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RESEARCH ARTICLE

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VLSI ARCHITECTURE OF TURBO CODES FOR DEDICATED SHORT RANGE COMMUNICATION (DSRC) SYSTEMS

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ABSTRACT

The dedicated short-range communication (DSRC) is an emerging technique to push the intelligent transportation system into our daily life. In this paper, we consider the performance of a dedicated short range communication system for inter vehicle communication (IVC).Turbo coding technique is proposed for to process DSRC system efficiently and enhance the signal reliability. Turbo coding is a forward error correction (FEC) scheme. Turbo codes are implemented in 3G/4G mobile communications in UTMS and LTE and in satellite communications to achieve reliable information transfer over bandwidth or latency-constrained communication links in the presence of data-corrupting noise. Turbo codes provide a significant improvement in performance with similar complexity to convolutional codes, but its buses high reliable communication channel. The capability of this paper can fully support the DSRC standards of America, Europe, and Japan. This paper not only develops a fully reused VLSI architecture, but also exhibits an efficient performance compared with existing works.

Key Words-Dedicated short-range communication (DSRC), Turbo codes, VLSI.

1. INTRODUCTION

The dedicated short range communication is a protocol for one or two-way range communication especially for intelligent transportation system. The main goal of intelligent transportation systems (ITS) is to improve traffic efficiency and mobile safety without new road construction. The DSRC system standard based intervehiclecommunication (IVC)system plays a key role in ITS. The DSRC can be briefly classified into two categories: automobile to automobile and automobile to roadside. In automobile to automobile, the DSRC enables the message sending and broadcasting among automobiles for safety issues and public information announcement. The safety issues include blind-spot, intersection warning, intercar distance and collision-alarm.

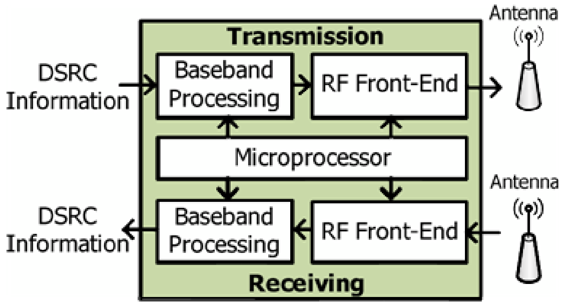


Fig.1. System architecture of DSRC architecture.

The automobile to roadside focuses on the intelligent transportation services, such as electronic toll collection (ETC) system: with ETC, the toll-collecting is electronically accomplished with the contactless IC-card platform. Moreover, the ETC can be extended to the payment for parking-service, and gas-refueling. Thus, the DSRC system plays an important role in modern automobile industry.DSRC supports both Public Safety and Private operations. It provides very high data transfer rates and minimal latency ,Range – up to 100 m, Data Rate – 6 to 27 Mbps, Channels – 7 Licensed Channels.

The system architecture of DSRC transceiver is shown in fig.1. The upper and bottom parts are dedicated for transmission and receiving respectively. This transceiver is classified into three basic modules: microprocessor, baseband processing, and RF front-end. The microprocessor interprets instructions from media access control to schedule the tasks of baseband processing and RF-frontend. The baseband processing is responsible for modulation, error correction, clock synchronization, and encoding. The RF-frontend transmits and receives the wireless signal through the antenna. The data rate is individually targets at 500 kb/s, 4Mbs/s, and 27mb/s with carrier frequency of 5.8 and 5.9 GHZ. The modulation methods incorporate amplitude shift keying, phase shift keying and orthogonal frequency division multiplexing. Turbo codes are widely adopted for reducing dynamic power dissipation.

2. THE DSRC WIRELESS TRANSCEIVER MODEL

The IEEE802.11a standard was principally designed for indoor WLAN applications. Therefore, the physical layer parameters were optimized for the indoor low-mobility propagation environment. Aside from the fact that the DSRC signal bandwidth is 10 MHZ, the DSRC physical layer has the same frame structure, modulation and training sequences as specified in the IEEE802.11a standard. The basic DSRC parameters are shown in Table 1.

When vehicles are moving at speeds up to 120 miles/hour. And with communication ranges up to 1000m, the channel is very different from the IEEE802.1a indoor low mobility environment. As will be discussed later, the DSRC communication channel can be very hostile. One means of overcoming this problem is to use more powerful FEC. In this paper, we evaluate the performance of a DSRC system using Turbo codes rather than convolutional codes.

Table.1. DSRC parameters

Data Rate	3,4.5,6,9,12,18,27 Mbps
Modulation	BPSK,QPSK,16-QAM,64-QAM
Coding Rate	1/2,2/3,3/4
Number of Subcarriers	52
Subcarrier Spacing	156.25KHz
Number of Pilot Tones	4
Guard Interval	1.6μsec
OFDM Symbol Duration	8μsec
Signal Band width	10MHz

2.1.The DSRC transmitter

A block diagram of the DSRC transmitter is shown in fig.2. The input bit stream is first scrambled using the generator polynomial, s(x) =x7+x4+1 as defined in the IEEE 802.11a standard. The data are scrambled to prevent a long bits sequence that can cause errors during transmission. To avoid the adverse effect caused by InterSymbol Interference and Inter-Carrier Interference. Then the data bits encoded using a 64-state rate ½ convolutional code. Higher code rates are obtained by puncturing the convolutional encoder output. Theinterleaver redistributes the bits in both the time and frequency domains before transmission. This reduces the effects of burst error caused by the fading channel on the performance of the convolutional decoder.

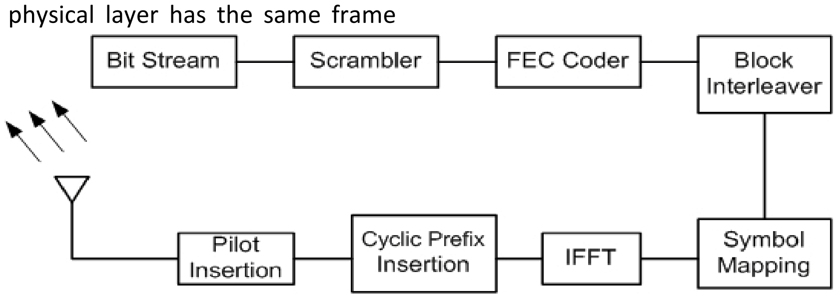


Fig.2.TheDSRCtransmittermodel

When the vehicles are moving slowly, i.e. in congested urban areas, the channel coherence time is normally much larger than the packet transmission period. A cyclic prefix is added at the beginning of each OFDM symbol to combat the ISI introduced by the frequency selective fading channel.

2.2 The DSRC receiver

The DSRC receiver is shown in fig.3.We assume perfect timing and frequency synchronization. The received signal is transformed to the frequency domain .The resulting signal is then mapped to bits and de-interleaved. Then soft information is input to a decoder, and the output bits descrambled. Finally we get the original input as an output.

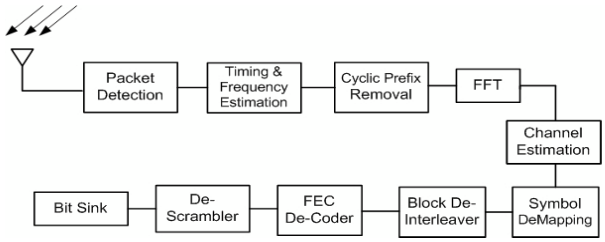


Fig.3.TheDSRCreceivermodel

3. TURBO CODES

The turbo codes are used to provide double data through at a given power or work with half the power. The two men were not known, most were thinking that they are wrong in calculation. They realized that it was true, many companies adopted new companies started turbo concept and icoding. Turbo encoding achieves remarkable performance with the relatively low complexity encoding. The turbo coding is the forward error correction scheme. The forward error correction techniques used for controlling errors in data transmission over unreliable noisy communication channel. Turbo encoding is an iterated soft decoding scheme.

Interestingly, the name turbo was given to this code because of the cyclic feedback mechanism that is high speed network to the decoders in an iterative. Turbo encoder transmits the encoded bits which form input to the decoder. The turbo decoder decodes information iteratively. Turbo codes can be concatenated series, parallel or in a hybrid manner. There are many different instances of the turbo codes using different components encoders, input/output ratios, and inter leavers and puncturing pattern. Turbo code is defined by several convolutional encoders and an equal number of interleavers. First, a string of K source bits is fed into each encoder. Next, theorder of the source bits are changed or altered in some way based on the encoder they were fed into.

3.1 Turbo encoder

A turbo code encoder sends out three sub-blocks of bits. The figure 4 shows how the source bits are passed through an interleaver and two separate encoders to generate three outputs. The first sub-block is the source data. The second and third sub-blocks are blocks of parity bits computed based on different convolutional coding schemes. The resulting transmitted code word consists of K source bits, M1 parity bits, and M2 parity bits.

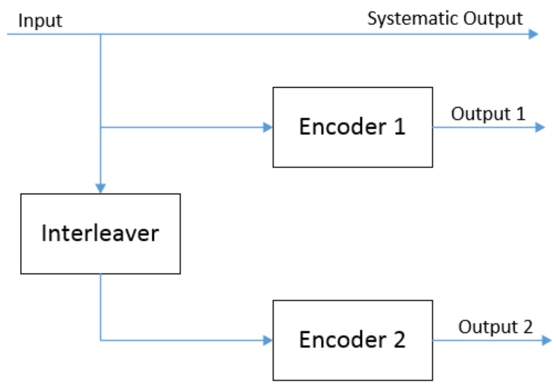


*Figure 4.*Turbo codeencoder.

3.2. Turbo decoder

The figure shows how a turbo code is decoded when it has been received. The encoded bit stream is sent through a series of decoders and interleavers to output the original data stream to the receiver. Turbo codes have exceptional performance with decoded error probabilities of around 10-5. The use of recursive convolutional encoder and interleavers is critical for turbo codes. This helps to make the turbo code appear to be more random and as a result reduces the number of low-weight code words. Low-weight code words are considered beneficial to turbo codes. Because of their attempt to maximize the minimum distance between two code words, a turbo code can correct about half of the patterns of channel errors.

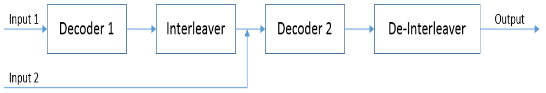


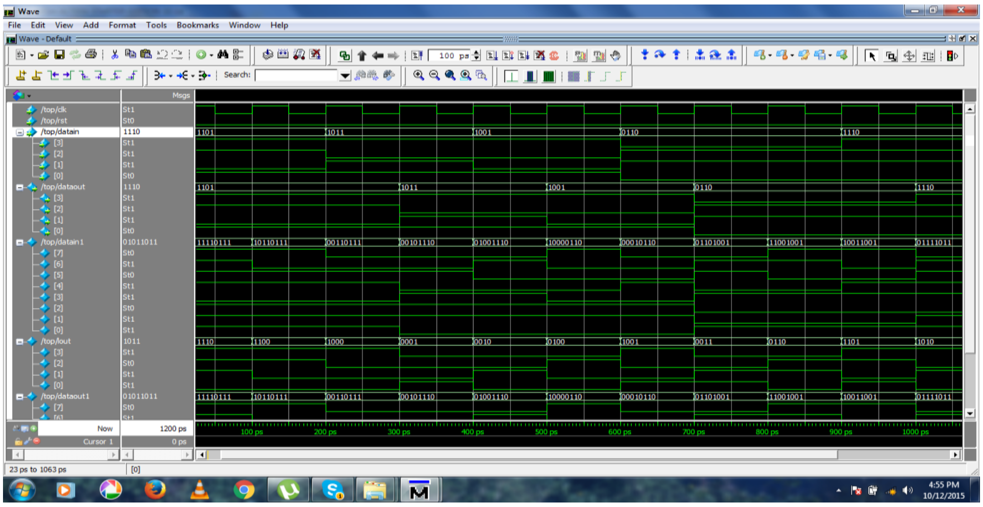
Figure 5. Turbo codedecoder.

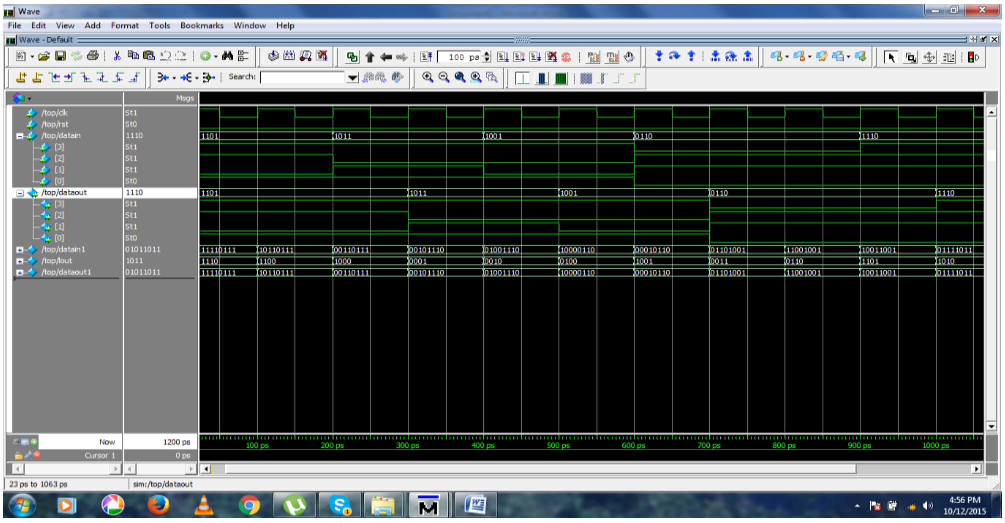
Turbo codes are also referred to as iterative codes because the decoder essentially works at making a series of guesses about what the encoded message is. By continually repeating this process, the error-rate will also decrease. Turbo codes are used to encoded data with inteleaver and soft information to detect the soft error. Turbo codes can available to use in short range communication with limited bandwidth and over achieve reliable communications. It provides efficient data encoded process and minimize data corruption with soft information.LPDC codes similar to turbo codes, but implementation of LDPC codes has lagged behind that of turbo codes in data encryption process and communication channel. The turbo codes are a recent development in the field of forward error correction channel coding. The codes make use of three simple ideas: parallel concatenation, interleaver, soft decoding. Turbo codes are finding use in 3G/4G mobile communications in UMTS, LTE and in satellite communications. Today many modern systems use turbo codes. We can use turbo codes for compression of binary sequences. Networks must be able to transfer data from one device to another with complete accuracy.

4. DSRC

DSRC (Dedicated Short Range Communications) A wireless technology for vehicular traffic. Using a modified 802.11a technology for North American cars and trucks, DSRCis designed for several applications. For example, ambulances can cause traffic lights down the road to change in their favour, and traffic congestion can be transmitted to automobile navigation systems. It allows vehicles to sense that they are about to crash, and the safety systems can begin to tighten seatbelts and warm up the airbags before impact. In addition, a standard for wireless payment allows parking lots and fast-food drive-ins to offer the same convenience as the automated highway toll systems such as E-ZPass. DSRC system consists of Road Side Units (RSUs) and the On Board Units (OBUs) with the transceivers and transponders. The DSR standards specify the operational frequencies and the system bandwidths, but also allow for optional frequencies which are covered by national regulations.Key Issue – QoS – Prioritization of Safety messages. If a neighboring car is in the middle of a streaming movie application, and I need to communicate about an accident, how to prioritize the message?DSRC has 1 control channel and other service channels. Safety messages are expected to use the control channel.

5. SIMULATION RESULTS





CONCLUSION

The turbo coding is used to save the overall dynamic power dissipation. It will provide security during data transmission and work with half of the given power, mainly this coding is used to increase the data rate. The encoding capability of this paper can fully support the DSRC standards of America Europe and Japan. This paper not only develops a fully reused VLSI architecture, but also exhibits the competitive performance compared with the existing works.

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