INTRODUCTION TO COMMUNICATION SYSTEMS (CT216)

Matlab code and Results :

Lab Group - 2 : Project Group - 2

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TOPIC : CONVOLUTIONAL CODING

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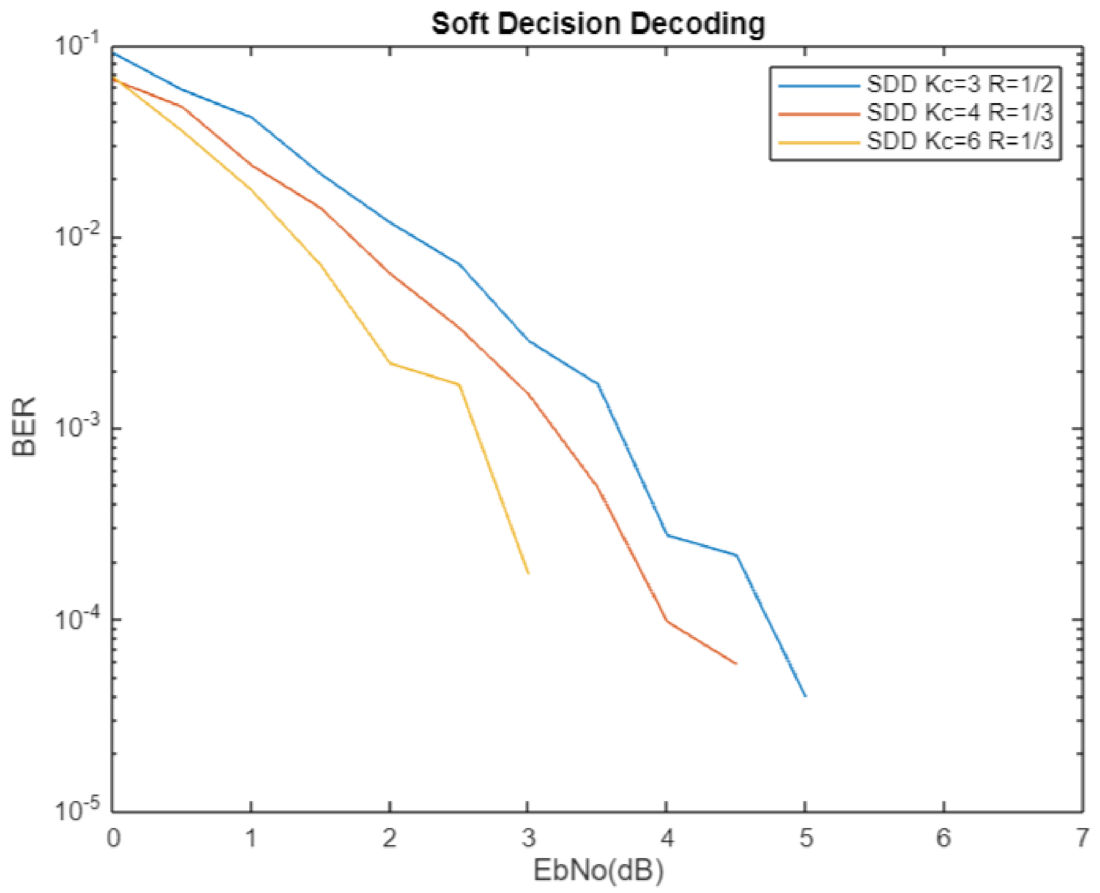
Honor code :

- The work that we are presenting is our own work.
- We have not copied the work (the code,the results,etc.) that someone else has done.
- Concepts,understanding and insights we will be describing are our own.
- We make this pledge truthfully.
- We know that violation of this solemn pledge can carry grave consequences.

```
function ans = encoding(kc, generation_polynomials, inp)

    n = length(generation_polynomials);
    ans = [];
    regval = 0;

    for i = 1:length(inp)
        curbit = inp(i);
        regval = bitor(bitshift(regval, -1), bitshift(curbit, (kc - 1)));

        for j = 1:n
            cur_poly = generation_polynomials(j);
            output = 0;
            p=dec2bin(cur_poly,kc);
            p=fliplr(p)-'0';
            rv=dec2bin(regval,kc)-'0';
            output=0;

             for k=1:kc
                 output=xor(output,(p(k) & rv(k)));
             end

            ans = [ans, output];
         end
     end
end


 function ans = decoding_soft(kc, generation_polynomials, inp)

    ns = bitshift(1, (kc-1));
    n = length(generation_polynomials);
    mtr = ones(floor(length(inp)/n) + 1, ns) * 1e9;
    previous_states = cell(floor(length(inp)/n) + 1, 1);

     for i = 1:length(previous_states)
            previous_states{i} = cell(ns, 1);

         for j = 1:ns
             previous_states{i}{j} = {1e9, 1e9};
         end

     end

    idx = 0;
 for t = 1:(length(inp)/n)
     for st = 0:ns-1
     if (t == 1) && (st == 0)
                 mtr(t, st+1) = 0;
     end
     for input_bits = 0:1
                    curstate = st;
                    next_state = bitor(bitshift(curstate, -1),(input_bits * ...
    bitshift(1, (kc-2))));
                    euclidian_distance = 0;
         for i = 1:n
                            output = 0;
                            poly = generation_polynomials(i);
                            regvalue = bitor(curstate, bitshift(input_bits,
(kc-1)));
             for k = 0:(kc-1)
                            output = bitxor(output, bitand(bitshift(poly,
-k), ...
    1) & bitand(bitshift(regvalue, -(kc-k-1)), 1));
             end
                    output=1-2*output;
                    euclidian_distance=euclidian_distance+(abs(output-...
inp(idx+i))*abs(output-inp(idx+i)));
            end
                euclidian=sqrt(euclidian_distance);
                a = mtr(t+1, next_state+1);
                b = mtr(t, curstate+1);
 if a > b + euclidian_distance
                    mtr(t+1, next_state+1) = b + euclidian_distance;
                     previous_states{t+1}{next_state+1} =
{curstate,input_bits};
 end
 end
 end
        idx = idx + n;
 end
    ans = [];
    temp = previous_states{(length(inp)/n)+1}{1};
    ans = [temp{2} ans];
    cur = (length(inp)/n);

 while cur >1
        temp = previous_states{cur}{temp{1}+1};
        ans = [temp{2} ans];
        cur = cur - 1;
 end
 end



 function modulated_op = modulator(encoded_message,sigma)
     s = 1 - 2 * encoded_message; % BPSK modulation
     modulated_op= s + sigma * randn(1, length(encoded_message));
 end


EbNodB = 0:0.5:10;
 R1 = 1/2;
 R2 = 1/3;
 R3 = 1/3;

 n1 =2;
 n2 =3;
 n3 =3;

 k1 =1;
 k2 =1;
 k3 =1;

 kc1 = 3;
 kc2 = 4;
 kc3 = 6;


% practical_error = zeros(1,length(EbNodB));
 %theoratical_error = zeros(1,length(EbNodB));

 soft_error1=zeros(1,length(EbNodB));
 soft_error2=zeros(1,length(EbNodB));
 soft_error3=zeros(1,length(EbNodB));

 idx =1;
 idx2=1;
 N = 500;
 for j=EbNodB
 EbNo = 10^(j/10);

 sigma1 = sqrt (1/(2*R1*EbNo));
 sigma2 = sqrt (1/(2*R2*EbNo));
 sigma3 = sqrt (1/(2*R3*EbNo));

 BER_th = 0.5*erfc(sqrt(EbNo));

 Nerr_soft1=0;
 Nerr_soft2=0;
 Nerr_soft3=0;

 for i = 1 : N
 msg = randi ([0 1],1,100); %generate random message

  msg1=[msg zeros(1,kc1-1)];
 msg2=[msg zeros(1,kc2-1)];
 msg3=[msg zeros(1,kc3-1)];
 encoded_array1=encoding(kc1,[5 7],msg1);
 encoded_array2=encoding(kc2,[11 13 15],msg2);
 encoded_array3=encoding(kc3,[39 43 61],msg3);

 modulated_message1=modulator(encoded_array1,sigma1);
 modulated_message2=modulator(encoded_array2,sigma2);
 modulated_message3=modulator(encoded_array3,sigma3);


 %decoded_message=decoding(kc,[5 7],demodualted_message);
 soft_decoded_message1=decoding_soft(kc1,[5 7],modulated_message1);
 soft_decoded_message2=decoding_soft(kc2,[11 13 15],modulated_message2);
 soft_decoded_message3=decoding_soft(kc3,[39 43 61],modulated_message3);

 Nerr_soft1=Nerr_soft1+sum(soft_decoded_message1~=msg1);
 Nerr_soft2=Nerr_soft2+sum(soft_decoded_message2~=msg2);
 Nerr_soft3=Nerr_soft3+sum(soft_decoded_message3~=msg3);
% Nerrs=Nerrs+sum(msg ~= decoded_message);
 end
 soft_error1(idx)=(Nerr_soft1)/(N*length(msg1));
 soft_error2(idx)=(Nerr_soft2)/(N*length(msg2));
 soft_error3(idx)=(Nerr_soft3)/(N*length(msg3));

 %practical_error(idx) = (Nerrs/(N*length(msg)));
 %theoratical_error(idx2) = theoratical_error(idx2)+BER_th;

 idx = idx+1;
 idx2 = idx2+1;
 end

 %semilogy(EbNodB,practical_error,'LineWidth',2.0);

 %semilogy(EbNodB,theoratical_error,'LineWidth',2.0);

 semilogy(EbNodB,soft_error1,'LineWidth',0.5);
 hold on;
 semilogy(EbNodB,soft_error2,'LineWidth',0.5);
 semilogy(EbNodB,soft_error3,'LineWidth',0.5);

 legend('SDD R=1/2 & Kc=3','SDD R=1/3 & Kc=4','SDD R=1/3 & Kc=6');
 title('Soft Decision Decoding');
 %xlim([0 1]);
 xlabel('EbNo(dB)');
 ylabel('BER');
 hold off;
```


Soft Decision Decoding
SDD Kc=3 R=1/2
SDD Kc=4 R=1/3
SDD Kc=6 R=1/3
BER
EbNo(dB)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
0
1
2
3
4
5
6
7