Homework-6

Q1:

A close up of a logo

Description automatically generated

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 |

**Note:**

**You are only asked to consider the case in which the pattern is on top of each of the five alternatives. This means that in each case you need only compute 5 values.**

Only consider the anchor.

I

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

A:

|  |  |  |
| --- | --- | --- |
| 𝛌 = | **1** | 2 |
|  | 4 | 3 |
| f = | **1** | 2 |
|  | 7 | 3 |
| C = 𝛌 ⊗ f = | 42 | |
| Q = C = | 42 | |

B:

|  |  |  |
| --- | --- | --- |
| 𝛌 = | **1** | 2 |
|  | 4 | 3 |
| f = | **2** | 2 |
|  | 2 | 2 |
| C = 𝛌 ⊗ f = | 20 | |
| Q = C = | 20 | |

C:

|  |  |  |
| --- | --- | --- |
| 𝛌 = | **1** | 2 |
|  | 4 | 3 |
| f = | **8** | 9 |
|  | 11 | 10 |
| C = 𝛌 ⊗ f = | 100 | |
| Q = C = | 100 | |

D:

|  |  |  |
| --- | --- | --- |
| 𝛌 = | **1** | 2 |
|  | 4 | 3 |
| f = | **11** | 20 |
|  | 40 | 30 |
| C = 𝛌 ⊗ f = | 301 | |
| Q = C = | 301 | |

E:

|  |  |  |
| --- | --- | --- |
| 𝛌 = | **1** | 2 |
|  | 4 | 3 |
| f = | **100** | 100 |
|  | 100 | 100 |
| C = 𝛌 ⊗ f = | 1000 | |
| Q = C = | 1000 | |

To sum up:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Image | A | B | C | D | E |
| Q | 42 | 20 | 100 | 301 | 1000 |

II

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

A:

|  |  |  |
| --- | --- | --- |
| 𝛌 = | **1** | 2 |
|  | 4 | 3 |
| f = | **1** | 2 |
|  | 7 | 3 |
| C = 𝛌 ⊗ f = | 42 | |
| f2 = f^2 = | **1** | 4 |
|  | 49 | 9 |
| 𝛌1 = | **1** | 1 |
|  | 1 | 1 |
| N2 = | 63 | |
| Q = C/√N2 = | 5.292 | |

B:

|  |  |  |
| --- | --- | --- |
| 𝛌 = | **1** | 2 |
|  | 4 | 3 |
| f = | **2** | 2 |
|  | 2 | 2 |
| C = 𝛌 ⊗ f = | 20 | |
| f2 = f^2 = | **4** | 4 |
|  | 4 | 4 |
| 𝛌1 = | **1** | 1 |
|  | 1 | 1 |
| N2 = | 16 | |
| Q = C/√N2 = | 5 | |

C:

|  |  |  |
| --- | --- | --- |
| 𝛌 = | **1** | 2 |
|  | 4 | 3 |
| f = | **8** | 9 |
|  | 11 | 10 |
| C = 𝛌 ⊗ f = | 100 | |
| f2 = f^2 = | **64** | 81 |
|  | 121 | 100 |
| 𝛌1 = | **1** | 1 |
|  | 1 | 1 |
| N2 = | 366 | |
| Q = C/√N2 = | 5.227 | |

D:

|  |  |  |
| --- | --- | --- |
| 𝛌 = | **1** | 2 |
|  | 4 | 3 |
| f = | **11** | 20 |
|  | 40 | 30 |
| C = 𝛌 ⊗ f = | 301 | |
| f2 = f^2 = | **121** | 400 |
|  | 1600 | 900 |
| 𝛌1 = | **1** | 1 |
|  | 1 | 1 |
| N2 = | 3021 | |
| Q = C/√N2 = | 5.476 | |

E:

|  |  |  |
| --- | --- | --- |
| 𝛌 = | **1** | 2 |
|  | 4 | 3 |
| f = | **100** | 100 |
|  | 100 | 100 |
| C = 𝛌 ⊗ f = | 1000 | |
| f2 = f^2 = | **10000** | 10000 |
|  | 10000 | 10000 |
| 𝛌1 = | **1** | 1 |
|  | 1 | 1 |
| N2 = | 40000 | |
| Q = C/√N2 = | 5 | |

To sum up:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Image | A | B | C | D | E |
| Q | 5.292 | 5 | 5.227 | 5.476 | 5 |

Q2:

The result of detecting the template

|  |  |  |
| --- | --- | --- |
| 1 | **2** | 1 |

in the image (all unspecified values are 0).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  | 4 | 4 | 4 |  |  |  |  |
|  |  |  | 1 | 2 | 1 |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |

a. with non-normalized cross correlations matching.

Q =

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| coord | x = 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| y = 0 |  |  |  |  |  |  |  |  |  |  |
| 1 |  |  |  |  |  |  |  |  |  |  |
| 2 |  |  | 4 | 12 | **16** | 12 | 4 |  |  |  |
| 3 |  |  | 1 | 4 | 6 | 4 | 1 |  |  |  |
| 4 |  |  |  |  |  |  |  |  |  |  |

The best match is in x = 4, y = 2.

b. with normalized cross correlations matching.

N2 =

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| coord | x = 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | 8 | | 9 |
| y = 0 |  |  |  |  |  |  |  | |  | |  |  |
| 1 |  |  |  |  |  |  |  | |  | |  |  |
| 2 |  |  | 16 | 32 | 48 | 32 | 16 | |  | |  |  |
| 3 |  |  | 1 | 5 | 6 | 5 | 1 | |  | |  |  |
| 4 |  |  |  |  |  |  |  | |  | |  |  |

Q =

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| coord | x = 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | 8 | | 9 |
| y = 0 |  |  |  |  |  |  |  | |  | |  |  |
| 1 |  |  |  |  |  |  |  | |  | |  |  |
| 2 |  |  | 1 | 4.243 | **6.928** | 4.243 | 1 | |  | |  |  |
| 3 |  |  | 1 | 1.789 | 2.449 | 1.789 | 1 | |  | |  |  |
| 4 |  |  |  |  |  |  |  | |  | |  |  |

The best match is still in x = 4, y = 2.