

HAMMING CODE FOR SINGLE BIT ERROR DETECTION & ERROR CORRECTION WITH

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Abstract—Single bit error detection and correction can be done through hamming code. Hamming code can be made with either even parity or odd parity check method. The information signal can get corrupted in the process of transmission which can lead to wrong information reception. We have used even parity check method for encrypting the information signal and forming the hamming code. The information signal is first encrypted and then transmitted using some transmission media which may be corrupted in the process. The receiver receives the signal and detects and corrects the signal using even parity check method. 11 bit information signal which is encrypted to form 15 bit hamming code where, 4 bits are the redundant bit which is transmitted. And at the receiver, it is decrypted to get the original 11 bit information signal.

Keywords:- Hamming code, Even parity .

I.INTRODUCTION

In communication system, a secure data transmission from transmitter to receiver is very major issue. Hamming code error detection and correction methodology is used for error free communication in communication system. Hamming code is a linear error correcting code named after its inventor 'Richard Hamming'. Hamming code can detect up to two simultaneous bit error.

In communication system, the information signal is send through transmitter and is transmitted through some random media. In the process of transmission the information gets corrupted, so we get a signal at the receiver which is different than the original information signal. The general idea for achieving error detection and correction is to add some redundancy (i.e., some extra data) to a message,

Which receivers can use to check consistency of the delivered message, and to recover data determined to be corrupted.

The information 'k bits' is encrypted using even parity check method to form hamming code of n bits. The information signal is added with redundant bits 'r' to form the code this code is then transmitted. The receiver receives the code and corrects it to get the original k bits information signal.

II.HAMMING CODE

Hamming codes are the codes used in communication for error free transmission of information. Hamming codes can detect up to two and correct up to one bit errors. Hamming code is formed by adding the information and redundant bits i.e, $n= k + r$. The size of the redundant bit is determined by the formula:

$$2r \geq k+ r+ 1$$

The code is represented by (n, k) code where 'n' is the codeword length and 'k' is data length. We can use this formula for calculating the number of redundancy bits. A very common hamming code is (7, 4) it contains 4 bit information and 3 bit redundancy. Redundancy is added at the encoder to form the codeword and will be removed at the decoder after getting the correct sequence and the desired information will be the final output.

We calculate the redundant bits according to the information bits and place the bits in the codeword in positions given by the sequence be $2^0, 2^1, 2^3, 2^4, 2^5, \dots, 2^{r-1}$, where r is the number of redundancy bits.

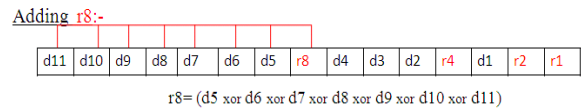
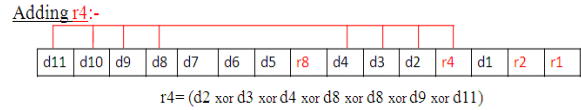
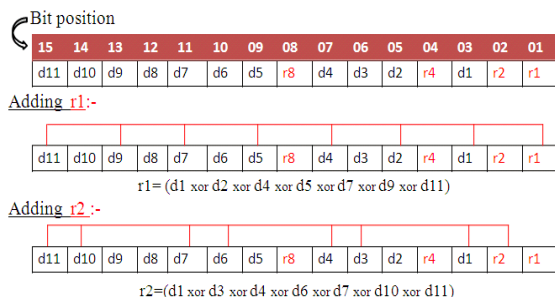
The redundant bits can be calculated either by Even parity check method or Odd parity check

method. Here in this paper we have used even parity check method for the Hamming Encoder and Decoder.

Even Parity Check Method :-The value of redundancy bit can be finding by XORING of different location of information data bit for different redundancy bit. The property of XOR gate is that if number of one`s are even in input its shows the output zero else its shows output one. By using this property we can easily find the number of one`s in a given string are even or odd for a particular redundancy bit.

III.CALCULATION OF REDUNDANCY AT ENCODER WITH 11BIT INFORMATION SIGNAL

We have used even parity check method for calculating redundancy. The value of redundancy bit can be finding by XORING of different location of information data bit for different redundancy bit. The property of XOR gate is that if number of one`s are even in input its shows the output zero else its shows output one. Let the number information bits is k and the corresponding redundancy is r and the codeword length $n = k + r$, So the bit positions of the redundancies in codeword will be $2^0, 2^1, 2^3, 2^4, 2^5, \dots, 2^{r-1}$. The values of the redundancies can be given by x-or operation of the information bits present at the positions alternately in codeword for r1 and taking two consecutive leaving next two and so for r2. Similarly we take 2t bits and left next 2t for r(t). Here for a test purpose we have taken 11 bit information signal and 4 bit redundancy is required to form a 15 bit codeword. And we have calculated the redundancy by even parity check method and will be at the 1st, 2nd, 4th, 8th position bit of the codewords.



Let the 11 bit information signal be “10011100101”, so the value of redundancies become,

r1: d1 x-or d2 x-or d4 x-or d5 x-or d7 x-or d9 x-or d11

r2: d1 x-or d3 x-or d4 x-or d6 x-or d7 x-or d10 x-or d11

r4: d2 x-or d3 x-or d4 x-or d8 x-or d9 x-or d10 x-or d11

r8: d5 x-or d6 x-or d7 x-or d8 x-or d9 x-or d10 x-or d11

The value of **r1** is 1(the number of one`s are 5)

The value of **r2** is 0(the number of one`s are 4)

The value of **r4** is 1(the number of one`s are 3)

The value of **r8** is 0(the number of one`s are 4)

Therefore the final output sequence of the encoder becomes “101001101001101”.

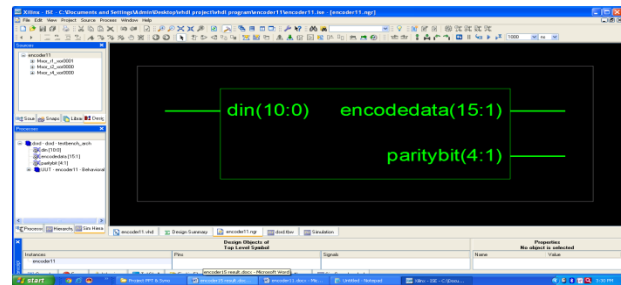


Fig1:Fig shows the black box of encoder.

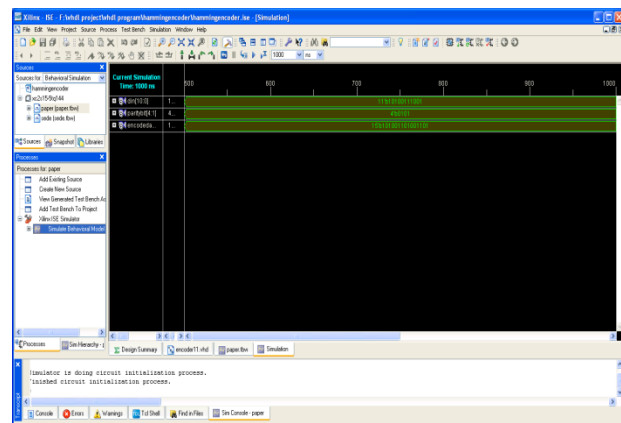


Fig2: Simulation window shows waveform of hamming encoder in binary format.

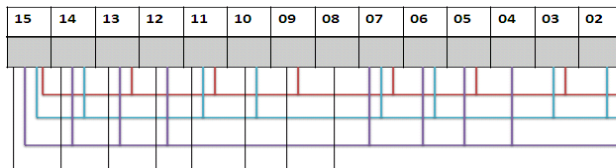
CALCULATION FOR ADDING ERROR IN NOISE MIXER

Here, in this paper we also design error injector for the 15bit information signal to complete the whole process. In the system, when the transmitted signal of 15bit is received as an input by the noise mixer, it gets XOR with another input of 15bit which is given to the noise mixer.

For example, the encoded signal "101001101001101" is XOR with another input signal "0000100000000" to the noise injector, we get the corrupted output from mixer i.e. 101000101001101. This corrupted 15bit is given as input to the decoder i.e. the last stage of input.

CALCULATION FOR 11 BIT ORIGINAL SIGNAL OBTAIN AT DECODER

In the decoder, the original 11bit information signal is decoded from 15bit received signal. First, the decoder finds out the redundancy values and from these 4 redundancy values the position of the corrupted bit is obtained. The decoder inverts that bit and removes the 4 bit redundancy and then gives the output of 11bit original information signal.



$$r1 = 1 \oplus 3 \oplus 5 \oplus 7 \oplus 9 \oplus 11 \oplus 13 \oplus 15$$

$$r2 = 2 \oplus 3 \oplus 6 \oplus 7 \oplus 10 \oplus 11 \oplus 14 \oplus 15$$

$$r4 = 4 \oplus 5 \oplus 6 \oplus 7 \oplus 12 \oplus 13 \oplus 14 \oplus 15$$

$$r8 = 8 \oplus 9 \oplus 10 \oplus 11 \oplus 12 \oplus 13 \oplus 14 \oplus 15$$

As before, we get the 15bit data from noise mixer i.e. "101000101001101". Now, at the decoder we find out 4bit redundancy and get the error bit position.

Bit Position	15	14	13	12	11	10	09	08	07	06	05	04	03
	1	0	1	0	0	0	1	0	1	0	0	1	1

- The value of $r1 = 0$ (the no. of 1's are 6)
- The value of $r2 = 1$ (the no. of 1's are 3)
- The value of $r4 = 0$ (the no. of 1's are 4)
- The value of $r8 = 1$ (the no. of 1's are 3)

Therefore, the value "1010" shows the binary bit position of the corrupted bit i.e. 10th position. Now invert that bit means '0' invert into '1' and we get "101001101001101". Now remove the redundancy and the corrected codeword is obtained as 11bit i.e. "10011100101"

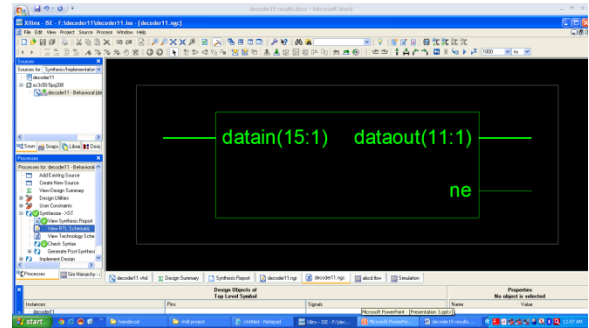


Fig3: figure shows the black box of decoder.

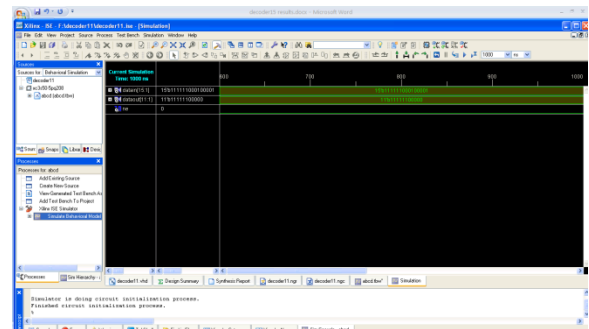


Fig4: Simulation window shows the waveform of hamming decoder in binary format.

HAMMING SYSTEM

We have designed the encoder, decoder & noise mixer individually. The encoder takes an 11-bit input and, after adding a redundancy bit, produces a 15-bit encoded data. This encoded data is transferred to the noise mixer, where, with the help of a PN sequence, XORing of the input 15-bit encoded data is done, and we get a corrupted 15-bit data. This corrupted data is then transferred to the decoder block, where we detect and correct the position of the error and thus finally obtain the 11-bit original data.

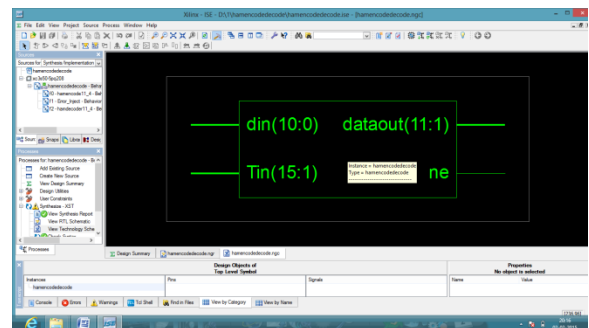


Fig5: Fig shows the black box of hamming decoder.

V.CONCLUSION

We see from this paper how we can use the even parity check method for any sequence of information. And we have shown it for 11 bit information signal. It speeds up the communication as we can encode the total information as a whole and send as one, there is no need for splitting. And using the same parity method at the destination we can successfully recover the original information sequence. The circuitry for this is also reduced as it makes the detection and correction becomes easier and using the VLSI makes it much more efficient.

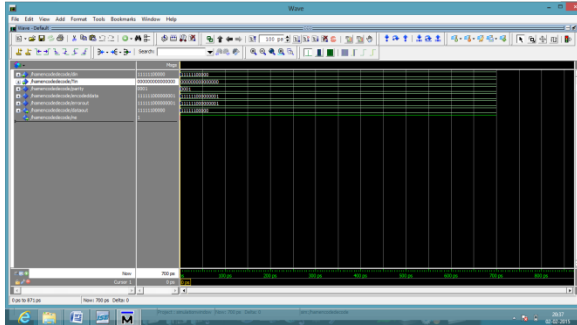


Fig6: Simulation window shows the waveform of hammedecode.

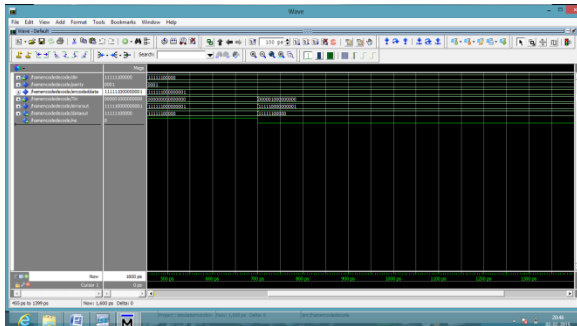


Fig7: Simulation window shows the waveform of hammedecode with error.

IV. ADVANTAGES & APPLICATIONS

If we use the correcting codes no resending of data is required as it will automatically detect the error and correct it. We can use transmitter of higher bit capacity no need to break the data into smaller section. So it speeds up the communication. Application of the VHDL is very effective as it is much easier to write the codes. These error correcting techniques are used in many applications as in mobile communication, storage devices, television, satellite communications and all other communications.

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