Homework-6 Solutions

Question 1

1	2	2	2	8	9	11	20	100	100
7	3	2	2	11	10	40	30	100	100
A		B		C		D		E	

A,B,C,D,E above are 5 small windows in an image. Our goal is to use template matching to detect the following pattern:

1	2
4	3

I

If the technique of non-normalized cross correlation is used, which pattern gives the best match value?

Answer: E.

	A	B	C	D	E
match value	42	20	100	291	1000

II

If the technique of normalized cross correlation is used, which pattern gives the best match value?

Answer: D.

	A	B	C	D	E
match value	$42/\sqrt{63} = 5.291$	$20/\sqrt{16} = 5$	$100/\sqrt{366} = 5.227$	$301/\sqrt{3021} = 5.476$	$1000/\sqrt{40000} = 5$

Question 2

The result of detecting the template | 1 | 2 | 1 | in the image

			4	4	4				
			1	2	1				

a. with non-normalized cross correlation matching. Cross correlation of the template with the image gives: Therefore, the best match is found for cross correlation value of 16, at the coordinate $x = 4$, $y = 1$.

		4	12	16	12	4			
		1	4	6	4	1			

b. with normalized cross correlations matching. First square the original image values
Next compute the cross correlation with | 1 | 1 | 1 |

			16	16	16				
			1	4	1				

		16	32	48	32	16			
		1	5	6	5	1			

Next divide the values found in Part a by the square root of the above values giving:

		1	$3/\sqrt{2}$	$4/\sqrt{3}$	$3/\sqrt{2}$	1			
		1	$4/\sqrt{5}$	$6/\sqrt{6}$	$4/\sqrt{5}$	1			

The best match is found at coordinate $x = 4$, $y = 2$.

If desired the results can be normalize to a (0,1) range by dividing each element by $\sqrt{1^2 + 2^2 + 1^2}$

		$1/\sqrt{6}$	$\sqrt{3}/2$	$2\sqrt{2}/3$	$\sqrt{3}/2$	$1/\sqrt{6}$			
		$1/\sqrt{6}$	$4/\sqrt{30}$	1	$4/\sqrt{30}$	$1/\sqrt{6}$			