Research Paper ENGINEERING

Design of Multidirectional Parity Code Using Hamming Code Technique for Error Detection and Correction

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ABSTRACT

In data communication system reliability and efficiency of data transmission are important issues. Reliability of data transmission is improved by channel coding which employs forward error correction (FEC) techniques. Forward error correction techniques are used to detect and correct the errors in data using check bits also known as redundant bits. These redundant bits are generated from the data and sent with data for detection and correction of error in data. When data with redundant bits is transmitted through noisy channel noise may corrupt data as well as redundant bits appended with data. If redundant bits are also corrupted by noise then FEC cannot detect and correct error in data. The proposed error detection and correction technique uses multidirectional parity code to detect and correct error in data part and Hamming code for detection and correction of error in multidirectional parity check bits or redundant bits. This technique is a combination of multidirectional parity code and Hamming code which can detect and correct burst error. The design of encoder and decoder for multidirectional parity code with Hamming code has been realized using MATLAB.

KEYWORDS Bit Overhead (BO), Code rate (R), Forward error correction (FEC), Error detection, Error correction, Redundant bit.

1 INTRODUCTION

Reliability and efficiency of data are advisable with the demand of increased transmission. The improvement in reliability and efficiency of data transmission can be achieved by channel coding and source coding techniques respectively. Source coding incorporates transformation of data from one form to another whereas in channel coding the data is made secured from the noise by making use of error detection and correction techniques.

This paper illustrates a reliable and high efficient technique for detection and correction of error based on multidirectional parity code with Hamming code. This technique uses multidirectional parity code along with Hamming code to provide better secured data transmission in noisy environment. Multidirectional parity code is used to detect and correct errors in data and Hamming code is used to detect and correct error in check bits or redundant bits generated from the data.

2 RELATED WORK

M. Kishani et al. [1] proposed a high level error detection and correction technique known as Horizontal, Vertical and Diagonal (HVD) code for multiple error detection and correction. This technique uses parity codes in four directions in a data part to improve the reliability of memories. M. Imran et al. [2] proposed a technique to improve the reliability of a given off the shelf component by manipulating software based error correction algorithm of it's already existed 4-D parity codes. This technique can correct triple bit adjacent errors, without adversely affecting the performance of system. M. Planz et al. [3] proposed Cross-Parity check method for an on-line detection of multiple bit-errors in registers or register files of microprocessors. Transient or 'soft' errors caused by radiation as single event upsets (SEUs) or electromagnetic coupling are the focus of the proposed technique. P. Sharma et al. [4] proposed a matrix method to detect and correct single bit error. This method works on even and odd parity. This method checks horizontal and vertical parity bits of transmitting and receiving data. S. Sharma et al. [5] proposed an error detection and correction technique to protect the semiconductor memories against soft errors. This technique is based on 2-D parities. B. K. Gupta et al. [6] proposed a review on Hamming code and described that Hamming code can be used to detect and correct single bit error in a block of data.

3 PROPOSED TECHNIQUE

The proposed technique is a type of channel coding which comprises of Multidirectional parity code and Hamming code. In this technique, at transmitter end, the binary data is stored in a memory of size (= No. of rows and = No. of columns) and Multidirectional parity code is applied on it. Thereafter the multidirectional parity check bits generated from the data using Multidirectional parity code are encoded using Hamming code. These encoded parity check bits are known as redundant bits and appended at the end of data to generate a systematic codeword. This codeword is transmitted through free space media. At receiver end, reverse operation is performed to retrieve the data from the received codeword. Multidirectional parity code is used to detect and correct the errors in data and Hamming code is used to detect and correct the error in multidirectional parity check bits which characterize data. Communication system using multidirectional parity code and Hamming code is shown in Figure 3.1.

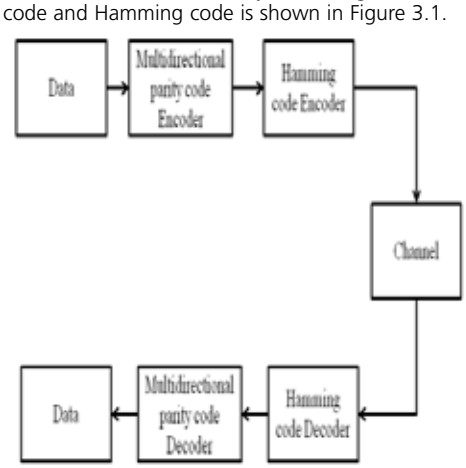

Figure 3.1 Communication system using multidirectional parity code and Hamming code

3.1 Encoding of data

For encoding of information which is available in form of binary data is stored in a memory of size. Multidirectional parity code is applied on this data for calculating horizontal, vertical and diagonal parity check bits using modulo-2 addition. These extra check bits are known as redundant bits that characterize data. These redundant bits are appended at the end of data.

Consider bit binary data is stored in a memory section of size and multidirectional parity code is applied on it. In multidirectional parity code implementation and represent the number of errors in the horizontal, vertical and diagonal of data part respectively, given as, and where and represent positions of error in horizontal, vertical and diagonal directions respectively. Generation of multidirectional parity check bits in horizontal, vertical and diagonal direction is shown in Figure 3.2

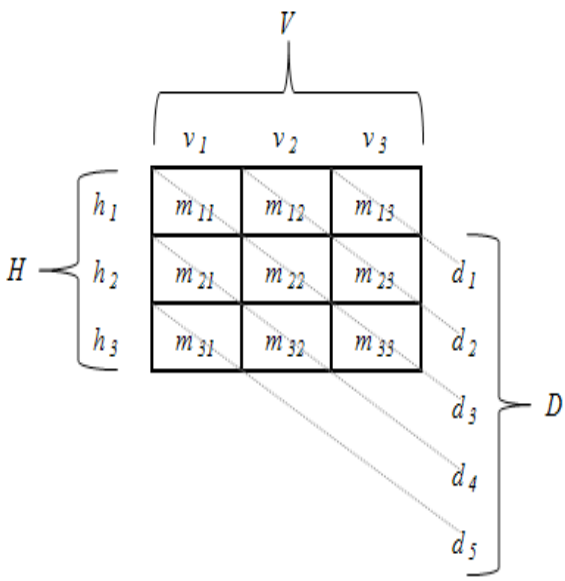

Figure 3.2 Multidirectional parity check bits generation

After the calculation of multidirectional parity check bits Hamming code is applied on these redundant bits for detection and correction of error in them and transmitted with the data.

Consider and are multidirectional parity check bits and and are Hamming check bits in Hamming code. Before transmission, Hamming check bits are generated by establishing even parity over each Hamming check bit and its associated multidirectional parity check bits using modulo-2 addition. Positions of Hamming check bits with multidirectional parity check bits in the Hamming code vector or check bit vector are shown in Figure 3.3

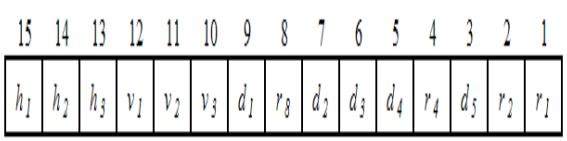

Figure 3.3 Hamming code vector/ Check bit vector

3.2 Decoding of data

At the receiver end the received codeword is firstly decoded using Hamming decoder. The Hamming decoder detects and corrects single bit error in multidirectional parity check bits.

After decoding of codeword using Hamming code this codeword is again decoded using Multidirectional parity code decoder to detect and correct the burst error in data. Multidirectional parity check bits are regenerated from the received data and bit positions of these parity bits are compared with the received one. If the result of comparison does not show any difference and and, it means the received data at the receiver is correct so no correction is required but if there is a difference between the received and calculated parities and or , the erroneous parity lines are identified and then the correction process starts [1, 2].

To detect the positions of error bits in received data the intersection of all corrupted parity bits is determined. The bit position in data part at which all the corrupted parity bits intersect is error bit. As the position of error bit is detected corresponding bit is changed from 0 to 1 or 1 to 0. Detection of a single bit error is shown in Figure 3.4 in which dashed circles show corrupted bit position in horizontal, vertical and diagonal directions and continuous circles show the error bit position in data part of received codeword.

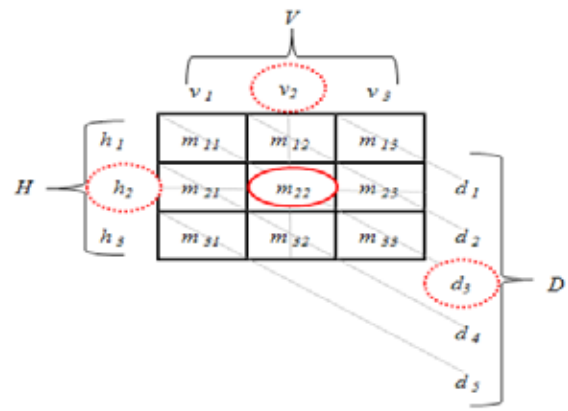

Figure 3.4 Regeneration of multidirectional parity bits for error detection and correction

4 ANALYSIS OF PROPOSED TECHNIQUE

The proposed method detects and corrects the error in a codeword with 100 % efficiency. As shown in Table 4.1 as the size of data increases the Bit Overhead decreases and Code Rate increases. But on increasing size of data the probability of detection and correction of error also decreases. The proposed technique can detect and correct the burst error in the codeword efficiently for small size of data. As the size of data is decreased the probability of detection and correction of error increased.

Table 4.1 Performance of multidirectional parity code with Hamming code for different size of data

S. No.	Size of memory	No. of data bits	Redundant bits	Length of code vector	Bit Overhead	Code Rate
1	16 x 8	128	47+6=53	181	41.40%	70.71%
2	32 x 8	256	79+7=84	340	32.81%	75.29%
3	64 x 8	512	143+8=151	663	29.49%	77.22%
4	128 x 8	1024	271+9=280	1304	27.34%	78.52%
5	256 x 8	2048	527+10=537	2585	26.22%	79.22%

Performance of the proposed method for different size of data is given in Figure 4.1.

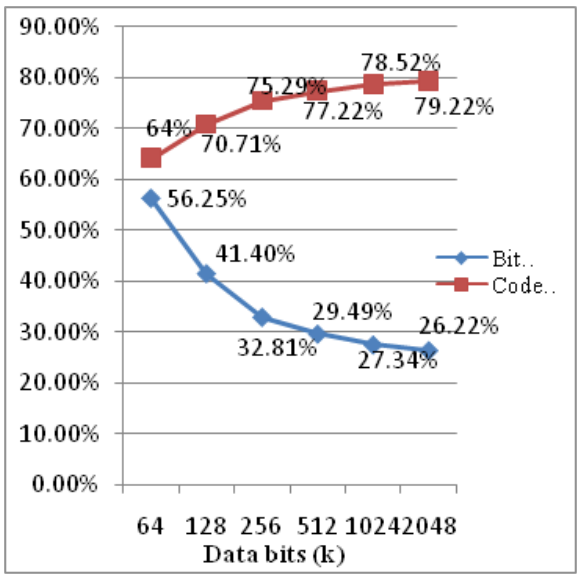

Figure 4.1 Performance of multidirectional parity code with Hamming code.

5 CONCLUSIONS

In this paper the proposed technique, Multidirectional parity code with Hamming code, improves the reliability of data transmission in data computer network with acceptable Bit Overhead (26.22%) and Code Rate (79.22%). The proposed scheme is very useful where retransmission of data is so expensive and redundant bits are also corrupted by noisy environment. Multidirectional parity code with Hamming code can correct four bit error, three error bits from the data parts and one error bit from redundant bits, in received codeword at receiver without the need of retransmission.

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