

A07 ITAI 1378 Manual CNN

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ITAI 1378: Computer Vision

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0	0	1	0	0
1	1	1	1	1
0	0	1	0	0
0	0	1	0	0
0	0	1	0	0

Table 1 represent 5 X 5 Image

-1	0	1
-1	0	1
-1	0	1

Table 2 represent 3 X 3 Vertical Edge Filter Image

-1	-1	-1
0	0	0
1	1	1

Table 3 represent 3 X 3 Horizontal Edge Filter Image

1	1	0	0
1	1	0	0

1	1	0	0
1	1	0	0

Overlaying the filter on the 1<sup>st</sup> image 5 x 5 with 2<sup>nd</sup> image of vertical edge filter 3x3 image by multiplying corresponding values and summing them.

Example for the top-left region of the image:

First Position (Top-Left, covering the first 3x3 block)

$$\begin{aligned}
 &(-1 \times 0) + (0 \times 0) + (1 \times 1) + (-1 \times 0) + (0 \times 0) + (1 \times 1) + (-1 \times 1) + (0 \times 1) + (1 \times 1) \\
 &= (-1 \times 0) + (0 \times 0) + (1 \times 1) + (-1 \times 0) + (0 \times 0) + (1 \times 1) + (-1 \times 1) + (0 \times 1) + (1 \times 1) \\
 &= 0 + 0 + 1 + 0 + 0 + 1 - 1 + 0 + 1 = 2
 \end{aligned}$$

Second Position (Shift Right by 1 column)

$$\begin{aligned}
 &(-1 \times 0) + (0 \times 1) + (1 \times 0) + (-1 \times 0) + (0 \times 1) + (1 \times 0) + (-1 \times 1) + (0 \times 1) + (1 \times 1) \\
 &= (-1 \times 0) + (0 \times 1) + (1 \times 0) + (-1 \times 0) + (0 \times 1) + (1 \times 0) + (-1 \times 1) + (0 \times 1) + (1 \times 1) \\
 &= 0 + 0 + 0 + 0 + 0 + 0 - 1 + 0 + 1 = 0
 \end{aligned}$$

Third Position (Shift Right by 1 column)

$$\begin{aligned}
 &(-1 \times 1) + (0 \times 0) + (1 \times 0) + (-1 \times 1) + (0 \times 0) + (1 \times 0) + (-1 \times 1) + (0 \times 1) + (1 \times 1) \\
 &= (-1 \times 1) + (0 \times 0) + (1 \times 0) + (-1 \times 1) + (0 \times 0) + (1 \times 0) + (-1 \times 1) + (0 \times 1) + (1 \times 1) \\
 &= -1 + 0 + 0 - 1 + 0 + 0 - 1 + 0 + 1 = -2
 \end{aligned}$$

Fourth Position (Shift Right by 1 column)

$$\begin{aligned}
 &(-1 \times 0) + (0 \times 0) + (1 \times 0) + (-1 \times 1) + (0 \times 0) + (1 \times 1) + (-1 \times 1) + (0 \times 0) + (1 \times 1) \\
 &(-1 \times 0) + (0 \times 0) + (1 \times 0) + (-1 \times 1) + (0 \times 0) + (1 \times 1) + (-1 \times 1) + (0 \times 0) + (1 \times 1) \\
 &= 0 + 0 + 0 - 1 + 0 + 1 - 1 + 0 + 1 = -1 \\
 &0 + 0 + 0 - 1 + 0 + 1 - 1 + 0 + 1 = -1
 \end{aligned}$$

Fifth Position (Shift Right by 1 column, reaches last column)

$$\begin{aligned}
 &(-1 \times 0) + (0 \times 0) + (1 \times 0) + (-1 \times 0) + (0 \times 0) + (1 \times 0) + (-1 \times 1) + (0 \times 0) + (1 \times 0) \\
 &(-1 \times 0) + (0 \times 0) + (1 \times 0) + (-1 \times 0) + (0 \times 0) + (1 \times 0) + (-1 \times 1) + (0 \times 0) + (1 \times 0) \\
 &= 0 + 0 + 0 + 0 + 0 + 0 - 1 + 0 + 0 = -1 \\
 &0 + 0 + 0 + 0 + 0 + 0 - 1 + 0 + 0 = -1
 \end{aligned}$$

Resulting image grid

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

Table 4 represent outcome from calculating overlaying filters

## Interpretation of Results

- **Positive values (e.g., 2, 3)** → Detected **vertical edges** where pixel intensity changes.
- **Zero values (0)** → No major edge detected, meaning a uniform region.
- **Negative values (-2, -3, -1)** → Detected edges in the opposite direction.

The high positive values on the left and high negative values on the right indicate a **strong vertical edge** in the center, which aligns with the vertical structure in the original image.

### **References:**

Krizhevsky, A., Sutskever, I., & Hinton, G. E. (2012). ImageNet classification with deep convolutional neural networks. *Advances in Neural Information Processing Systems*, 25, 1097-1105.

LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. *Nature*, 521(7553), 436-444.

Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep Learning*. MIT Press.