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BT20ECE075
LAB-07

I. Aim:

Cyclic Code Encoding Using Matlab

II. Software Required:

Matlab;

III. Theory:

Hamming Code: is known to be a subclass of linear block codes where cyclic shift in the bits of the codeword results in another codeword. It is quite important as it offers easy implementation and thus finds applications in various systems.

Cyclic codes are widely used in satellite communication as the information sent digitally is encoded and decoded using cyclic coding. These are error-correcting codes where the actual information is sent over the channel by combining with the parity bits.

Cyclic codes are known to be a crucial subcategory of linear coding technique because these offers efficient encoding and decoding schemes using a shift register. These are used in error correction as they can check for double or burst errors. Various other important codes like, Reed Solomon, Golay, Hamming, BCH, etc. can be represented using cyclic codes.

Basically, a shift register and a modulo-2 adder are the two crucial elements considered as building blocks of cyclic encoding. Using a shift register, encoding can be efficiently performed. The fundamental elements of shift registers are flip flops (that acts as a storage unit) and input-output. While the other i.e., a binary adder has two inputs and one output.

Properties of Cyclic Block Code

- **Linearity**According to this property, a linear combination of two codewords must be another codeword.

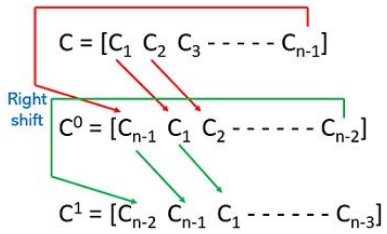
$$C_i + C_j = C_p$$

110	110	101
+	+	+
101	011	011
=	=	=
011	101	110

- **Cyclic**According to this property, after a right or left shift in the bits of codewords the resultant code generated must be another codeword. Suppose, C is a codeword given as:

$$C = [C_1, C_2, C_3 - - - - - C_{n-1}]$$

Here we have performed the right cyclic shift that has produced these codewords.



IV. Cyclic Encoding:

linear codeword is generally given as c(n,k). Here n represents the total bits in the codeword and k denotes the message bits. Thus, the parity bits are (n-k). Suppose we are given a code (7,4) then on comparing with general format the codeword will have 7 bits and the actual message bits are 4 while rest 3 are parity bits.

A cyclic codeword is given as:

$$C = [C_1, C_2, C_3 - - - - - C_{n-1}]$$

Then the codeword polynomial will be represented as:

$$C(X) = C_0 + C_1X + C_2X^2 + - - - - - + C_{n-1}X^{n-1}$$

For a given codeword C = [1011], the codeword polynomial will be given as:

$$C(X) = 1*X^0 + 0*X^1 + 1*X^2 + 1*X^3$$

$$C(X) = X^3 + X^2 + 1$$

In a similar way, for any message codeword m, the message polynomial:

$$M(X) = m_0 + m_1X + m_2X^2 + - - - - - + m_{k-1}X^{k-1}$$

And generator polynomial

$$G(X) = g_0 + g_1X + g_2X^2 + - - - - - + g_{n-k}X^{n-k}$$

Codewords are classified as systematic and non-systematic codewords.

A systematic codeword is one in which the parity bits and message bits are present in separated forms.

C = [parity bit, message bits]

But a non-systematic codeword is the one in which the message and parity bits exist in inter-mixed format and cannot be separated just by noticing the initial and final bits.

V. Matlab Code:

Editor - C:\Users\GUNA\OneDrive\Desktop\Matlab programs\cyclic.m

lbc.m | HammingCode.m | cyclic.m

```
clc;
%Taking inputs of codeword length,messgebits,generator and Message matrix
n=input('Enter codeword length\n');
k=input('Enter No of msg bits\n');
G=input('Enter Generator matrix\n');
d=dec2bin(0:2^k-1); %Generating message vectors using k;
disp('Message Vectors:');
disp(d);
[i,px]=cyclgen(n,G); %generating matrix using function which does an row operations to get [pk,i] form
disp('Generator sub matrix using Generator Polynomial:');
disp(px);
g=circshift(px,[0,k]); %shifting the matrix to form Generator matrix[i,pk]
disp('Generator matrix :');
disp(g);
c=rem(d*g,2);%codevectors=messagevectors*generatormatrix
disp('Code Vectors:');
disp(c);
```

VI. Code Explanation:

VII. Matlab Outputs:

```
Enter codeword length
7
Enter No of msg bits
4
Enter Generator matrix
[1 1 0 1]
Message Vectors:
0000
0001
0010
0011
0100
0101
0110
0111
1000
1001
1010
1011
1100
1101
1110
1111
Generator matrix :
     1     0     0     0     1     1     0
     0     1     0     0     0     1     1
     0     0     1     0     1     1     1
     0     0     0     1     1     0     1

Code Vectors:
     0     0     0     0     0     0     0
     0     0     0     1     1     0     1
     0     0     1     0     1     1     1
     0     0     1     1     0     1     0
     0     1     0     0     0     1     1
     0     1     0     1     1     1     0
     0     1     1     0     1     0     0
     0     1     1     1     0     0     1
     1     0     0     0     1     1     0
     1     0     0     1     0     1     1
     1     0     1     0     0     0     1
     1     0     1     1     1     0     0
     1     1     0     0     1     0     1
     1     1     0     1     0     0     0
     1     1     1     0     0     1     0
     1     1     1     1     1     1     1
```

VIII. Conclusion:

We have successfully Encoded the cyclic codes using Matlab