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Seminar Report

Linear and Nonlinear Filters

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1 Introduction

2 Linear Filters

As its name suggests, the function which is used to pass the image through must be linear and shift invariant. A common formula for linear filtering is the *Correlation Filtering*.

$$g(i, j) = \sum_{l \in \mathcal{M}} \sum_{k \in \mathcal{N}} f(i+k, j+l) \cdot h(k, l)$$

or commonly notated as $g = f \otimes h$.

The desired output pixel $g(i, j)$, where i and j specify the coordinates of it, is based on a $M \times N$ sized neighborhood, meaning not only does one pixel define an output pixel, but also a specified number of its neighbors. The influence of each pixel in the neighborhood is defined by the filter coefficient $h(k, l)$, also called its *kernel* or *mask*.

An interesting note is that, when the kernel is convolved with an impulse signal (an image with 0 everywhere except the origin), it reproduces the kernel itself, whereas with correlational filtering, it produces the reflected signal.

$$\underbrace{\begin{bmatrix} 128 & 34 & 123 \\ 68 & 54 & 73 \\ 100 & 95 & 17 \end{bmatrix}}_{\text{input neighborhood}} \otimes \underbrace{\begin{bmatrix} 0.1 & 0.1 & 0.1 \\ 0.1 & 0.2 & 0.1 \\ 0.1 & 0.1 & 0.1 \end{bmatrix}}_{\text{kernel}} = 75$$

As the above example with a 3×3 kernel, a total of 9 pixels is needed to calculate a single output pixel.

Another common variant on the formula is having the signs of the offsets reversed.

$$g = f * h$$

$$g(i, j) = \sum_{l \in \mathcal{M}} \sum_{k \in \mathcal{N}} f(i-k, j-l) \cdot h(k, l)$$

With this formula, $*$ is called the *convolutional* operator, and the kernel h is called the *impulse response function*.

3 example page from template

Please specify your name, matriculation number, the name of your advisor and the title of your report in `titlepage.tex`.

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4 Section Title

I am a section. LaTeX will give me a number *automatically* and put me into the table of contents. Using `\label` and `\ref` you can write that this is Section 4. Another section is Section 5.

You can use the commands `\eg`, `\ie`, `\etal` to get *e.g.*, *i.e.*, *et al.* And “this is a quote.”

4.1 Subsection Title With Capitalized Words

We can make bulleted lists as follows.

- I am an item,
- I am another item.

4.1.1 Subsubsection with only the first word capitalized

I am a subsubsection, an even smaller subsection. Let's see a table.

Method	Accuracy (%)
Boring old method	86.6
Shiny new method	86.7

Table 1: This is the caption for the table.

Tab. 1 is an example table. The table also got a number automatically and will be placed where LaTeX thinks it looks good. You can specify a preference with `h(ere)`, `t(op)`, `b(ottom)`, `p(age)`.

5 Another Section

Figure 1: Insert caption here. Image from [?].

Similarly to tables, we can also create figures. Fig. 1 also got a number.

6 Equations

LaTeX is also really good at printing equations. You can do it inline, such as $E = mc^2$, or centered, like

$$\mathcal{L}_{\mathcal{T}}(\vec{\lambda}) = \sum_{(\mathbf{x}, \mathbf{s}) \in \mathcal{T}} \log P(\mathbf{s} \mid \mathbf{x}) - \sum_{i=1}^m \frac{\lambda_i^2}{2\sigma^2}. \quad (1)$$

Equations are numbered as well, *e.g.*, above we have Eq. 1.