DCCDL LAB5

matlab

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1. Please show how you calculate the scaling factor, write down the N value that you use and the result of $S(N)$.

procedure.m | CSD.m | porcedures6.m

```
%% procedure1

format long

s_n = ones(1,35);
temp_2 = zeros(1,35);

for i = 1:35
    temp_2(1,i) = 1/(sqrt(1+2^(-2*(i-1))));
end

for i = 1:35
    for j= 1:i
        s_n(1,i) = s_n(1,i)*(temp_2(1,j));
    end
end

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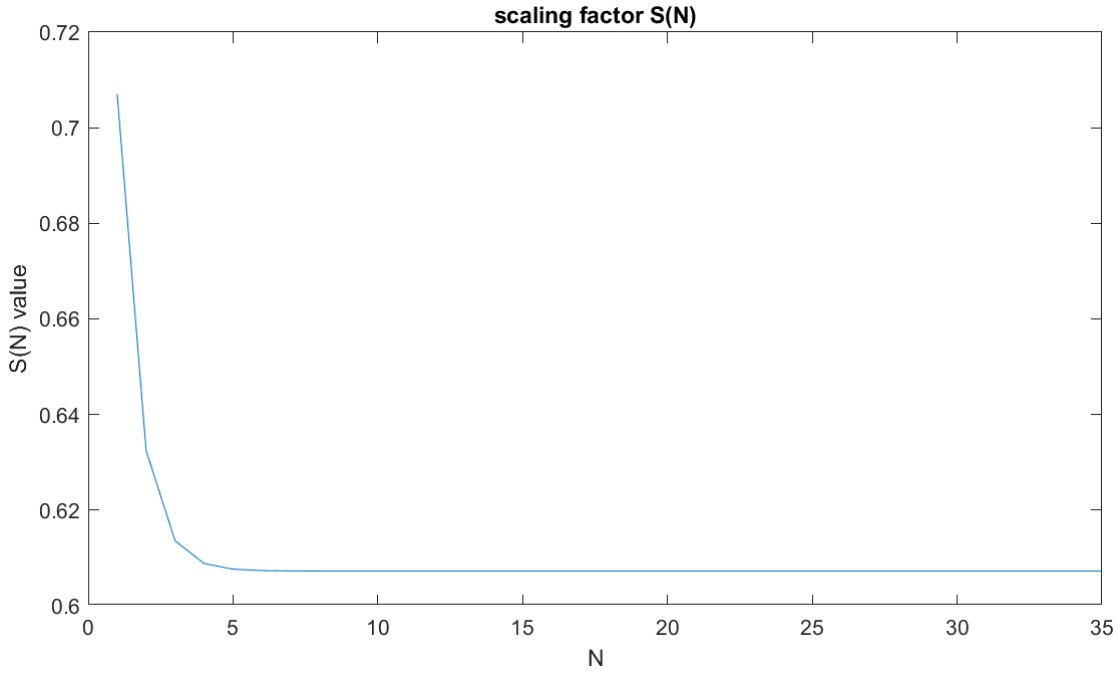
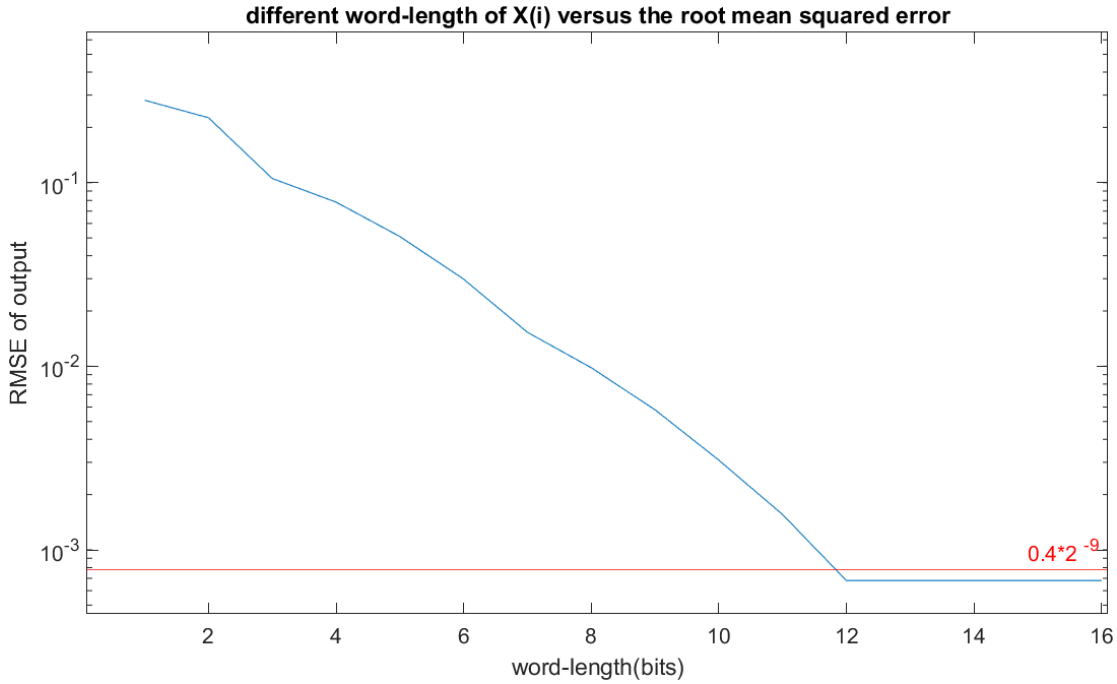
$$S(N) = \frac{1}{\prod_{i=0}^{N-1}\sqrt{1+2^{-2i}}}$$



```
S(N)= [0.70710678118654746 0.63245553203367577 0.61357199107789628 0.60883391251775243 ...
       0.60764825625616825 0.607351770141296    0.60727764409352614 0.60725911229889284 ...
       0.60725447933256249 0.60725332108987529 0.60725303152913446 0.607252959138945 ...
       0.60725294104139727 0.60725293651701029 0.60725293538591352 0.60725293510313938 ...
       0.60725293503244582 0.6072529350147724  0.607252935010354   0.60725293500924948 ...
       0.60725293500897337 0.60725293500890432 0.60725293500888711 0.60725293500888278 ...
       0.60725293500888167 0.60725293500888144 0.60725293500888144 0.60725293500888144 ...
       0.60725293500888144 0.60725293500888144 0.60725293500888144 0.60725293500888144 ...
       0.60725293500888144 0.60725293500888144 0.60725293500888144];
```

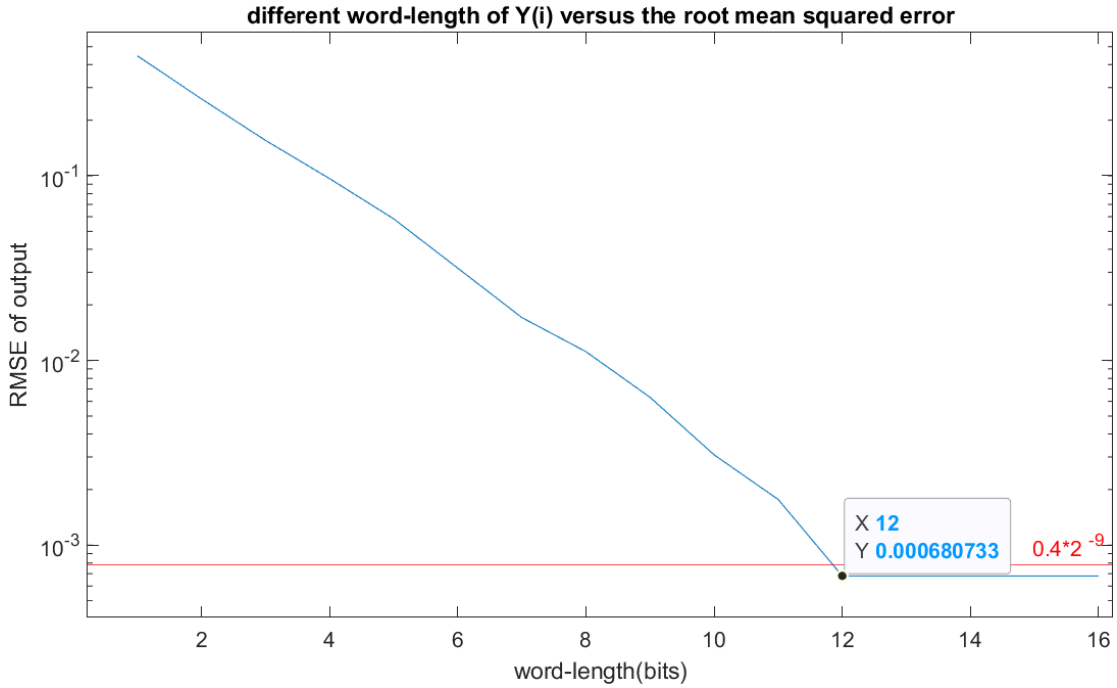
此次架構我預計使用 N=11，S(N)= 0.60725303152913446。

2. Write down the word-length of $X(i)$ and $Y(i)$ that you use. Please explain it.



word-length of X(i) = S2.12, 15bits

上圖為不同的 X(i)word-length 與相對應的 RMSE 的關係圖，從結果來看我將小數位定為 12bits。考慮到 X(i)成長的可能性，為防止其溢位將整數位多增加一位。



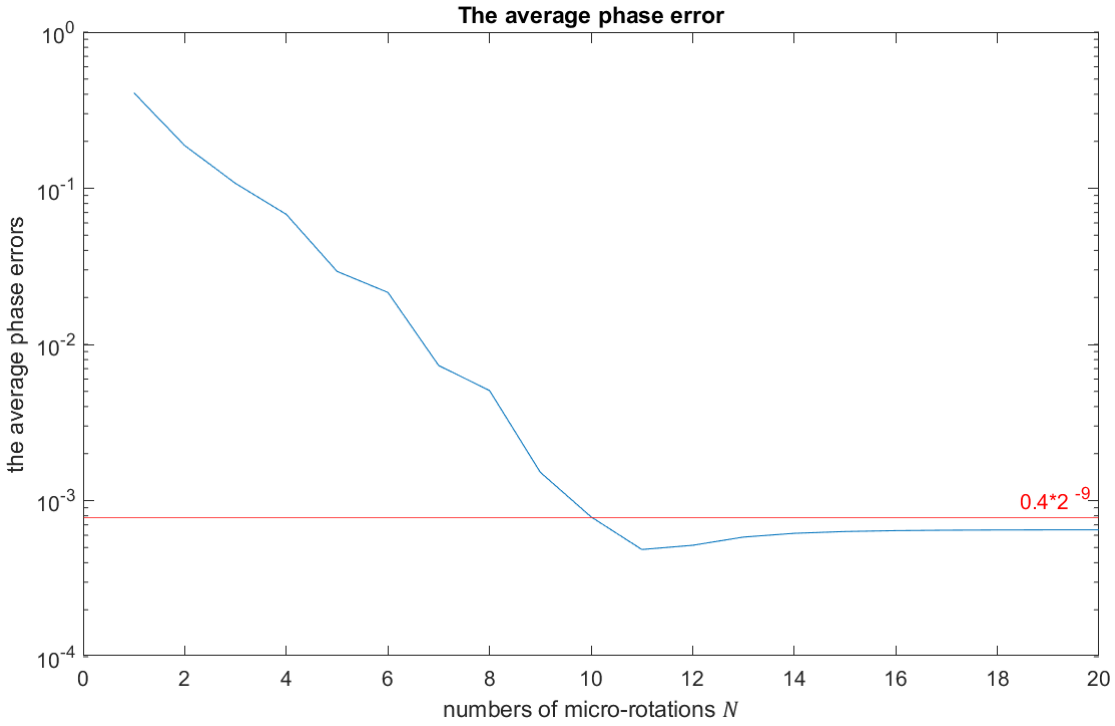
word-length of Y(i) = 2.12, 15bits

上圖為不同的 Y(i)word-length 與相對應的 RMSE 的關係圖，從結果來看我將小數位定為 12bits。但是在每級計算中 Y(i)皆與 X(i)做加減法，因此將其長度與 X(i)設為相同長度。

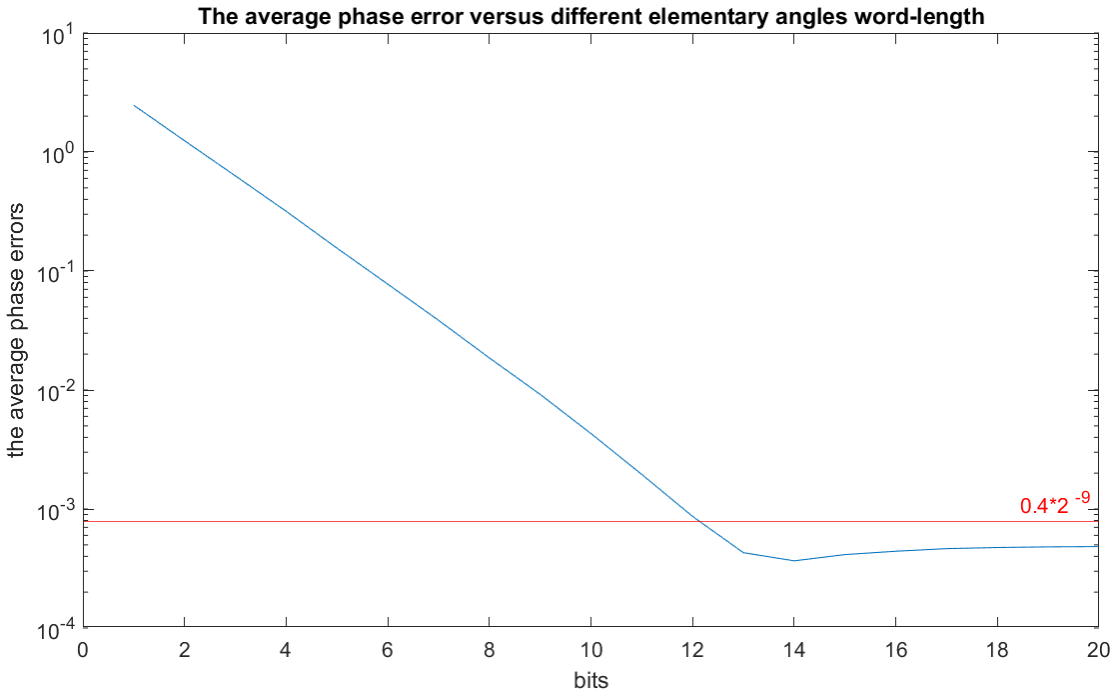
3. Please draw a figure to denote the average phase errors of 11 input pairs (X, Y) versus different numbers of micro-rotations N and draw a figure to show the resulted phase errors of 11 input pairs versus the word-length of quantized elementary angles. Explain how you determine it. Also list a table of the elementary angles (both in floating-point representation and binary fixed-point representation).

學號尾數為 5，β=2 ,a = 0.4x 2^{-9}

The average phase errors of 11 input pairs (X, Y) versus different numbers of micro-rotations N:



the resulted phase errors of 11 input pairs versus the word-length of quantized elementary angles:



Elementary angle word-length: s1.13 (15bits)

Table of the elementary angles (floating-point representation):

Form N=1 ~ N=11 , table of the elementary angles:

0.785278320312500 0.463623046875000 0.244873046875000
0.124267578125000 0.0623779296875000 0.0311279296875000
0.0155029296875000 0.00769042968750000 0.00378417968750000
0.00183105468750000 0.000854492187500000

Table of the elementary angles (fixed-point representation):

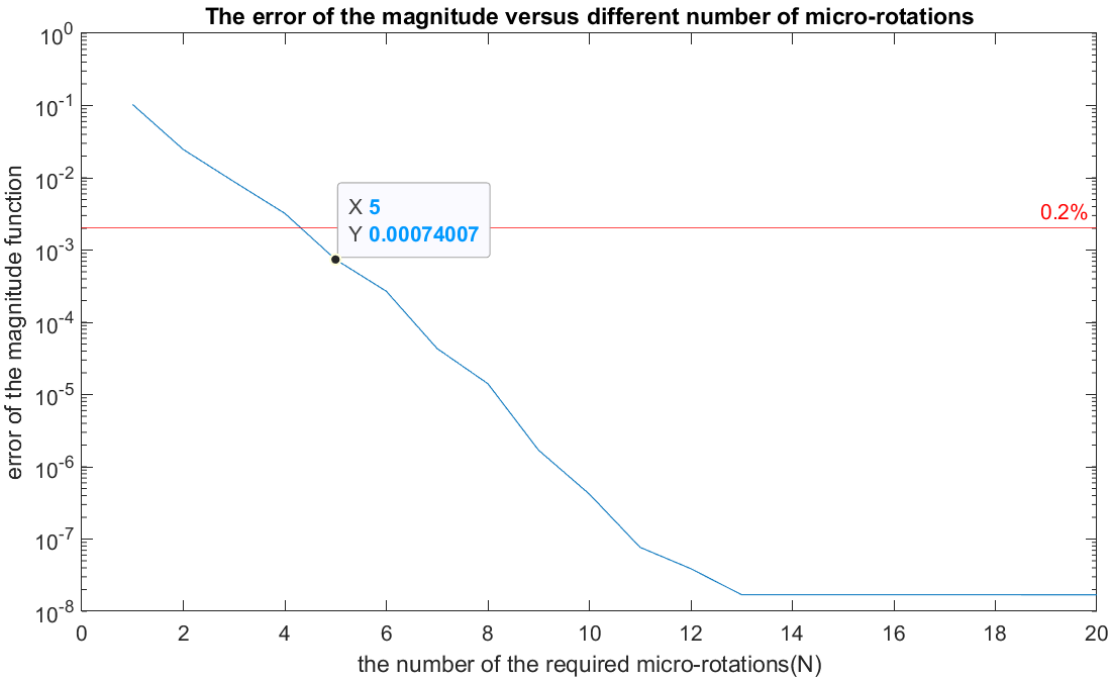
Form N=1 ~ N=11, word-length:16bits(s1.14) , table of the elementary angles:

0.463623046875000 0.244964599609375 0.124328613281250
0.0624084472656250 0.0312194824218750 0.0155944824218750
0.00778198242187500 0.0038757324218750 0.00192260742187500
0.000946044921875000 0.0004577636718750

Binary: (N=1~11)

1100100100001
0111011010110
0011111010110
0001111111010
0000111111111
0000011111111
0000001111111
0000000111111
0000000011111
0000000001111
0000000000111

4. Please show how you decide the number of micro-rotations for the magnitude function with error tolerance of 0.2%.

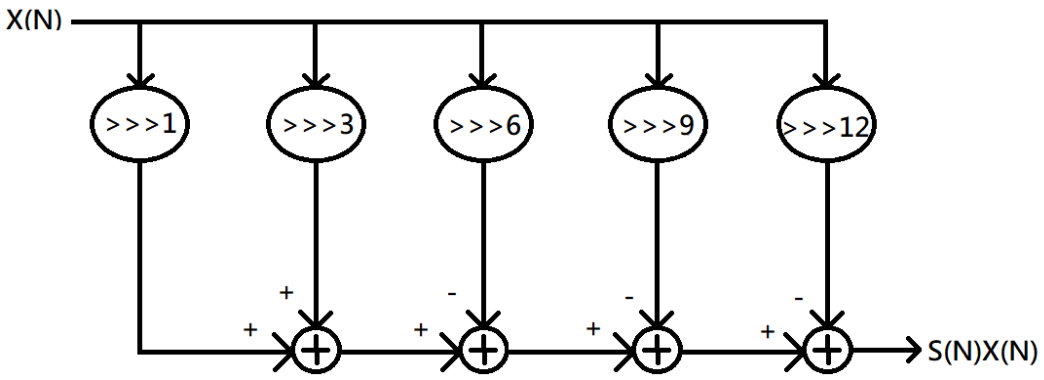


Need 5 times of micro-rotations.

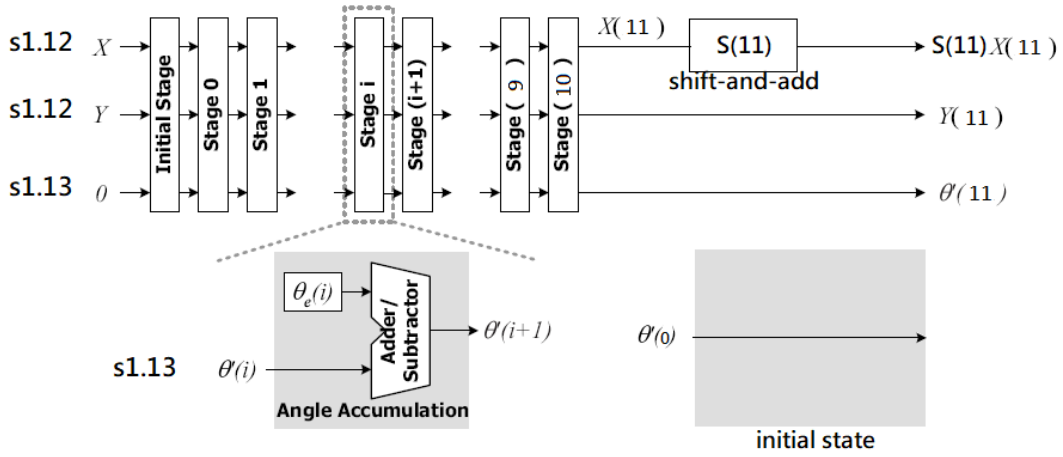
考慮 Q3 需要 11 次的 micro-rotations，而 Q4 只需要 5 次即可達到 magnitude error 小於容忍值的結果，因此採用 11 次 micro-rotations 的架構。

5. Write down the power-of-2 expression for the scaling factor $S(N)$. Depict your design for the shift-and-add block. (Using CSD)

S(N) = 0.607253031529135;
運算時將 S(N)的 word-length 設為 s1.12
將 S(N)量化之後乘上 2^{12} 後的值為 2487
其二進位表示法為 00 1001 1011 0111
經過 CSD 運算後為 00 1010 0-100 -100-1



6. Depict your design of the complete CORDIC architecture for the arctangent function. Mark the word-length in the block diagram.



7. Depict your design of the complete CORDIC architecture for the magnitude function. Mark the word-length in the block diagram.