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MANUAL CNNs

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**Below is an 8x8 grid representing an image of a black square**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

Filter 3x3:

Horizontal edge:

|  |  |  |
| --- | --- | --- |
| -1 | -1 | -1 |
| 0 | 0 | 0 |
| 1 | 1 | 1 |

Vertical edge:

|  |  |  |
| --- | --- | --- |
| -1 | 0 | 1 |
| -1 | 0 | 1 |
| -1 | 0 | 1 |

The result of applying the vertical edge filter to the image:

Black for negative values, gray for positive values, and white for zero.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| -2 | -2 | 2 | 2 | 0 | 0 |
| -3 | -3 | 3 | 3 | 0 | 0 |
| -3 | -3 | 3 | 3 | 0 | 0 |
| -2 | -2 | 2 | 2 | 0 | 0 |
| -1 | -1 | 1 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |

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From the images above, the right and bottom side of the grid have zero values, the middle has the highest values, while the left side has the lowest values. With contrasting colors to highlight edges, and the presence of a square. Multiple black cells on the left side suggest the filter detects edges, while positive value areas indicate high response, and the square shape.

The result of applying the horizontal edge filter to the image:

**-2 is dark red, -1 is red, 0 is white, 1 is light green, 2 is green.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| -1 | -2 | -2 | -1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 2 | 2 | 1 | 0 | 0 |
| 1 | 2 | 2 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 |

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Edges of the detected square are represented with red, dark red, and green, while the white rows indicate areas without significant features detected.

**Works Cited**

Cohen, Stanley. “The Basics of Machine Learning: Strategies and Techniques.” *Artificial Intelligence and Deep Learning in Pathology*, 2021, pp. 13–40, https://doi.org/10.1016/b978-0-323-67538-3.00002-6.