**CMSE-492 MT Exam 20.04.2018 (110 min, 20 points)**

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Totally 4 questions, 14 pages

**Task 1. (5 points)** Embed secret bits from S=’10110110011’ into the cover image, CI=(110,158) by Wang’s Modulo operator method using T=160, ml=16, mu=32. Check correctness of embedding by extraction. Show details of your calculations, give necessary explanations.

**Hint: Wang’s method Embedding and Extraction**

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The first pixel P1=110<T=160, hence EC=log2ml=log216=4, Res=110 mod 16 = 14, Dec=10112=1110. D=|Res-Dec|=|14-11|=3. Ml/2=8<=P1<T-ml/2=160-8=152, hence, Case 1, 2 is used. D=3<=ml/2=8, hence, AV=D, Res=14>Dec=11, hence, Ps1=P1-AV=110-3=107. Check it by extraction. Since Ps1=107<T=160, Case 1 is applied: Res= Ps1 mod ml= 107 mod 16 =11, EC log216=4. . Thus, secret bits extracted are s1=1011 that complies with the bits embedded.

The second pixel, P2=158<T=160, hence, EC=log216=4, Res= P2 mod ml=158 mod 16 =14. Dec= D={Rs-Dec|=01102=610, D=|Res-Dec|=|14-6|=8. Case 1 is applied since P2=158<T=160. Condition 3, Case 1, is true since T-ml/2=160-16/2=152<=P2=158<T=160. Hence, Ps2=P2-Res+Dec=158-14+6=150. Check correctness of embedding by extraction. Case 1 is applied because Ps2=150<T=160. Hence, Res=Ps2 mod ml = 150 mod 16 =6, EC=log216=4, hence, s2=0110 that complies with the data embedded.

**Task 2. (5 points)** Embed secret bits from S=’10110110011’ into the cover image, CI=(110,158) by Wu and Tsai Pixel-value differencing method using ranges R1=[0,7], R2=[8,15], R3=[16,31], R4=[32,63], R5=[64,127], R6=[128,255]. Before embedding, check that the pixel pair is to be used/not used for embedding.

Extract the data embedded. Before extraction, check the pixel pair for the abandonment condition; check that the condition returns exactly the same result as it was when checking for embedding this pair. Show details of your calculations, give necessary explanations.

**Hint:**







For our case, (p1, p2)=(110, 158), d=p2-p1=158-110=48 belongs to R4=[32, 63]. Hence, n=log2(u-l+1)= log2(63-32+1)= log232=5, b=S(1:5)=101102=22. d’=l+b=32+22=54. Falling-off-boundary checking: m=u-d=63-48=15, since d is even, f((p1,p2),m)=f((110, 158), 15)=(p1-floor(m), p2+ceiling(m))=(110-7,158+8)=(103, 166) which are inside 0..255, hence, no falling-off-boundary, and the pixel pair is used for 5 bits, S(1:5), embedding (embed b=22): m=d’-d=54-48=6, f((p1,p2),m)=f((110, 158), 6)=(p1-floor(m), p2+ceiling(m))=(110-3,158+3)=(107, 161)=(ps1, ps2).

Extraction. For our case, (ps1, ps2)=(107, 161), d=ps2-ps1=161-107=54 belongs to R4=[32, 63]. Hence, n=log2(u-l+1)= log2(63-32+1)= log232=5. Falling-off-boundary checking: m=u-d=63-54=9, since d is even, f((ps1,ps2),m)=f((107, 161), 9)=(p1-floor(m), p2+ceiling(m))=(107-4,161+5)=(103, 166) which are inside 0..255, and equal to the checking result in embedding. Hence, no falling-off-boundary, and the pixel pair is used for 5 bits extraction: b=d-l=54-32=2210=101102 that is exactly same as it was embedded.

**Task 3. (5 points)** Embed secret bits from S=’10110110011’ into the cover image, CI=(110,158) by Khodaei et al. Hybrid method. Extract the data embedded from the stego pixels. Show details of your calculations, give necessary explanations.

**Hints:**

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(p1, p2)=(110,158), The both pixels are less than T=192, hence, by Case 1, 3 bits, s1=101=5, are LSB embedded into p1, and the next 3 bits, s2=101=5, are LSB embedded into p2: p1’=p1-(p1 mod 8)+s1=110-6+5=109, p2’=p2- (p2 mod 8) + s2= 158-6+5=157. Check by extraction from (p1’,p2’)=(109,157). The both stego pixels are less than T=192, hence, y Case 1, 3 LSB are extracted from p1’, and the next 3 LSB are extracted from p2’: s1=p1’ mod 8= 109 mod 8 = 5 =101, s2=p2’ mod 8 = 157 mod 8 = 5 =101, thus the 6 bits extracted from the stego pixel pair are ‘101101’ that is the same as it was embedded.

**Task 4.**  **(5 points)** Consıder a 1x4 mask M=(0,1,1,0) and its negation, -M.

Consider the grayscale image, I, below having 1 rows and 8 columns:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Col1 | Col2 | Col3 | Col4 | Col5 | Col6 | Col7 | Col8 |
| Row1 | 110 | 220 | 25 | 11 | 12 | 23 | 12 | 123 |

Specify 2 pixel groups, G1, G2 for M. Classify the groups as RM, SM, R-M, S-M, UM, U-M. Show details of your calculations, give necessary explanations

**Hints:**









G1=(110,220,25,11), G2=(12,23,12,123)

f(G1)=|220-110|+|25-220|+|11-25|=110+195+14=319

f(G2)= |23-12|+|12-23|+|123-12|=11+11+111=133

FM(G1)=(F0(110),F1(220),F1(25),F0(11))=(110,221,24,11)

FM(G2)=(F0(12),F1(23),F1(12),F0(123))=(12,22,13,123)

f(FM(G1))=| 110-221|+|24-221|+|24-11|=111+197+13=321

f(FM(G2))=| 12-22|+|13-22|+|13-123|=10+9+110=129

F-M(G1)=(F0(110),F-1(220),F-1 (25),F0(11))=(110,219,26,11)

F-M (G2)=(F0(12),F-1 (23),F-1 (12),F0(123))=(12,24,11,123)

f(F-M (G1))=| 110-219|+|26-219|+|26-11|=109+193+15=317

f(F-M (G2))=| 12-24|+|11-24|+|11-123|=12+13+112=137

f(FM(G1))=321>f(G1)=319 => G1 is Regular for M

f(FM(G2))=129<f(G2)=133 => G2 is Singular for M

f(F-M(G1))=317<f(G1)=319 => G1 is Singular for -M

f(F-M (G2))=137<f(G2)=133 => G2 is Regular for –M

Hence

RM=1 (50%), SM=1 (50%), UM=0%

R-M=1 (50%), S-M =1 (50%), U-M =0%