Digital Communication Lab

Laboratory report submitted for the partial fulfillment
of the requirements for the degree of

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in
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by

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Chapter *1*

Experiment - 8

1.1 Aim of the Experiment

1. Performance analysis of Linear Block Codes/Repetition Coding.

1.2 Hardware Software Required

1. Desktop/Laptop
2. MATLAB

1.3 Theory

Linear block code is a type of error-correcting code in which the actual information bits are linearly combined with the parity check bits so as to generate a linear codeword that is transmitted through the channel.

In block coding, the complete message bits are divided into blocks where each block holds the same number of bits. Suppose each block contains k bits, and each k bits of a block defines a dataword. Hence, the overall datawords will be 2 raised to k. Now, in order to perform encoding, the datawords are encoded as codewords having n number of bits. We have recently discussed that a block has k bits and after encoding there will be n bits in each block (of course, n¿k) and these n bits will be transmitted across the channel. While the additional n-k bits are not the message bits as these are named as parity bits but during transmission, the parity bits act as they are a part of message bits.

Generally, generator matrix, G is used to produce codeword from dataword. The relation between c, d and G is given as: c = dG

A fundamental property of code matrices states that: GHt = 0 , where Ht is transpose of H matrix

For a received codeword the verification of correction is obtained by multiplying the code with Ht.

cHt = 0

As we know that c =dG

So, substituting dG in replace of c in second last equation, we will have, dGHt = 0 . If this product is unequal to 0 then this shows the presence of error. Generally, s called syndrome is given as :s = cHt. A relation between transmitted and received codeword is written in a way that,cR = cT + e

1.4 Code and result

```
clc;
clear ;
close all;
d=randi([0,1],[16,4]);
g=[1,1,0,1,0,0,0;0,1,1,0,1,0,0;1,1,1,0,0,1,0;1,0,1,0,0,0,1];
c=mod(d*g,2);
I=[1,0,0,;0,1,0,;0,0,1];
P=[1,1,0;0,1,1;1,1,1;1,0,1];
p1=P';
H=[I,p1];
e=eye(16,7);
r=mod(c+e,2);
h1=H';
disp(h1);
syndrome=mod(r*h1,2);
if(syndrome==0)
    disp("No error");
else
    disp("Error");
end
for i=1:7
    for j=1:3
    if(h1(i,j)==syndrome(i,j))
        break;
    end
    end
end
err=j;
corr=zeros;
for i=1:16
    for j=1:7
        corr(i,j)=r(i,j);
        if(j==err)
            if(corr(i,j)==0)
                corr(i,j)=1;
            else
                corr(i,j)=0;
            end
        end
    end
end
disp("Message bits");
disp(d);
disp("Code word");
disp(c);
disp("Hamming distance=3");
disp("Parity Check Matrix");
disp(P);
disp("H matrix");
disp(H);
disp("H transpose matrix");
disp(h1);
disp("Error Matrix");
disp(e);
disp("Error pos");
disp(err);
disp("Display syndrome");
disp(syndrome);
disp("Error is present in ");
disp(err);
```

```
disp("Corrected Matrix");
disp(corr);
```

```
     1     0     0
     0     1     0
     0     0     1
     1     1     0
     0     1     1
     1     1     1
     1     0     1

Error
Message bits
     1     1     0     1
     0     0     0     1
     1     0     0     0
     0     0     1     0
     0     1     1     1
     0     1     0     0
     0     1     0     0
     0     1     0     1
     1     1     1     1
     1     1     1     1
     0     0     0     1
     0     1     0     1
     0     1     1     0
     0     0     1     0
     0     1     1     0
     0     0     0     0

Code word
     0     0     0     1     1     0     1
     1     0     1     0     0     0     1
     1     1     0     1     0     0     0
     1     1     1     0     0     1     0
     0     0     1     0     1     1     1
     0     1     1     0     1     0     0
     0     1     1     0     1     0     0
     1     1     0     0     1     0     1
     1     1     1     1     1     1     1
     1     1     1     1     1     1     1
     1     0     1     0     0     0     1
     1     1     0     0     1     0     1
     1     0     0     0     1     1     0
     1     1     1     0     0     1     0
     1     0     0     0     1     1     0
     0     0     0     0     0     0     0

Hamming distance=3
Parity Check Matrix
     1     1     0
     0     1     1
     1     1     1
     1     0     1

H matrix
     1     0     0     1     0     1     1
     0     1     0     1     1     1     0
     0     0     1     0     1     1     1

H transpose matrix
```

```
     1     0     0
     0     1     0
     0     0     1
     1     1     0
     0     1     1
     1     1     1
     1     0     1

Error Matrix
     1     0     0     0     0     0     0
     0     1     0     0     0     0     0
     0     0     1     0     0     0     0
     0     0     0     1     0     0     0
     0     0     0     0     1     0     0
     0     0     0     0     0     1     0
     0     0     0     0     0     0     1
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0
     0     0     0     0     0     0     0

Error pos
     1

Display syndrome
     1     0     0
     0     1     0
     0     0     1
     1     1     0
     0     1     1
     1     1     1
     1     0     1
     0     0     0
     0     0     0
     0     0     0
     0     0     0
     0     0     0
     0     0     0
     0     0     0
     0     0     0
     0     0     0

Error is present in
     1

Corrected Matrix
     0     0     0     1     1     0     1
     0     1     1     0     0     0     1
     0     1     1     1     0     0     0
     0     1     1     1     0     1     0
     1     0     1     0     0     1     1
     1     1     1     0     1     1     0
     1     1     1     0     1     0     1
     0     1     0     0     1     0     1
     0     1     1     1     1     1     1
     0     1     1     1     1     1     1
     0     0     1     0     0     0     1
```

```
     0     1     0     0     1     0     1
     0     0     0     0     1     1     0
     0     1     1     0     0     1     0
     0     0     0     0     1     1     0
     1     0     0     0     0     0     0
```

1.5 Conclusion

We generated a random codeword then generated a generator matrix and after identifying parity check matrix checked for the error.We got some error then using syndrome matrix we tried to correct those errors.We were able to correct only those codewords which have error in only one bit.