Method and System for real-time decision-based carrier tracking for software defined radios

Abstract

The present disclosure relates to a system for real-time decision-based carrier tracking for software defined radios using M-ary QAM modulation. The system consists of a USRP module, a shift register, a demodulator, a matching filter, a NI-USRP configure signal VI, a button, a NI USRP Tx data VI, and a front panel. In the present disclosurea Scalable and Real-time decision based carrier trackingfor Software Defined Radio (SDR)for M-ary QAM modulation using Universal Software Radio Peripheral (USRP) has been proposed. The proposed SDR system provides a Real-time decision-based carrier tracking for improved efficiency and performance.The real-time transfer of data has been done using the USRP-2922 hardware using the M-ary QAM modulation scheme for data transmission. The disclosed system showed improved stability and provides a reconfigurable and highly flexible architecture for future modulation schemes to be incorporated. 24 100 universal software radio peripheral shift register 104 (USRP)module 102 demodulato 106 matching filter108 NI USR P config ure signal VI 110 button112 NI-USRPwrite Tx data VI 114 front panel 116 Figure1 200 generating IQwaveform from a USRP module and thereby feeding to a s hift registerforpipelining,whereinacquiredIQsignalisresampledtomultiplesofthe expectedsymbol rate demodulatingthes ignalaccording tothetypeof thedatato betransmIttedand 204 thereby truncating a transient from the demodulated signal at the receiver end verifyingtheparametersofthereceivedsignalusingaN-USRPconfiguresignalVand thereby initiating waveform acquisition in an Rx session before transmissionof the data [V 206 startsfromthetransmittersidetoretrievewaveformdatacompletely initiatingthetransmissionthroughthetransmitterbyaNl-USRPwriteTxdataVI selectingRxparameterwindowusIngafrontpaneltospecifythelPaddressforthe 210 receiver side USRP and thereafter configuring the Rx parameters and the acquisition durationtime at the receiverend in (sec). Figure 2

Classifications

H04L27/34 Amplitude- and phase-modulated carrier systems, e.g. quadrature-amplitude modulated carrier systems

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Inventor: Nafeesh Ahmad, Ayyanna Gurikar, Prashanth K. Y., C. Kamalanathan, Swarnjeet Kaur, Nikhil MARRIWALA, Sunita Panda, Anusha R., Ayalapogu Ratna Raju, V. Subba Ramaiah, Bhanu Sharma, Kulwant Singh, Atla Sridhar

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Claims (10)

Hide Dependent

WE CLAIM

1. A system for real-time decision-based carrier tracking for software defined radios using M ary QAM modulation, the system comprises:

A universal software radio peripheral (USRP)module for generating IQ waveform;

a shift register for pipelining the generated IQ waveform, wherein acquired IQ signal is resampled to multiples of the expected symbol rate;

a demodulator for demodulating the signal according to the type of the data to be transmitted;

a matching filter for truncating a transient from the demodulated signal at the receiver end;

a NI-USRP configure signal VI for verifying the parameters of the received signal;

a button for initiating waveform acquisition in an Rx session before transmission of the data starts from the transmitter side to retrieve waveform data completely;

a NI-USRP write Tx data VI for initiating the transmission through the transmitter; and

a front panel for selecting Rx parameter windowfor specifying the IP address for receiver side USRP and thereafter configuring the Rx parameters and the acquisition duration time at the receiver end in (sec).

2. The system as claimed in claim 1, wherein real-time transfer of data is performed using USRP-2922 hardware by employing the M-ary QAM modulation scheme for data transmission, wherein the QAM modulation scheme is used for data transmission applications over bandpass channels hence.

3. The systemas claimed in claim 1, comprises aconvolutional encoding employed with a Viterbi decoding (FEC techniques) for error correction and removal of noise and a convolutional decoder to receive codewords as an array of values representing Boolean bits, whereinthe decoder applies the Viterbi hard decision decoding technique to obtain the maximum likelihood transmitted data sequence.

4. The system as claimed in claim 1, wherein the parameters are code rate and constraint length.

5. The system as claimed in claim 1, comprises a SDR transceiver employing a turbo encoder designed by parallel concatenation of two recursive systematic convolutional (RSC) codes separated by an inter leaver.

6. A method for real-time decision-based carrier tracking for software defined radios using M ary QAM modulation, the method comprises:

generating IQ waveform from a USRP module and thereby feeding to a shift register for pipelining, wherein acquired IQ signal is resampled to multiples of the expected symbol rate;

demodulating the signal according to the type of the data to be transmitted and thereby truncating a transient from the demodulated signal at the receiver end;

verifying the parameters of the received signal using a NI-USRP configure signal VI and thereby initiating waveform acquisition in an Rx session before transmission of the data starts from the transmitter side to retrieve waveform data completely;

initiating the transmission through the transmitter by a NI-USRP write Tx data VI for; and

selecting Rx parameter windowusing a front panel to specify the IP address for the receiver side USRP and thereafter configuring the Rx parameters and the acquisition duration time at the receiver end in (sec).

7. The method as claimed in claim 6, whereina process for front end implementation of M QAM, SDR transmitter using USRPcomprises:

generating IQ waveform from a USRP module and thereby feeding to a shift register for pipelining;

sampling acquired IQ signal to multiples of the expected symbol rate and thereupon modulating the signal according to the type of the data to be transmitted; adding a transient to the modulated signal using a matching filter which is thereafter transmitted; and verifying parameters of the transmitted signal upon signal and check for the constellation graph display NI-USRP configure signal VI.

8. The method as claimed in claim 6, wherein input bit-stream array (Message Data) is divided into chunks of length equal to the data length, whereinthe convolutional encoder design sequentially encodes each chunk and recombines the encoded data to return the output codeword in the output bitstream array.

9. The method as claimed in claim 6, comprises three options for transmitting the data arerandom data, text and the image, wherein number of bits to be transmitted are indicated by the transmitted bits andthe data to be sent is encoded using a Turbo Coding/Convolution Coding by selecting from the type of encoding button.

10. The method as claimed in claim 6, wherein the data is initially encoded before transmission using either turbo coding or convolution coding and then modulating usingthe QAM and transmitted over the channel through USRP.

Description

universal software radio peripheral shift register 104 (USRP)module 102

demodulato 106 matching filter108

NI USR P config ure signal VI 110 button112

NI-USRPwrite Tx data VI 114 front panel 116

Figure1

200

generating IQwaveform from a USRP module and thereby feeding to a s hift registerforpipelining,whereinacquiredIQsignalisresampledtomultiplesofthe expectedsymbol rate

demodulatingthes ignalaccording tothetypeof thedatato betransmIttedand 204 thereby truncating a transient from the demodulated signal at the receiver end

verifyingtheparametersofthereceivedsignalusingaN-USRPconfiguresignalVand thereby initiating waveform acquisition in an Rx session before transmissionof the data [V 206 startsfromthetransmittersidetoretrievewaveformdatacompletely

initiatingthetransmissionthroughthetransmitterbyaNI-USRPwriteTxdataVI

selectingRxparameterwindowusIngafrontpaneltospecifythelPaddressforthe 210 receiver side USRP and thereafter configuring the Rx parameters and the acquisition durationtime at the receiverend in (sec).

Figure 2

Method and System for real-time decision-based carrier tracking for software defined radios

FIELD OF THE INVENTION

The present disclosure relates to a system for real-time decision-based carrier tracking for software defined radios using M-ary QAM modulation.

BACKGROUND OF THE INVENTION

SDR refers to the technology where software modules are designed and run on a generic platform made up of digital signal processors and many general-purpose microprocessors used to employ different radio functions like modulation (generation of signal to be transmitted) at the transmitter and demodulation (tuning/detection) of the received signal at the receiver. SDR technology can implement secured military, commercial and civilian radio applications. SDR technology further can be used to implement a wide range of radio applications such as Bluetooth, Wireless Local Area Network (WLAN), Global Positioning System (GPS), Wireless Code Division Multiple Access (WCDMA), General Packet Radio Service (GPRS), etc. With the new development of different ways and means by which people communicate i.e. data communications, articulation/voice communications, video communications, broadcast messaging, command and control communications, emergency acknowledgement communications, etc., modifying radio devices easily and cost-effectively has become critical. SDR technology brings flexibility in the system, cost efficiency, and control to drive communications forward. SDR has wide-reaching benefits for the end-user realized by service providers and product developers. SDR system has the capability of replacing traditional hardware which is still in common use like the FM radio or TV transmission as it can adapt to a variable environment for many different applications. SDR system offers a very promising futuristic technology which reduces the hardware cost as it can replace systems like FM radio or TV broadcast and cellular communication systems. SDR system is an advantageous, adjustable and future-proof solution to deploy both existing and emerging standards. An SDR system provides reconfigurability, intelligence and capability to program hardware with software upgrades. Moreover, it can provide global seamless connectivity and also provides the solution to interoperability. In a nutshell, SDR is a technology which offers multi-mode, multi modulation reconfigurable and future-proof environment.

In Global System for Mobile communication (GSM), Gaussian Minimum Shift Keying (GMSK) is used (GMSK is a form of continuous-phase frequency shift keying). In General Packet Radio Service (GPRS), 8-Phase Shift Keying (8PSK) is used. Many users in GPRS and GSM can be given the right to use the network by making use of the Time Division Multiple Access (TDMA) or the Frequency Division Multiple Access (FDMA) schemes. Another modulation scheme that offers many benefits is Code Division Multiple Access (CDMA) modulation which is used in standards like IS-95 and UMTS (a competitor to GSM and GPRS). In CDMA information bits are modulated using a higher rate sequence of pseudorandom bits called PN sequence. PN sequences are generated to be orthogonal to each other. This allows multiple users to use the time-frequency medium at the same time. Orthogonal Frequency Division Multiplexing (OFDM) is another digital modulation scheme commonly used for wide band multi-carrier communication systems. For any dependable communication system, FEC codes are the main part of it. FEC is a method of adding redundant bits to the information to be sent from the transmitter to help the receiver correct errors. The FEC codes are divided into two types namely the Convolutional codes and block codes.

The Block codes are usually defined by n and k, where n describes the total number of coded bits and k gives the number of input bits. The coding history came into existence with the seminal work on "The mathematical theory of communication." The theory is that the data can be transmitted without errors if the channel capacity is higher than the bit rate. It is proved that by the use of appropriate codes errors can be removed from the message signal received. The error free codes can be termed as block codes. Block codes are the ones where the redundancy is added to blocks of the data. The convolutional codes are the codes in which the redundancy is added continuously. Viterbi decoder can be used to decode the Convolutional codes. This can be done using a soft Vierbi decoder also. Another method for error free decoding is through the use of Turbo codes and LDPC codes. The turbo codes have shown a performance very near to the Shannon limit. The turbo codes use numerous iterative decoding algorithms such as the Gallager"s low parity density check (LDPC) codes.

However, it has been observed that the transfer of sensitive data using the wireless communication systems has not always proved to be a safer option. Therefore to avoid the aforementioned there is a need of a system for real-time decision-based carrier tracking for software defined radios using M-ary QAM modulation.

SUMMARY OF THE INVENTION

The present disclosure relates to a system for real-time decision-based carrier tracking for software defined radios using M-ary QAM modulation. In the present disclosure a Scalable and Real-time decision-based carrier trackingfor Software Defined Radio (SDR)for M-ary QAM modulation using Universal Software Radio Peripheral (USRP) has been proposed. The disclosed SDR system has been designed and tested using Graphical User Interface (GUI) language Lab VIEW which provides easy real-time interface and provides a Real-time decision based carrier tracking for improved efficiency and performance.USRP-2922 hardware using the M-ary QAM modulation scheme for data transmission is used for the real-time transfer of data. The disclosed SDR system has been designed for a safe and secure data transfer between the two ends.The performance of the proposed system is analyzed in terms of Bit Error Rate (BER) vs. Signal to Noise ratio (Eb/No). In the present disclosed system one can transfer Random data (Binary Bits), Text or an Image which can be encoded using the desired Forward Error Correction Codes (FEC) namely the Convolution coding/Viterbi soft decision decoding and the Turbo coding/decoding.

The present disclosure seeks to provide a system for real-time decision-based carrier tracking for software defined radios using M-ary QAM modulation. The system comprises: a universal software radio peripheral (USRP)module for generating IQ waveform;a shift register for pipelining the generated IQ waveform, wherein acquired IQ signal is resampled to multiples of the expected symbol rate;a demodulator for demodulating the signal according to the type of the data to be transmitted;a matching filter for truncating a transient from the demodulated signal at the receiver end;a NI-USRP configure signal VI for verifying the parameters of the received signal;a button for initiating waveform acquisition in an Rx session before transmission of the data starts from the transmitter side to retrieve waveform data completely;a NI-USRP write Tx data VI for initiating the transmission through the transmitter; and a front panel for selecting Rx parameter windowfor specifying the IP address for receiver side USRP and thereafter configuring the Rx parameters and the acquisition duration time at the receiver end in (sec).

The present disclosure also seeks to provide a method for real-time decision-based carrier tracking for software defined radios using M-ary QAM modulation. The method comprises: generating IQ waveform from a USRP module and thereby feeding to a shift register for pipelining, wherein acquired IQ signal is resampled to multiples of the expected symbol rate;demodulating the signal according to the type of the data to be transmitted and thereby truncating a transient from the demodulated signal at the receiver end;verifying the parameters of the received signal using a NI-USRP configure signal VI and thereby initiating waveform acquisition in an Rx session before transmission of the data starts from the transmitter side to retrieve waveform data completely;initiating the transmission through the transmitter by a NI USRP write Tx data VI for; andselecting Rx parameter windowusing a front panel to specify the IP address for the receiver side USRP and thereafter configuring the Rx parameters and the acquisition duration time at the receiver end in (sec).

An objective of the present disclosure is to provide a system for real-time decision-based carrier tracking for software defined radios using M-ary QAM modulation

Another object of the present disclosure is to use USRP-2922 hardware using the M-ary QAM modulation scheme for the real time transfer of data.

Another object of the present disclosure is toimprovestability and provides a reconfigurable and highly flexible architecture for real-time data transfer.

Another object of the present disclosure is to provide a SDR system which is designed for a safe and secure data transfer between the two ends.

Yet, another object of the present disclosure is to analyze of performance of the system in term of Bit Error Rate (BER) vs. Signal to Noise ratio (Eb/N).

To further clarify advantages and features of the present disclosure, a more particular description of the invention will be rendered by reference to specific embodiments thereof, which is illustrated in the appended drawings. It is appreciated that these drawings depict only typical embodiments of the invention and are therefore not to be considered limiting of its scope. The invention will be described and explained with additional specificity and detail with the accompanying drawings.

BRIEF DESCRIPTION OF FIGURES

These and other features, aspects, and advantages of the present disclosure will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

Figure 1 illustrates a block diagram of a system for real-time decision-based carrier tracking for software defined radios using M-ary QAM modulation in accordance with an embodiment of the present disclosure;

Figure 2 illustrates a flow chart of a method for real-time decision-based carrier tracking for software defined radios using M-ary QAM modulation in accordance with an embodiment of the present disclosure;

Figure 3 illustrates a USRP system block diagram in accordance with an embodiment of the present disclosure;

Figure 4 illustrates a table of specification for USRP- 2922 in accordance with an embodiment of the present disclosure;

Figure 5 illustrates the QAM modulation process in accordance with an embodiment of the present disclosure;

Figure 6 illustrates a rate 2/3 Convolutional Encoder in accordance with an embodiment of the present disclosure;

Figure 7 illustrates a Convolution Interleaver used for data input and output in accordance with an embodiment of the present disclosure;

Figure 8 illustrates Convolution Deinterleaver used for data input and output in accordance with an embodiment of the present disclosure;

Figure 9 illustrates a table of inputs fed into the Viterbi Soft-Decision Decoder in accordance with an embodiment of the present disclosure;

Figure 10 illustrates the System Diagram for Proposed Turbo Encoder in accordance with an embodiment of the present disclosure;

Figure 11 illustrates the block diagram of turbo decoder in accordance with an embodiment of the present disclosure;

Figure 12 illustrates the Decision-based carrier phase and frequency tracking in accordance with an embodiment of the present disclosure;

Figure 13 illustrates the Phase and Frequency Tracking VI in accordance with an embodiment of the present disclosure;

Figure 14 illustrates the front panel of transmitter in accordance with an embodiment of the present disclosure;

Figure 15 illustrates the specify message/text window in accordance with an embodiment of the present disclosure;

Figure 16 illustrates specify packet for transmission in accordance with an embodiment of the present disclosure;

Figure 17 illustrates FrontPanelofUSRP Receiver/ Rx Parameter in accordance with an embodiment of the present disclosure;

Figure 18 illustrates the output parameters in accordance with an embodiment of the present disclosure;

Figure 19 illustrates the Experimental Setupof the Proposed SDR system using NI-USRP 2922 in accordance with an embodiment of the present disclosure;

Figure 20 illustrates the analysis of the M-QAM signal with the help of constellation diagram, Eye diagram and the BER vs. EJ/N Output curve in accordance with an embodiment of the present disclosure;

Figure 21 illustrates a table of parameters used in turbo coding in accordance with an embodiment of the present disclosure;

Figure 22 illustrates the encoded and decoded output image obtained for Convolution Coding in accordance with an embodiment of the present disclosure;

Figure 23 illustrates the encoded and decoded output Image obtained by usingTurbo Coding in accordance with an embodiment of the present disclosure;

Figure 24 illustrates a table depicting the features of the proposed SDR Transceiver System Using NI USRP for Real-time data transfers in accordance with an embodiment of the present disclosure;

Figure 25 illustrates the BER vs. Eb/No curve for QAM Transceiver using Convolution coding with raised cosine filterin accordance with an embodiment of the present disclosure;

Figure 26 illustrates BER vs. Eb/No curve for QAM Transceiver using Convolution coding with root raised cosine filterin accordance with an embodiment of the present disclosure;

Figure 27 illustrates BER vs. Eb/No curve for QAM Transceiver using Turbo coding with raised cosine filterin accordance with an embodiment of the present disclosure;

Figure 28 illustrates BER vs. Eb/No curve for QAM Transceiver using Turbo coding with root raised cosine filter in accordance with an embodiment of the present disclosure;

Further, skilled artisans will appreciate that elements in the drawings are illustrated for simplicity and may not have been necessarily been drawn to scale. For example, the flow charts illustrate the method in terms of the most prominent steps involved to help to improve understanding of aspects of the present disclosure. Furthermore, in terms of the construction of the device, one or more components of the device may have been represented in the drawings by conventional symbols, and the drawings may show only those specific details that are pertinent to understanding the embodiments of the present disclosure so as not to obscure the drawings with details that will be readily apparent to those of ordinary skill in the art having benefit of the description herein.

DETAILED DESCRIPTION

For the purpose of promoting an understanding of the principles of the invention, reference will now be made to the embodiment illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated system, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

It will be understood by those skilled in the art that the foregoing general description and the following detailed description are exemplary and explanatory of the invention and are not intended to be restrictive thereof.

Reference throughout this specification to "an aspect", "another aspect" or similar language means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present disclosure. Thus, appearances of the phrase "in an embodiment", "in another embodiment" and similar language throughout this specification may, but do not necessarily, all refer to the same embodiment.

The terms "comprises", "comprising", or any other variations thereof, are intended to cover a non-exclusive inclusion, such that a process or method that comprises a list of steps does not include only those steps but may include other steps not expressly listed or inherent to such process or method. Similarly, one or more devices or sub-systems or elements or structures or components proceeded by "comprises.a" does not, without more constraints, preclude the existence of other devices or other sub-systems or other elements or other structures or other components or additional devices or additional sub-systems or additional elements or additional structures or additional components.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. The system, methods, and examples provided herein are illustrative only and not intended to be limiting.

Embodiments of the present disclosure will be described below in detail with reference to the accompanying drawings.

Figure 1 illustrates a block diagram of a system for real-time decision-based carrier tracking for software defined radios using M-ary QAM modulation in accordance with an embodiment of the present disclosure. The system 100 includes a universal software radio peripheral (USRP) module for generating IQ waveform. The USRP is an RF-based software programmable radio transceiver developed and designed for wireless communications research.

In an embodiment a shift register unit 104 is used for pipelining the generated IQ waveform, wherein acquired IQ signal is resampled to multiples of the expected symbol rate.

In an embodiment a demodulator unit 106 is used for demodulating the signal according to the type of the data to be transmitted. The signal is modulated according to the type of the data to be transmitted.

In an embodiment a matching filter unit 108 is used for truncating a transient from the demodulated signal at the receiver end.

In an embodiment a NI-USRP configure signal unit 110 is used for VI for verifying the parameters of the received signal. NI USRP-2922 SDR transceiver has been used in the real-time testing of the proposed transceiver for SDR. The NI USRP-2922 hardware has been programmed using Lab VIEW. The NI USRP-2922 provides an RF platform which is affordable and easy-to use for rapid prototyping applications such as physical layer communication, spectrum monitoring, and many more.

In an embodiment a button unit 112 is used for initiating waveform acquisition in an Rx session before transmission of the data starts from the transmitter side to retrieve waveform data completely.

In an embodiment a NI-USRP write Tx data VI unit 114 is used for initiating the transmission through the transmitter.

In an embodiment a front panel unit 116 is used for selecting Rx parameter windowfor specifying the IP address for receiver side USRP and thereafter configuring the Rx parameters and the acquisition duration time at the receiver end in (sec).

Figure 2 illustrates a flow chart of a method for real-time decision-based carrier tracking for software defined radios using M-ary QAM modulation in accordance with an embodiment of the present disclosure. At step 202 the method 200 includes, generating IQ waveform from a USRP module and thereby feeding to a shift register for pipelining, wherein acquired IQ signal is resampled to multiples of the expected symbol rate

At step 204 the method 200 includes demodulating the signal according to the type of the data to be transmitted and thereby truncating a transient from the demodulated signal at the receiver end.

At step 206 the method 200 includes verifying the parameters of the received signal using a NI-USRP configure signal VI and thereby initiating waveform acquisition in an Rx session before transmission of the data starts from the transmitter side to retrieve waveform data completely.

At step 208 the method 200 includes initiating the transmission through the transmitter by a NI-USRP write Tx data VI.

At step 210 the method 200 includes selecting Rx parameter windowusing a front panel to specify the IP address for the receiver side USRP and thereafter configuring the Rx parameters and the acquisition duration time at the receiver end in (sec).

Figure 3 illustrates a USRP system block diagram in accordance with an embodiment of the present disclosure. The USRP is an RF-based software-programmable radio transceiver developed and designed for wireless communications research. NI USRP-2922 SDR transceiver has been used in the real-time testing of the proposed transceiver for SDR. The NI USRP-2922 hardware has been programmed using Lab VIEW. The NI USRP-2922 provides an RF platform which is affordable and easy-to-use for rapid prototyping applications such as physical layer communication, spectrum monitoring, and many more.The USRP-2922 uses two separate transmit and receive signal chains.

Figure 4 illustrates a table of specification for USRP- 2922 in accordance with an embodiment of the present disclosure. This table shows the specification of a NIUSRP-2922. NI USRP-2922 SDR transceiver has been used in the real-time testing of the proposed transceiver for SDR. The NI USRP-2922 hardware has been programmed using LabVIEW. The NI USRP 2922 provides an RF platform which is affordable and easy-to-use for rapid prototyping applications such as physical layer communication, spectrum monitoring, and many more.

Figure 5 illustrates the QAM modulation process in accordance with an embodiment of the present disclosure. QAM modulation scheme iswidely used for data transmission applications over bandpass channels. It uses two separate product modulators and two carriers of the same frequency which differ in phase by -900 [19]. The multiplexed signal s(t)consists of the sum of these two product modulator outputs as shown by equation

s(t)= Am (t)cos(2rcfft)+ Acm 2 (t)sin(2rcfft)

Where m, (t) and m2 (t) are two different message signals applied to product modulators.

The two paths to the adder are typically referred to as the„"(in-phase), and„Q"(Quadrature) arms.

Figure 6 illustrates a rate 2/3 Convolutional Encoder in accordance with an embodiment of the present disclosure. Convolutional Encoding used with Viterbi decoding is one of the FECtechniques that are used in the present disclosed system for error correction and removal of noise. Convolutional codes are described by two different parameters: the code rate (k/n) and the constraint length(K). Where„' is the number of bits into the Convolutional encoder,'n' is the number of channel symbol output by the Convolutional encoder in a given encoder cycle,„K" is the "length" of the Convolutional encoder.The number of encoder cycles that can be retained by the input bit and later used for encoding after it had first appeared at the input to the Convolutional encoder is indicated by the parameter„m". The „nfparameter is closely related to

„K". The memory length of the encoder is described by the „nf parameter. The encoded bits depend on the current k input bits and also on few past input bits.Convolutional codes are commonly specified by three parameters; (n,km)

Where, n = number of output bits; k = number of input bits; m = number of memory registers.

For a rate 2/3 convolutional encoder, the generator matrix is specified as

100100 011000 44 30 011100 101000 = 34 50 110000 010000 60 20

The present disclosed system uses a rate 2/3 convolutional encoderconstraint length equal to 4 is used. A memory element/ shift register is represented by „D

Figure 7 illustrates a Convolution Interleaver used for data input and output in accordance with an embodiment of the present disclosure. The data in be: x, xl, x2, x3, x4, x5, x6, x7, x8, x9, x10, x11, x12, x13, ...

D = unit delay in the path.The unit delay = 1, and the initial state shift registers are initialized with values of 0 for the interleaver.

Figure 8 illustrates Convolution Deinterleaver used for data input and output in accordance with an embodiment of the present disclosure. Interleaved Data: x, 0, 0, 0, x4, xl, 0, , x8, x5, x2, 0, x12, x9, ...

D = unit delay in the path. The unit delay = 1, and the initial state shift registers are initialized with values of 0 for the de-interleaver.

Interleaved Data: 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, xO, xl, x2, x3, x4, x5, x6, x7, x8, x9,...

Figure 9 illustrates a table of inputs fed into the Viterbi Soft-Decision Decoder in accordance with an embodiment of the present disclosure. In the Viterbi soft decision decoding, the decoder accepts unsigned integers. Additionally, it requires you to specify the number of soft-decision bits, nsof, before decoding. These soft-symbol decisions are obtained by quantizing the soft binary symbol decisions to the specified bits of precision from the demodulator a shown in the table. These unsigned integers range from 0 to 2"sof. An eight-level quantization (nsfp = 3) yields less than a 0.25 dB reduction in coding gain relative to the unquantized Viterbi decoding. When nfp = 1, the Viterbi soft-decision decoding algorithm reverts to performing hard-decision decoding. The table describes the nature of inputs fed into the Viterbi Soft-Decision decoder and assumes that M-ary symbol decisions from the demodulator are quantized to 3 bits of precision.

Figure 10 illustrates the System Diagram for Proposed Turbo Encoder in accordance with an embodiment of the present disclosure. The proposed SDR transceiver uses a turbo encoder designed by parallel concatenation of two recursive systematic convolutional (RSC) codes separated by an inter leaverwhich are 1/2 rate RSC encoders. A permutation function „a" permutation the interleaved data received from the lower encoder which receives the data directly by the upper encoder. It is a pseudo-random inter leaver which is used to map bits in position i to position a(i) on the basis of some prescribed randomly generated rule. The data of the bottom encoder is not transmitted whereas the data of the top encoder is transmitted. The overall code rate of a turbo code composed of two 1/2 rate RSC encoders is 1/3.

Turbo encoder used in the proposed SDR transceiver uses two constituent convolution encoders El and E2 in a parallel concatenated mode which are used to encode the input bit string bkof length N. Equations (ix) &(x) signifies the "parity bits" number which is transferred

P1 = a N (ix)

andP2 = (1 - a)N (x)

Here a signifies "permeability rate". If a higher value of a is chosen, it degrades the convergence performances of the decoders of the proposed SDR transceiver by providing higher "Minimum Hamming Distance (MHD)". The fractional part of the codeword bits (01 and 02) which are re-encoded in the paths are specified by equations (xi) and (xii)

01= n = 2aR (xi)

P2 and02=- = 2(1-a)R (xii) n

Here, the length of the codeword is denoted by n and R indicates the code rate of the proposed Turbo encoder used in the SDR transceiver system. The fractional data strings (0,1and Oq2) are tackled by the component decoders of each code string are stated in the following equations (xiii) and (xiv)

1= 1R(xiii)

andan q02= (1-a)R 1+R (xiv) (xv

The probability of error occurs at the channel output is designated by p and the average probability of errors evaluated at each decoder intrinsic input for the permeability factor a and 1-a are designated by pi' and P2' respectively. The value of a has been selected for a given code rate. Hence the overall code rate of the proposed Turbo encoder is given by equation (xvi):

R= 1 1± a±2(1-a)pl - (xvi) (xi

The generator polynomial of the turbo encoder is given below by equation (xvi):

1 0 1 (xvi)

For the proposed SDR transceiver system a turbo encoder is proposed which takes data of length 1024 at the input and gives an output data of length 2052. The output of the turbo encoder is then modulated using selected M-ary modulation scheme and transmitted using the WizFi210, XBee-PRO RF Module, USRP board, and antenna.

Figure 11 illustrates the block diagram of turbo decoder in accordance with an embodiment of the present disclosure. To decode the bitstream on which turbo operation has been performed a turbo decoder is used. An estimate of the information sent can be found by solving posteriori log-likelihood ratios given by equations(xvii) and (xviii):

A 0 log P[me=1|y(-),y('),z()] (vi P[mi=|y(O)y(),z(2) (xvii)

a 2) _ 0, P [mff =1|f(0),y(),2z(2] (Xviii) p ogP[T=0|f(0),y (1),(2)

Where, y(O) is the observed information bits, y() is the observed parity bits from the encoder on the top, y(2) is the observed parity bits from the encoder on the bottom, y() is the interleaved version of y(O)

A is the a posteriori log-likelihood ratio (LLR)

z is the extrinsic information which is related to LLR by equations (xix) and (xx)

(1) = A - y(0) - (2) Az i y1 z1 (xix)

) = A 2) - p0) - 2 (xx)

To solve the equations (xvii) to (xviii), the structure is shown in Fig: 7 is used. Decoder1 determines solution to equation (xvii) and decoder2 determines solution to equation (xviii) [26]. Fig: 7represents the block diagram for turbo decoder. The LLR is decoded by each decoder from the information it receives. The extrinsic information is then sendto the other decoders for further processing.

Figure 12 illustrates the Decision-based carrier phase and frequency tracking in accordance with an embodiment of the present disclosure. The phase offset is considered to be denoted by 0, between the transmitter and the receiver.

Figure 13 illustrates the Phase and Frequency Tracking VI in accordance with an embodiment of the present disclosure. The figure shows the decision directed carrier phase and frequency tracking used in the proposed SDR transceiver system for exact recovery of the data transmitted at the receiver end.It is observed that the received signal changes on the introduction of noise in the channel. In the present disclosure, real-time data has been transmitted and received securely with the flexibility of changing the protocols, with two forward error correcting codes using the M-ary digital modulation technique QAM. Different pulse shaping filters such as Root-raised cosine and Raised cosine filter have been used where the user has the flexibility to select the same as per the requirement. A fully reconfigurable digital transceiver has been proposed, simulated and tested using NI USRP-2922.

Figure 14 illustrates the front panel of transmitter in accordance with an embodiment of the present disclosure. The figure shows the Front panel for the Transmitter section of the SDR system using Lab VIEW. Tx Parameters used to select Transmitter parameters. USRP IP address field helps to select the IP address of the transmitter device. Tx„IQ" Sampling Rate [s/sec] is used to set the Sampling rate to 500k for text and binary data and <2M for the image. Tx Frequency field is used to set the Frequency for the transmission (2.5GHz). (User has the option to use any frequency from 400MHz to 4.4GHz for USRP 2922).Tx Gain (dB) is used to enter Tx Gain at the transmitter end (12 dB - 31 dB).Tx Antenna is used to select the Tx Antenna as Tx1.

Figure 15 illustrates the specify message/text window in accordance with an embodiment of the present disclosure. To transmit the data in real-time the tab„specify message"tab is selected in the transmitter front panel. The figure shows that how the proposed system is used for transmitting the Text and in similar fashion the data to be sent is encoded using the Tubo Coding/Convolution Coding by selecting from the type of encoding button.The modulation tab is used to set the type of M-ary modulation scheme i.e. QAM.

Figure 16 illustrates specify packet for transmission in accordance with an embodiment of the present disclosure. Specify packet tab is used to set the characteristics of the real-time data to be transmitted from the transmitter end.

Figure 17 illustrates FrontPanelofUSRP Receiver/ Rx Parameter in accordance with an embodiment of the present disclosure. Different parameters such as the constellation diagram, eye diagram and BER vs. E/No ratio with respective received data are analyzed and represented for analysis in this figure. In this panel, Rx Parameter window is selected to specify the IP address for the receiver side USRP and configure the Rx parameters and the Acquisition Duration time at the receiver end in (sec). Rx „IQ" Sampling Rate [s/sec] on the receiver side used to set the Sampling rate to 500k. Rx Frequency (Hz) field is used to set the Frequency to 2.5GHz. Rx Gain is measured in (dB) and a value similar to the transmitter is entered here i.e. 12dB. Rx Antenna field is used to select the Rx Antenna for reception through the USRP. Rx1 is selected for the same. Acquisition Duration measured in (sec) is set according to the type offile to be received.

Figure 18 illustrates the output parameters in accordance with an embodiment of the present disclosure. In this figure Different parameters such as the constellation diagram, eye diagram and BER vs. Eb/No ratio with respective received data are analyzed and represented for analysis. The „Constellation Graph" indicates the constellation Graph of the Received bits with respect to data. The „Eye Diagram"is plotted on a chart that indicates the waveform segments for eye diagram display of the Received bits with respect to data. Display„I/)"specifies whether to generate „IUata or „Q"datato the eye diagram. Eye length input in the VI gives the number of symbol periods on the horizontal scale of the eye diagram.

Figure 19 illustrates the Experimental Setupof the Proposed SDR system using NI-USRP 2922 in accordance with an embodiment of the present disclosure. The proposed SDR system has been designed and tested using Graphical User Interface (GUI) language LabVIEW which provides easy real-time interface.

Figure 20 illustrates the analysis of the M-QAM signal with the help of constellation diagram, Eye diagram and the BER vs. Eb/No Output curve in accordance with an embodiment of the present disclosure. Wherein the figure a)is for 4QAM, b)is for 8 QAM, c)is for 16 QAM, d)is for 32 QAM, e)is for 64 QAM, f)is for 128 QAM, and g)is for

256 QAM. The decision points are highlighted through the constellation plot which helps to analyze phase errors, as well as amplitude errors at these decision points. The constellation diagram also helps to analyze many impairments in the received signal.

Figure 21 illustrates a table of parameters used in turbo coding in accordance with an embodiment of the present disclosure. The table shows the different parameters used while using Turbo coding algorithm for M-QAM modulation technique. The table helps us to analyze how the distortion in the signal is increasing as we increase the higher-order modulation of QAM.

Figure 22 illustrates the encoded and decoded output image obtained for Convolution Coding in accordance with an embodiment of the present disclosure. Wherein the figure a)is using 4-QAM, b)is using 8- QAM, c)is using 16 -QAM, d)is using 32-QAM, e)is using 64 QAM, f)is using 128 -QAM, and g)is using 256-QAM. The figures represent the output of the proposed SDR system in terms of transmitted Image using Convolution Coding/ Viterbi Decoding. The image sent from the transmitter gets corrupted by noise in the channel which is air and then is downloaded by the designated receiver which has the key to decode the respective image. Hence the system is secure and also provides better BER with respect to any other systems. The biggest advantage of the proposed design is that it is meant to work for real-time input and hence the output obtained is for the real-world use. It is pretty much clear that for higher-order QAM the output gets distorted and posses higher errors while using convolution coding.

Figure 23 illustrates the encoded and decoded output Image obtained by usingTurbo Coding in accordance with an embodiment of the present disclosure. Wherein the figure a) is using 4-QAM, b) is using 8- QAM, c) is using 16 -QAM, d) is using 32-QAM, e) is using 64 QAM, f) is using 128 -QAM, and g) is using 256-QAM. The figures represent the output of the proposed SDR system in terms of transmitted Image using Turbo Coding and decoding. The image sent from the transmitter gets corrupted by noise in the channel which is air and then is downloaded by the designated receiver which has the key to decode the respective image. Hence the system is secure and also provides better BER with respect to any other systems. It is pretty much clear that for higher-order QAM the output gets distorted and posses higher errors while using convolution coding.When the same transfer is made using Turbo coding the time taken to receive the image is a bit more but the quality of the image received is much better than that for convolution coding.

Figure 24 illustrates a table depicting the features of the proposed SDR Transceiver System Using NI USRP for Real-time data transfers in accordance with an embodiment of the present disclosure. The table highlights the features of the proposed SDR Transceiver System Using NI USRP for Real-time data transfers and it can be seen that Turbo coding performs much better than the convolution coding. Through the table, it can be seen that the average SNR value for M-QAM technique is (>10.2812dB) for Turbo coding with the average BER vs. (E/No) as 14.3 whereas under similar conditions the average SNR value for M-QAM technique using Convolution coding is (>10.2812dB) with the average BER vs. (Eb/No) as 14.5. It is concluded that under similar conditions the performance of Turbo coding comes out to be much better as compared with that of the Convolution Coding.

Figure 25 illustrates the BER vs. Eb/No curve for QAM Transceiver using Convolution coding with raised cosine filterin accordance with an embodiment of the present disclosure. The chart comprises of the BER vs. Eb/No curve for QAM based SDR Transceiver using Convolution codingNiterbi Decodingusing raised cosine filter. It is also seen that as we move to higher-order M-QAM techniques the noise in the output is more and the BER value is not good, hence it is recommended that for the existing systems a lower order M-QAM should be used for the transmission.

Figure 26 illustrates BER vs. Eb/No curve for QAM Transceiver using Convolution coding with root raised cosine filterin accordance with an embodiment of the present disclosure. The chart comprises of the BER vs. Eb/No curve for QAM based SDR Transceiver using Convolution codingNiterbi Decoding using root raised cosine filter. It is also seen that as we move to higher-order M-QAM techniques the noise in the output is more and the BER value is not good, hence it is recommended that for the existing systems a lower order M-QAM should be used for the transmission.

Figure 27 illustrates BER vs. Eb/No curve for QAM Transceiver using Turbo coding with raised cosine filterin accordance with an embodiment of the present disclosure.The chart comprises of the BER vs. Eb/No curve for QAM based SDR Transceiver using Turbo coding and decoding using raised cosine filter. It is proved that lower-order M-QAM technique gives a better BER Turbo coding and decoding than that of the Convolution codingNiterbi Decoding It is also seen that as we move to higher-order M-QAM techniques the noise in the output is more and the BER value is not good, hence it is recommended that for the existing systems a lower order M-QAM should be used for the transmission.

Figure 28 illustrates BER vs. Eb/No curve for QAM Transceiver using Turbo coding with root raised cosine filter in accordance with an embodiment of the present disclosure.The chart comprises of the BER vs. Eb/No curve for QAM based SDR Transceiver using Turbo coding and decoding using root raised cosine filter. It is proved that lower-order M-QAM technique gives a better BER Turbo coding and decoding than that of the Convolution codingNiterbi Decoding It is also seen that as we move to higher-order M-QAM techniques the noise in the output is more and the BER value is not good, hence it is recommended that for the existing systems a lower order M-QAM should be used for the transmission.

The drawings and the forgoing description give examples of embodiments. Those skilled in the art will appreciate that one or more of the described elements may well be combined into a single functional element. Alternatively, certain elements may be split into multiple functional elements. Elements from one embodiment may be added to another embodiment. For example, orders of processes described herein may be changed and are not limited to the manner described herein. Moreover, the actions of any flow diagram need not be implemented in the order shown; nor do all of the acts necessarily need to be performed. Also, those acts that are not dependent on other acts may be performed in parallel with the other acts. The scope of embodiments is by no means limited by these specific examples. Numerous variations, whether explicitly given in the specification or not, such as differences in structure, dimension, and use of material, are possible. The scope of embodiments is at least as broad as given by the following claims.

Benefits, other advantages, and solutions to problems have been described above with regard to specific embodiments. However, the benefits, advantages, solutions to problems, and any component(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential feature or component of any or all the claims.

Similar Documents

Publication	Publication Date	Title
EP1553705B1	2007-02-28	Iterative demodulation and decoding of multi-level turbo or LDPC (low-density parity-check) coded modulation signals
US7197690B2	2007-03-27	Bandwidth efficient coded modulation scheme based on MLC (multi-level code) signals having multiple maps
US8250432B2	2012-08-21	Variable modulation with LDPC (low density parity check) coding
US7600180B2	2009-10-06	Iterative metric updating when decoding LDPC (low density parity check) coded signals and LDPC coded modulation signals
US7627803B2	2009-12-01	System and method for variable forward error correction (FEC) protection
CN102075487B	2013-02-27	Multidimensional constellation mapping based coding and modulating method, demodulating and decoding method and system

CN101989887B	2013-06-12	Code modulation method, demodulation and decoding method and system
US7995678B2	2011-08-09	System and method for communicating data using weighted bit soft decisions for differentially encoded phase shift keying
US20040258177A1	2004-12-23	Multi-dimensional space Gray code maps for multi-dimensional phase modulation as applied to LDPC (Low Density Parity Check) coded modulation
US20060156169A1	2006-07-13	LDPC (Low Density Parity Check) coding and interleaving implemented in MIMO communication systems
US20050180369A1	2005-08-18	Reduced latency concatenated reed solomon-convolutional coding for MIMO wireless LAN
US20040255231A1	2004-12-16	LDPC (Low Density Parity Check) coded modulatiion symbol decoding using non-Gray code maps for improved performance
KR20110033144A	2011-03-30	Serial concatenation of trellis coded modulation and an inner non-binary ldpc code
US20060195765A1	2006-08-31	Accelerating convergence in an iterative decoder
US7903756B2	2011-03-08	System and method for communicating data using waveform with extended preamble
CN101262307B	2010-08-04	A serial cascaded compiling and decoding system including rotary modulation mode of constellation map
CN101980491A	2011-02-23	MAP modulating and decoding method of FFH communication system based on Turbo encoding and BFSK modulation
CN101969309B	2014-07-16	MAP modulating and coding method of FFH communication system coded by Turbo and modulated by BFSK
AU2021102150A4	2021-06-10	Method and System for real-time decision-based carrier tracking for software defined radios
EP1411642A1	2004-04-21	Iterative metric updating when decoding LDPC (low density parity check) coded signals and LDPC coded modulation signals
Bai et al.	2012	Simple rateless error-correcting codes for fading channels
EP1494359A2	2005-01-05	Multi-dimensional space Gray code maps for mulit-dimensional phase modulation as applied to LDPC (low density parity check coded modulation
WO2008074919A1	2008-06-26	Method, apparatus and system for communicating information
JP5153588B2	2013-02-27	Wireless communication device
Kim et al.	2012	Concatenated codes using coded modulation with a phase shift

Priority And Related Applications

Priority Applications (1)

Application	Priority date	Filing date	Title
AU2021102150A	2021-04-22	2021-04-22	Method and System for real-time decision-based carrier tracking for software defined radios

Applications Claiming Priority (1)

Application	Filing date	Title
AU2021102150A	2021-04-22	Method and System for real-time decision-based carrier tracking for software defined radios

Legal Events

Date	Code	Title	Description
2021-06-10	FGI	Letters patent sealed or granted (innovation patent)	

Concepts

machine-extracted

Download Filter table

Name	Image	Sections	Count	Query match
carrier		title,claims,abstract,description	24	0.000
modifying		claims,abstract,description	45	0.000
biological transmission		claims,abstract,description	26	0.000
initiatory		claims,abstract,description	14	0.000
transient		claims,abstract,description	9	0.000
peripheral		claims,abstract,description	7	0.000
transmitter		claims,description	27	0.000

method	claims,description	18	0.000
sampling	claims,description	5	0.000
Maximum Likelihood	claims	1	0.000

Show all concepts from the description section