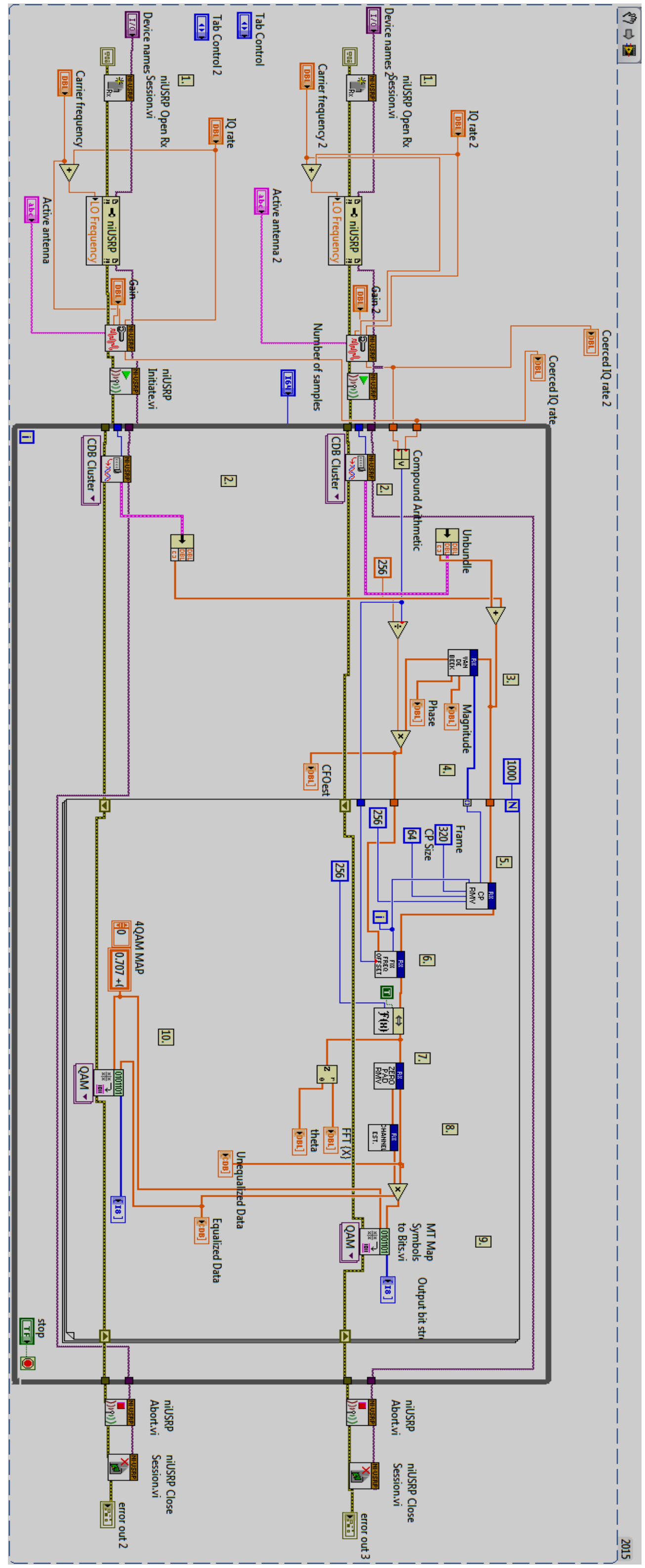

Fig 11. MIMO OFDM Receiver VI Snippet

niUSRP Open Rx Session VI is the first VI that is used to create a software session with the USRP for receiving an RF signal. A session is necessary to send configuration data and retrieve IQ data from the USRP. niUSRP Property Node VI:Gets or sets NI-USRP properties. niUSRP Configure Signal VI can be used with a receive (Rx) session. It sets the IQ rate, carrier frequency, gain, and active antenna. For multiple USRP configurations the channel list specifies a specific USRP. Not all IQ rates, frequencies and gains are valid. niUSRP Initiate VI starts the receive session and tells the USRP that all configuration is complete and that the USRP should begin to capture IQ data (samples). niUSRP Fetch Rx Data (Polymorphic) VI allows you to retrieve IQ data from a USRP that has an Rx session created with the niUSRP Open Rx Session VI. Van De Beek VI uses Maximum likelihood symbol time and carrier frequency offset(CFO) estimator in OFDM. Redundat information contained within the cyclic prefix enables this estimation without additional pilots. Removes cyclic prefix(CP) from a frame and extracts N-point data symbols. One Frame contains CP+DATA. Zero pad Removal and DE interleave VI Removes zero padding, DE interleaves data and extracts reference symbols Channel Estimation Linear VI: Estimates channel based on received reference symbols and known reference symbols. MT Maps Symbols to Bits VI: Maps complex valued PSK,QAM,PAM,ASK,FSK,MSK and CPM modulated symbols to an output bit stream based on the symbol map that you specify. niUSRP Close Session VI closes the current Rx session and releases the memory in use by that session.

IV. Results and Discussion

The proposed MIMO-OFDM beneficiary utilizing USRP gadget plans was investigated through reproductions of a 2×2 framework with 2 verto reception apparatuses at the transmitter and 2 verto at the recipient. The data bits of each transmit chain are encoded with a ½-rate convolutional encoding 32-QAM adjusted and along these lines mapped to 48 information subcarrier of a 64-pointOFDM framework in light of the IEEE 802.11a standard. In this way one codeword traverses over all frequencies and moreover more than 10 back to back OFDM images to yield adequate decoder execution The bearer recurrence was decided to 5.2GHz and the speed in nature was accepted to 50km/h bringing about a most extreme Doppler recurrence move of 240Hz. The channel show utilized is Rayleigh blurring channel. The channel recreation permits examination of basic remote channel attributes, for example, commotion, multipath, and cutting. By adding irregular information to the transmitted flag, basic commotion is recreated. Multipath recreation includes including constricted and deferred duplicates of the transmitted flag to the first. This recreates the issue in remote correspondence when the flag proliferates on numerous ways. Fig 12 and Fig 13 shows the front panel of USRP device and tells us the no of bits transmitted and number of bits received.

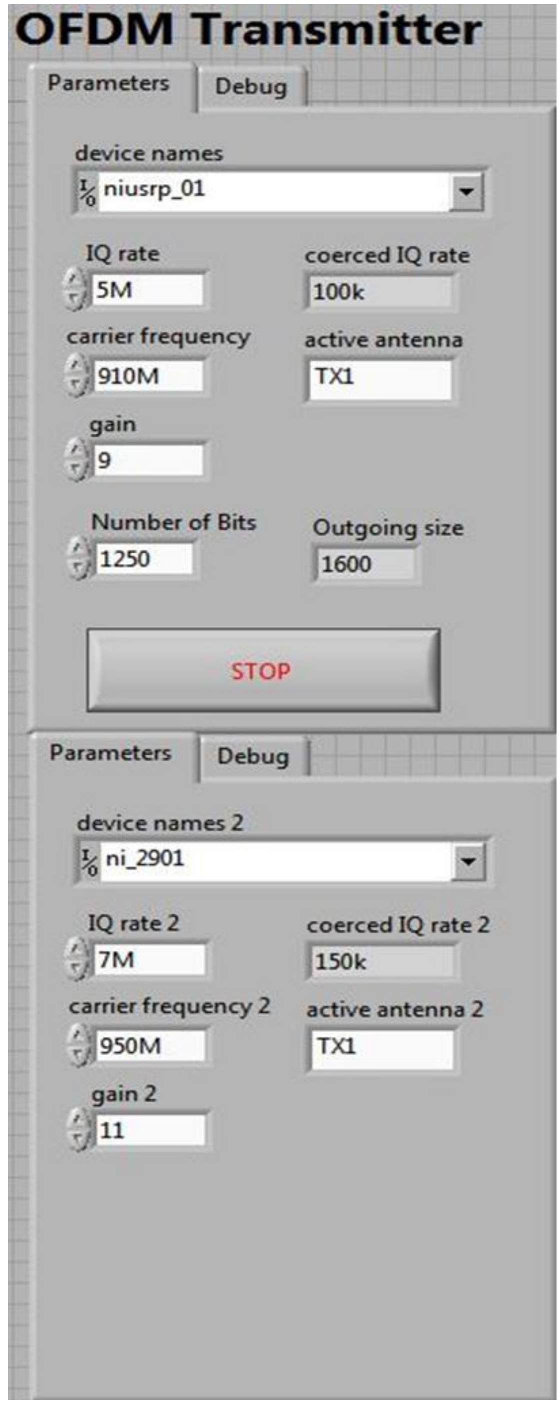

Fig 12. Front panel output of MIMO-OFDM in LabVIEW

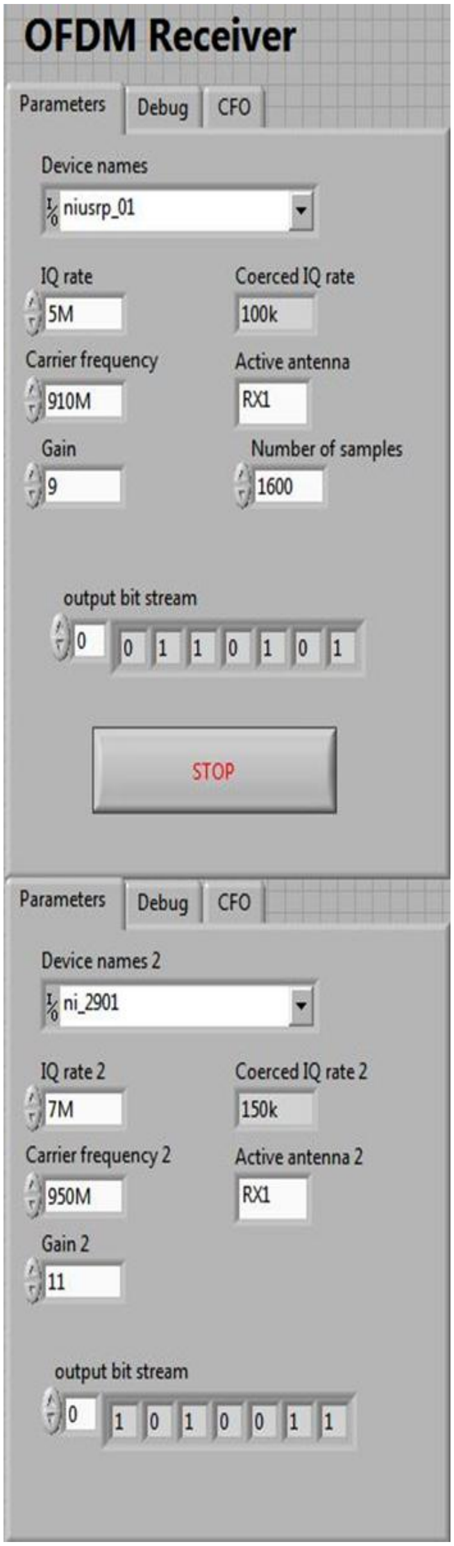

Fig 13. Front panel of MIMO OFDM Receiver using LabVIEW

V. Conclusion

The demand for high data rate wireless communication has been increasing dramatically over the last decade. This paper has provided an analysis of OFDM behaviors, principles and simulation results found with the help of working setup of OFDM system implementation using LabVIEW software and USRP hardware which conclude the successful transmission and reception of information bit using 4 QAM techniques with equalized data and amplitude after MIMO-OFDM receiver.

VI. FUTURE SCOPE

Wireless communication system is a vast field to work on and the number of generations being developed one by one and some of the improved functions in them, SDR has a lot of potential for implementing the emerging wireless applications. A lot of research is being done on the SDR in different applications to make it available for commercial use.

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