

Scale Invariant Semantic Segmentation with RGB-D Fusion

Master thesis
University of Kaiserslautern

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February 8, 2018

Kurzfassung

<insert your name>

<insert title>

Schlagwörter: <insert key words>

Abstract

Alwi Husada

Scale Invariant Semantic Segmentation with RGB-D Fusion

Key words: <insert key words>

Declaration

I hereby declare that this thesis is my own work and effort and that it has not been submitted anywhere for any award. Where other sources of information have been used, they have been acknowledged.

Kaiserslautern, February 8, 2018

Alwi Husada

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CHAPTER 1

Introduction

This \LaTeX template is designed for the creation of thesis documents (bachelor, master, phd) and targets both beginner and experienced users of \LaTeX . It supports all basic functionality and requirements of a technical document such as the inclusion of graphics, math, tables, references, bibliography and much more. In contrast to a standard \LaTeX document this template not only loads all state of the art packages (`preamble/packages.tex`) to provide the best functions for each task, but also includes a separate document for the style/layout of the document (`preamble/style.tex`). It therefore tries to separate functionality and layout as much as possible. And the best, everything is documented in the code and furthermore in a separate documentation file (`TemplateDocumentation.pdf`)

This document shows in section 3.1 a general tutorial for \LaTeX with links to the documentation for further tasks. You can view the underlying code in file `content/demo/latextutorial.tex` or in this document in section 3.1.11.

The code of the template itself is documented in `TemplateDocumentation.pdf`.

CHAPTER 2

Theory

Duis porta orci. Integer eu arcu at enim tempus facilisis. Pellentesque dignissim orci sed est. Etiam elementum laoreet mi. Donec nunc sapien, dictum in, tristique sed, aliquam vitae, massa. Morbi magna magna, vestibulum tempor, lobortis non, convallis nec, nibh. In sed nibh. Suspendisse adipiscing dictum pede. Suspendisse non augue. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque lacinia, velit sed commodo convallis, diam dolor consequat ligula, a scelerisque quam neque et purus. Praesent vel augue. Sed lectus leo, dignissim eget, vulputate eu, auctor ut, nulla. Vivamus a quam. Nulla tellus. Pellentesque tempor pulvinar nunc.

2.1 Section heading

Fusce vitae quam eu lacus pulvinar vulputate. Suspendisse potenti. Aliquam imperdiet ornare nibh. Cras molestie tortor non erat. Donec dapibus diam sed mauris laoreet volutpat.

$$J_f(a) := \frac{\partial f}{\partial x}(a) := \frac{\partial(f_1, \dots, f_m)}{\partial(x_1, \dots, x_n)}(a) := \left(\frac{\partial f_i(a)}{\partial x_j} \right)_{i=1, \dots, m; j=1, \dots, n} \quad (2.1)$$

2.1.1 Subsection heading

Aliquam dignissim laoreet mi. Duis pulvinar nulla id velit euismod fringilla. In hac habitasse platea dictumst. Vestibulum dolor tellus, gravida a, condimentum nec, laoreet ut, nisi. Aenean lacus purus, tristique in, sagittis sit amet, pellentesque non, neque. Sed egestas nibh vitae velit. Nunc adipiscing. Donec sed lectus. Donec ultrices lacus nec orci. Fusce sit amet nulla. Suspendisse vulputate, mi nec nonummy sodales, ligula massa molestie est, at sagittis nisi est in leo.

Subsubsection heading

Mauris rutrum volutpat massa. Suspendisse potenti. Nam varius. Fusce nec leo. Morbi vestibulum augue ac justo. Vivamus in odio in turpis pharetra blandit. Mauris aliquet ullamcorper libero. Integer quam mi, venenatis ut, tristique ut, tempus at, ipsum. Donec malesuada. In quis tellus et ipsum hendrerit imperdiet. Vivamus sapien ipsum, suscipit sed, gravida a, lacinia laoreet, ipsum. Quisque augue. Nulla justo enim, auctor at, hendrerit nec, porttitor non, urna. Duis tincidunt tincidunt dui. Lorem ipsum dolor sit amet, consectetur adipiscing elit. Suspendisse potenti. Aenean sit amet mauris. In luctus purus nec lorem. Proin orci tortor, tempus sit amet, molestie hendrerit, placerat egestas, tellus.

CHAPTER 3

Experiments

3.1 LaTeX Typesetting By Example

This section demonstrates a basic set of LaTeX formatting commands and shows how they look like in this template. For comparison of the typeset output with the input document refer to the code listing starting on page 11.

The content presented here is based on similar text by Phil Farrell¹ and Harvey Gould². For further reading on the possibilities of this template please refer to the documentation: `TemplateDocumentation.pdf`.

3.1.1 Plain Text

Type your text in free-format; lines can be as long or as short as you wish. You can indent or space out your input text in any way you like to highlight the structure of your manuscript and make it easier to edit. LaTeX fills lines and adjusts spacing between words to produce an aesthetically pleasing result.

Completely blank lines in the input file break your text into paragraphs. Several command exist to change the font for a single character, word, or set of words. Simply enclose the word and within braces of the forming command, *like this*. A font changing command not enclosed in braces, like the change to **bold here, keeps that change in effect until the end of the document or until countermanded by another font switch, like this change back to** the default font.

3.1.2 Font shapes

The default font in the template is Latin Modern (`lmodern`). It includes *italics*, **boldface**, *slanted*, `SMALL CAPS` and `monospaced` fonts as well as the corresponding sans serif variants of the same font family `sans serif`, *italics*, **boldface** and *slanted*. Note that for other fonts not all font shapes may be available.

3.1.3 Quotation and Citations

LaTeX provides the ‘quote’ and ‘quotation’ environments for typesetting quoted material or any other text that should be slightly indented and set off from the normal text.

However, if the text shall not just be indented but rather be a real quotation with a citation of the origin, then the commands ‘enquote’ for inline quotes and ‘blockquote’ for multi line quotes are more appropriate. The first is used to highlight the commands

¹ <https://pangea.stanford.edu/computing/unix/formatting/latexexample.php>

² <http://sip.clarku.edu/tutorials/TeX/>

in this section and the latter in the following text, which is a direct quotation from the documentation of the package *csquotes*:

This command determines the length of the text. If the length exceeds a certain threshold, the text will be typeset in display mode, i. e., as a block quotation. If not, `\blockquote` will behave like `\textquote`. Depending on the threshold type option, the threshold may be based on the number of lines required to typeset the text or on the number of words in the text. (csquotes.pdf)

The standard command for citations is `\cite` which may have a prenote argument for adding a page number or something similar. To show how a citation is typeset we cite here a book about LaTeX [**companion**]. Further commands such as `\parencite` [**companion**] and `\textcite` **companion** allow a different typeset of the citation. The resulting bibliography is printed out on page 25. Refer to the biblatex manual for further details on citation commands and modifications on the printout and the section on biblatex in the template documentation.

3.1.4 References

So far, in this text chapter and section headings, paragraphs (section 3.1.1), font changes (section 3.1.2) and citations (section 3.1.3) were demonstrated and in this section the use of references. Not that here the command `\cref` was used instead of the standard `\ref`.

The following sections show lists, tables and math.

3.1.5 Lists

LaTeX has three types of lists with the environment names *itemize*, *enumerate* and *description*. All lists have a separation between each item, to improve the reading of item texts spanning several lines. This item text can contain multiple paragraphs. These paragraphs are appropriately spaced and indented according to their position in the list.

- The ‘itemize’ sets off list items with *bullets*, like this.
- Of course, lists can be nested, each type up to at least four levels. One type of list can be nested within another type.
 - Nested lists of the same type will change style of numbering or *bullets* as needed.

1. The ‘enumerate’ environment numbers the list elements.

This is a new paragraph in the item text, which is not intended as in the normal text but separated from the previous paragraph.

2. The enumeration scheme changes with each nesting level
 - a) as shown in this nested enumerated list item.

Don’t forget to close off all list environments with the appropriate `\end{...}` command. Indenting `\begin{...}`, `\item`, and `\end{...}` commands in the input document according to their nesting level can help clarify the structure.

3.1.6 Tables

Tables are a little more difficult. One can achieve even the most complex and fancy layout, even spanning over multiple pages, but the code to create these tables is not necessarily the best readable one.

Table 3.1 is a very simple table showing data lined up in columns, where each column width is automatically calculated by LaTeX. Notice that the tabular is centered with `\centering` and printed in a smaller font to achieve a clear distinction to the normal text. The title is created above the tabular with `\captionabove`.

Table 3.1: Numbers of Computers in the department, By Type.

Mac (Apple)	2
Windows XP, 7	60
Linux (Server)	10

Table 3.2 on page 7 demonstrate the creation of a pleasant appearing table, which helps to read the table without attracting too much attention by the use of shaded colors. The caption uses the additional short caption in square brackets [], which is used in the list of tables, see page 27.

Table 3.2: Comparison of the mean-field predictions for the critical temperature of the Ising model with exact results and the best known estimates for different spatial dimensions d and lattice symmetries.

lattice	d	q	T_{mf}/T_c
square	2	4	1.763
triangular	2	6	1.648
diamond	3	4	1.479
simple cubic	3	6	1.330
bcc	3	8	1.260
fcc	3	12	1.225

The design and creating of complex tables is shown in much greater detail in the documentation of this template.

3.1.7 Mathematical Equations

Simple equations, like x^y or $x_n = \sqrt{a+b}$ can be typeset right in the text line by enclosing them in a pair of single dollar sign symbols. Don't forget that if you want a real dollar sign in your text, like \$2000, you have to use the `\$` command.

A more complicated equation should be typeset in *displayed math* mode using `\[... \]`, like this:

$$z \left(1 + \sqrt{\omega_{i+1} + \zeta - \frac{x+1}{\Theta+1}y + 1} \right) = 1$$

The `equation` environment displays your equations, and automatically numbers them consecutively within your document, like this: We can give an equation a label so that we can refer to it later.

$$E = -J \sum_{i=1}^N s_i s_{i+1}, \quad (3.1)$$

Equation (3.1) expresses the energy of a configuration of spins in the Ising model.¹

For more complex formulas it may be necessary to do some fine tuning by adding small amounts of horizontal spacing,

`\, small space` `\! negative space`

as is done in eq. (3.2).

$$\iiint_{\mathfrak{g}} [u \nabla^2 v + (\nabla u, \nabla v)] \, \mathrm{d}^3 V = \oint\!\!\!\oint_{\mathfrak{s}} u \frac{\partial v}{\partial n} \, \mathrm{d}^2 A \quad (3.2)$$

We also can also align several equations

$$\dot{q}_i = \frac{\partial H}{\partial p_i} \quad (3.3)$$

$$\dot{p}_i = -\frac{\partial H}{\partial q_i} \quad (3.4)$$

number them as subequations

$$\dot{q}_i = \frac{\partial H}{\partial p_i} \quad (3.5a)$$

$$\dot{p}_i = -\frac{\partial H}{\partial q_i} \quad (3.5b)$$

or with only a single number

$$\begin{aligned} \dot{q}_i &= \frac{\partial H}{\partial p_i} \\ \dot{p}_i &= -\frac{\partial H}{\partial q_i} \end{aligned} \quad (3.6)$$

Many further possibilities of displaying equations exist.

¹ It is necessary to process (typeset) a file twice to get the counters correct.

Common Greek letters

These commands may be used only in math mode. Only the most common letters are included here.

$$\alpha, \beta, \gamma, \Gamma, \delta, \Delta, \varepsilon, \zeta, \eta, \theta, \Theta, \kappa, \lambda, \Lambda, \mu, \nu, \xi, \Xi, \pi, \Pi, \rho, \sigma, \tau, \phi, \Phi, \chi, \psi, \Psi, \omega, \Omega$$

3.1.8 Literal text

It is desirable to print program code exactly as it is typed in a monospaced font. Use `\begin{lstlisting}` and `\end{lstlisting}` as in the following example:

```
1 double y0 = 10; // example of declaration and assignment statement
2 double v0 = 0;  // initial velocity
3 double t = 0;   // time
4 double dt = 0.01; // time step
5 double y = y0;
```

Two styles are defined in this template: `lstStyleCpp` and `lstStyleLaTeX`.

A complete file can be printed with listings using the command `\lstinputlisting`, see section 3.1.11 for an example.

3.1.9 Figures

Figures with captions are included in the `figure` environment in order to position the graphic inside the text. The size should be given in relation to natural text size. It is recommended to use a percentage value of the `\textwidth`. This size should not exceed 80% of the text width.

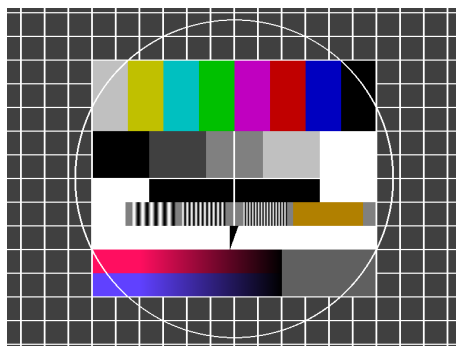


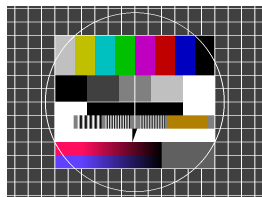
Figure 3.1: Test image for television (Origin of the image: <http://de.wikipedia.org/wiki/Testbild>).

All possibilities of grouping pictures side by side, on top or in matrices can be realized. Each subfigure is created in the same way as a graphic inside a figure, just enclosed by a figure environment, as shown in fig. 3.2.

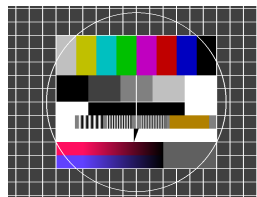
For complex subfigure constructs and correct alignment of the subcaption the `floatrow` provides powerful commands.

3.1.10 Index

An index is easy to create with LaTeX, but should only be done if the time is available to do it right, since it requires substantial work to create an index which is really useful for



(a) The first subfigure.



(b) The second subfigure.

Figure 3.2: Demonstration of the *subfigure* environment inside a figure environment

the reader.

A word is added to the index with the command `\index{word}` and these indexed words can be grouped with `\index{group!word}`. Within this document some index commands are inserted below the section headers of this tutorial for the purpose of demonstrating the indexing. The resulting index is displayed on page [37](#).

3.1.11 Code

```

1 % !TeX encoding=utf8
2 % !TeX program = pdflatex
3 % !TeX spellcheck = en-US
4
5 % LaTeX Tutorial for the latexthesistemplate
6 % based on
7 % - https://pangea.stanford.edu/computing/unix/formatting/latexexample.php
8 % - http://sip.clarku.edu/tutorials/TeX/
9 % and extended and modified by Matthias Pospiech
10
11 \ifcsdef{cs}{\cs}{\newcommand{\cs}[1]{\texttt{\textbackslash#1}\relax}}%
12
13 % Define colors in case they are not available because style.tex was
14 % not loaded
15 % table colors
16 \colorlet{tablebodycolor}{white!100}
17 \colorlet{tablerowcolor}{gray!10}
18 \colorlet{tablesubheadcolor}{gray!30}
19 \colorlet{tableheadcolor}{gray!25}
20
21 \section{LaTeX Typesetting By Example}
22 \label{sec:example:tutorial}
23 This section demonstrates a basic set of LaTeX formatting commands and shows how
24 they look like in this template. For comparison of the typeset output with the
25 input document refer to the code listing starting on page \pageref{sec:example:
26 code}.
27
28 The content presented here is based on similar text by Phil Farrell\footnote{\url
29 {https://pangea.stanford.edu/computing/unix/formatting/latexexample.php}} and
30 Harvey Gould\footnote{\url{http://sip.clarku.edu/tutorials/TeX/}}.
31 For further reading on the possibilities of this template please refer to the
32 documentation: \path{TemplateDocumentation.pdf}.
33
34 % ~~~~~
35 \subsection{Plain Text}
36 \label{sec:example:PlainText}
37 \index{example!text}
38
39 Type your text in free-format; lines can be as long
40 or as short as you wish.
41
42     You can indent           or space out
43     your input
44     text in
45
46     any way you like to highlight the structure
47     of your manuscript and make it easier to edit.
48 LaTeX fills lines and adjusts spacing between words to produce an
49 aesthetically pleasing result.
50

```

```

43 Completely blank lines in the input file break your text into
44 paragraphs.
45 Several command exist to change the font for a single character, word, or set of
46 words. Simply enclose the word and within braces of the forming command,
47 \emph{like this}.
48 A font changing command not enclosed in braces, like the change to \bfseries
49 bold here, keeps that change in effect until the end of the document or
50 until countermanded by another font switch, like this change back to
51 \normalfont the default font.
52 % ~~~~~
53 \subsection{Font shapes}
54 \label{sec:example:FontShapes}
55 \index{example!font shapes}
56
57 The default font in the template is Latin Modern (lmodern). It includes \textit{
58 italics}, \textbf{boldface}, \textsl{slanted}, \textsc{small caps} and \texttt{
59 monospaced} fonts as well as the corresponding sans serif variants of the same
60 font family \textsf{sans serif}, \textsf{\textit{italics}}, \textsf{\textbf{
61 boldface}} and \textsf{\textsl{slanted}}. Note that for other fonts not all font
62 shapes may be available.
63 % ~~~~~
64 \subsection{Quotation and Citations}
65 \label{sec:example:QuoteCite}
66 \index{example!quote}
67 \index{example!cite}
68 %
69 LaTeX provides the \enquote{quote} and \enquote{quotation} environments for
70 typesetting quoted material or any other text that should be slightly indented
71 and set off from the normal text.
72
73 However, if the text shall not just be indented but rather be a real quotation
74 with a citation of the origin, then the commands \enquote{enquote} for inline
75 quotes and \enquote{blockquote} for multi line quotes are more appropriate. The
76 first is used to highlight the commands in this section and the latter in the
77 following text, which is a direct quotation from the documentation of the package
78 \emph{csquotes}:
79 %
80 \blockquote[(csquotes.pdf)]{This command determines the length of the text.
81 If the length exceeds a certain threshold, the text will be
82 typeset in display mode, i. e., as a block quotation.
83 If not, \cs{blockquote} will behave like \cs{textquote}.
84 Depending on the threshold type option, the threshold may be based on the number
85 of lines required to typeset the text or on the number of words in the text.}
86
87 The standard command for citations is \texttt{\textbackslash}cite which may
88 have a prenote argument for adding a page number or something similar. To show
89 how a citation is typeset we cite here a book about LaTeX \cite[59]{companion}.

```

Further commands such as `\cs{parencite}` `\parencite{companion}` and `\cs{textcite}` `\textcite{companion}` allow a different typeset of the citation. The resulting bibliography is printed out on `\cpageref{sec:bibliography}`. Refer to the biblatex manual for further details on citation commands and modifications on the printout and the section on biblatex in the template documentation.

```
79 % ~~~~~
80 %
81 \subsection{References}
82 \label{sec:example:references}
83 \index{example!references}
```

So far, in this text chapter and section headings, paragraphs (`\cref{sec:example:PlainText}`), font changes (`\cref{sec:example:FontShapes}`) and citations (`\cref{sec:example:QuoteCite}`) were demonstrated and in this section the use of references. Not that here the command `\texttt{\textbackslash}cref` was used instead of the standard `\cs{ref}`.

The following sections show lists, tables and math.

```
88 % ~~~~~
89 %
90 \subsection{Lists}
91 \label{sec:example:lists}
92 \index{example!lists}
```

LaTeX has three types of lists with the environment names `\emph{itemize}`, `\emph{enumerate}` and `\emph{description}`. All lists have a separation between each item, to improve the reading of item texts spanning several lines.

This item text can contain multiple paragraphs. These paragraphs are appropriately spaced and indented according to their position in the list.

```
96 \begin{itemize}
97 \item
98 The \enquote{itemize} sets off list items with \emph{bullets}, like this.
```

```
100 %
101 \item Of course, lists can be nested, each type up to at least four levels.
102 One type of list can be nested within another type.
```

```
103 %
104 \begin{itemize}
105 \item Nested lists of the same type will change style of numbering
106 or \emph{bullets} as needed.
107 \end{itemize}
108 \end{itemize}
```

```
109 %
110 \begin{enumerate}
111 \item The \enquote{enumerate} environment numbers the list elements.
```

This is a new paragraph in the item text, which is not intended as in the normal text but separated from the previous paragraph.

```
115 %
```

```

116 \item The enumeration scheme changes with each nesting level
117   \begin{enumerate}
118   \item as shown in this nested enumerated list item.
119   \end{enumerate}
120 \end{enumerate}
121 %
122 Don't forget to close off all list environments with the
123 appropriate \verb+\end{...}+ command.
124 Indenting \verb+\begin{...}+, \verb+\item+, and \verb+\end{...}+
125 commands in the input document according to their nesting level can help
126 clarify the structure.
127
128 % ~~~~~~
129 \subsection{Tables}
130 \label{sec:example:tables}
131 \index{example!tables}
132 %
133 Tables are a little more difficult. One can achieve even the most complex and
134 fancy layout, even spanning over multiple pages, but the code to create these
135 tables is not necessarily the best readable one.
136
137 Table \ref{tab:Computers} is a very simple table showing data lined up in columns
138 , where each column width is automatically calculated by LaTeX.
139 Notice that the tabular is centered with \cs{centering} and printed in a
140 smaller font to achieve a clear distinction to the normal text. The title is
141 created above the tabular with \cs{captionabove}.
142
143 \begin{table}[hb]
144 \centering
145 \small\renewcommand{\arraystretch}{1.4}
146 \captionabove{Numbers of Computers in the department, By Type.}
147 \label{tab:Computers}
148 \begin{tabular}{lr}
149 \hline
150 Mac (Apple)      & 2  \\
151 Windows XP, 7    & 60 \\
152 Linux (Server)  & 10 \\
153 \hline
154 \end{tabular}
155 \end{table}

```

\Cref{tab:IsingModel} on \cpageref{tab:IsingModel} demonstrate the creation of a pleasant appearing table, which helps to read the table without attracting too much attention by the use of shaded colors. The caption uses the additional short caption in square brackets \texttt{[]}, which is used in the list of tables, see \cpageref{sec:lot}.

```

153 \begin{table}[ht]
154 \centering

```

```

156 \small\renewcommand{\arraystretch}{1.4}
157 \rowcolors{1}{tablerowcolor}{tablebodycolor}
158 %
159 \captionabove[Mean-field predictions for the critical temperature of the Ising
model]{Comparison of the mean-field predictions for the critical temperature of
the Ising model with exact results and the best known estimates for different
spatial dimensions  $d$  and lattice symmetries.}
160 \label{tab:IsingModel}
161 %
162 \begin{tabularx}{0.5\textwidth}{lXXX}
163 \hline
164 \rowcolor{tableheadcolor}
165 lattice &  $d$  &  $q$  &  $T_{\text{mf}}/T_c$  \\
166 \hline
167 square & 2 & 4 & 1.763 \\
168 %
169 triangular & 2 & 6 & 1.648 \\
170 %
171 diamond & 3 & 4 & 1.479 \\
172 %
173 simple cubic & 3 & 6 & 1.330 \\
174 %
175 bcc & 3 & 8 & 1.260 \\
176 %
177 fcc & 3 & 12 & 1.225 \\
178 \hline
179 \end{tabularx}
180 \end{table}
181
182 The design and creating of complex tables is shown in much greater detail in the
documentation of this template.
183
184 % ~~~~~
185 \subsection{Mathematical Equations}
186 \label{sec:example:math}
187 \index{example!math}
188
189 Simple equations, like  $x^y$  or  $x_n = \sqrt{a + b}$  can be typeset right
190 in the text line by enclosing them in a pair of single dollar sign symbols.
191 Don't forget that if you want a real dollar sign in your text, like \$2000,
192 you have to use the \verb+\$+ command.
193
194 A more complicated equation should be typeset in \emph{displayed math} mode using
\texttt{\textbackslash[ ... \textbackslash]}, like this:
195 %
196 \[
197 z \left( 1 + \sqrt{\omega_{i+1}} + \zeta - \frac{x+1}{\Theta + 1} y + 1 \right)
198 \quad \text{right}
199 \quad \quad = \quad \quad 1

```

```

200 \]
201 %
202 The \texttt{equation} environment displays your equations, and automatically
203 numbers them consecutively within your document, like this:
204 %
205 We can give an equation a label so that we can refer to it later.
206 \begin{equation}
207   \label{eqn:ising}
208   E = -J \sum_{i=1}^N s_i s_{i+1} ,
209 \end{equation}
210 Equation~\eqref{eqn:ising} expresses the energy of a configuration
211 of spins in the Ising model.\footnote{It is necessary to process (typeset) a
212 file twice to get the counters correct.}
213
214 For more complex formulas it may be necessary to do some fine tuning by adding
215 small amounts of horizontal spacing,
216 \begin{verbatim}
217 \, , small space      \! negative space
218 \end{verbatim}
219 as is done in eq.~\eqref{eqn:GreenTheorem}.
220 \begin{equation}
221   \underset{\mathcal{G}}{\quad} \iiint \!
222   \left[ \mathbf{u} \cdot \nabla^2 \mathbf{v} + \left( \nabla \cdot \mathbf{u}, \nabla \cdot \mathbf{v} \right) \right] \mathrm{d}^3 V
223   = \underset{\mathcal{S}}{\quad} \oiint \mathbf{u} \cdot \nabla \mathbf{v} - \frac{\partial \mathbf{v}}{\partial n}
224   \cdot \mathbf{n} \, \mathrm{d}^2 A
225 \end{equation}
226 \label{eqn:GreenTheorem}
227 \end{equation}
228 We also can also align several equations
229 \begin{align}
230   \dot{q}_i &= \frac{\partial H}{\partial p_i} \\
231   \dot{p}_i &= -\frac{\partial H}{\partial q_i}
232 \end{align}
233 number them as subequations
234 \begin{subequations}
235 \begin{align}
236   \dot{q}_i &= \frac{\partial H}{\partial p_i} \\
237   \dot{p}_i &= -\frac{\partial H}{\partial q_i}
238 \end{align}
239 \end{subequations}
240 or with only a single number
241 \begin{equation}
242 \begin{aligned}
243   \dot{q}_i &= \frac{\partial H}{\partial p_i} \\
244   \dot{p}_i &= -\frac{\partial H}{\partial q_i}
245 \end{aligned}
246 \end{equation}
247 Many further possibilities of displaying equations exist.
248 % ~~~~~

```



```

248 \subsubsection{Common Greek letters}
249 \label{sec:example:math:greekletters}
250 These commands may be used only in math mode. Only the most common
251 letters are included here.
252 %
253 \[\alpha, \beta, \gamma, \Gamma, \delta, \Delta,
254 \epsilon, \zeta, \eta, \theta, \Theta, \kappa,
255 \lambda, \Lambda, \mu, \nu, \xi, \Xi, \pi, \Pi,
256 \rho, \sigma, \tau, \phi, \Phi, \chi, \psi, \Psi,
257 \omega, \Omega\]
258
259 % ~~~~~
260 \subsection{Literal text}
261 \label{sec:example:verbatim}
262 \index{example!verbatim}
263 %
264 It is desirable to print program code exactly as it is typed in a
265 monospaced font. Use \cs{begin\{lstlisting\}} and
266 \cs{end\{lstlisting\}} as in the following example:
267
268 \begin{lstlisting}
269 double y0 = 10; // example of declaration and assignment statement
270 double v0 = 0; // initial velocity
271 double t = 0; // time
272 double dt = 0.01; // time step
273 double y = y0;
274 \end{lstlisting}
275 %
276 Two styles are defined in this template: \texttt{lstStyleCpp} and \texttt{
lstStyleLaTeX}.
277
278 A complete file can be printed with listings using the
279 command \cs{lstinputlisting}, see \cref{sec:example:code} for an example.
280 % ~~~~~
281 \subsection{Figures}
282 \label{sec:example:figures}
283 \index{example!figures}
284 %
285 Figures with captions are included in the \texttt{figure} environment in order to
position the graphic inside the text. The size should be given in relation to
natural text size. It is recommended to use a percentage value of the \cs{
textwidth}. This size should not exceed 80\,\% of the text width.
286
287 \begin{figure}[htb]
288 \centering
289 \includegraphics[width=0.4\textwidth]{images/testimage.png}
290 \caption[Test image for television]{Test image for television (Origin of the
image: \url{http://de.wikipedia.org/wiki/Testbild}).}
291 \label{fig:example:figure}

```

```

292 \end{figure}
293
294 All possibilities of grouping pictures side by side, on top or in matrices can be
    realized. Each subfigure is created in the same way as a graphic inside a figure
    , just enclosed by a figure environment, as shown in \cref{fig:example:subfigures
    }.
295
296 \begin{figure}[htb]
297   \begin{subfigure}[b]{.45\linewidth}
298     \centering
299     \includegraphics[width=0.5\linewidth]{images/testimage.png}
300     \caption{The first subfigure.}
301     \label{fig:example:subfigures:a}
302   \end{subfigure}%
303   \begin{subfigure}[b]{.45\linewidth}
304     \centering
305     \includegraphics[width=0.5\linewidth]{images/testimage.png}
306     \caption{The second subfigure.}
307     \label{fig:example:subfigures:b}
308   \end{subfigure}
309   \caption{Demonstration of the \emph{subfigure} environment inside a figure
    environment}
310   \label{fig:example:subfigures}
311 \end{figure}
312 %
313 For complex subfigure constructs and correct alignment of the subcaption the \
    texttt{floatrow} provides powerful commands.
314
315 % ~~~~~
316 \subsection{Index}
317 \label{sec:example:index}
318 \index{example!index}
319 %
320 An index is easy to create with LaTeX, but should only be done if the time is
    available to do it right, since it requires substantial work to create an index
    which is really useful for the reader.
321
322 A word is added to the index with the command \cs{index\{word\}} and these
    indexed words can be grouped with \cs{index\{group!word\}}. Within this document
    some index commands are inserted below the section headers of this tutorial for
    the purpose of demonstrating the indexing. The resulting index is displayed on
    page~\pageref{sec:Index}.
323 % ~~~~~
324 \clearpage
325 \subsection{Code}
326 \label{sec:example:code}
327
328 \ifcsdef{lstStyleLaTeX}{%
329   \lstinputlisting[style=lstStyleLaTeX,%nolol=true,%

```

```
330     caption={LaTeX Typesetting By Example}, label=lstLaTeXExample]
331     {content/template/latexutorial.tex}
332 }{}
```

Listing 3.1: LaTeX Typesetting By Example

CHAPTER 4

Results

CHAPTER 5

Summery and Outlook

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A First chapter of appendix

A.1 Parameters

Publications

Scientific publications

Submissions to international conferences

Submissions to national conferences

Curriculum Vitae

Delete these notes:

This is a modified version of a german CV. I have not translated it into English, because I am not familiar with English CV styles.

Remember that you do not write this CV to apply for a job. This is just a brief summary of your previous research career. A 'real' CV is much more complex!

Personalien

Name Max Musterman
 geboren am 01.02.1979 in Berlin
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Schulbildung

1998 Abitur, Gymnasium Musterschule in Berlin

Zivildienst

07/98 - 08/99 <Einfügen>

Studium

SS/99 - SS/06 Universität Hannover, Studium der Physik

 Thema der Diplomarbeit: 'Charakterisierung des Rauschverhaltens
 eines weit abstimmbaren Ytterbium dotierten kerngepumpten Faser-
 lasers', durchgeführt am Laserzentrum Hannover e. V.

Mai 2006 Abschluss: Diplom-Physiker

Promotion

09/2006 - heute Wissenschaftlicher Mitarbeiter am Institut für Quantenoptik, Leibniz
 Universität Hannover

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