Descent and Landing Analysis Toolkit - Manual

Users and Developers guide to the Descent and Landing Analysis Toolkit

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BlueBook Descent and Landing Analysis Toolkit - Manual

Preface

I am of the opinion that every LaTeX geek, at least once during his life, feels the need to create his or her own class: this is what happened to me and here is the result, which, however, should be seen as a work still in progress. Actually, this class is not completely original, but it is a blend of all the best ideas that I have found in a number of guides, tutorials, blogs and tex.stackexchange.com posts. In particular, the main ideas come from two sources:

- ▶ Ken Arroyo Ohori's Doctoral Thesis, which served, with the author's permission, as a backbone for the implementation of this class;
- ▶ The Tufte-Latex Class, which was a model for the style.

The first chapter of this book is introductive and covers the most essential features of the class. Next, there is a bunch of chapters devoted to all the commands and environments that you may use in writing a book; in particular, it will be explained how to add notes, figures and tables, and references. The second part deals with the page layout and design, as well as additional features like coloured boxes and theorem environments.

I started writing this class as an experiment, and as such it should be regarded. Since it has always been indended for my personal use, it may not be perfect but I find it quite satisfactory for the use I want to make of it. I share this work in the hope that someone might find here the inspiration for writing his or her own class.

Max Braun

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1.1 The Main Ideas

This document is intended to provide the physical and mathematical background concerning this simulation tool kit. It will provide the necessary information to operate the tool, tailor it to specific use cases, and develop the source code to augment it.

The first chapter will give a brief introduction in the physical and mathematical background required to build a three degree of freedom or a six degree of freedom simulation respectively. Compiling this tool lessons have been learned how to address certain problems, how to implement mathematical models in software in order to keep the code flexible and performant alike. This section will partly be a best picks from the available literature, partly methods defined within and for this particular project

1.2 Background

1.3 What This Toolkit Does

The kaobook class focuses more about the document structure than about the style. Indeed, it is a well-known LaTeX principle that structure and style should be separated as much as possible (see also Section **??** on page ??). This means that this class will only provide commands, environments and in general, the opportunity to do things, which the user may or may not use. Actually, some stylistic matters are embedded in the class, but the user is able to customise them with ease.

The main features are the following:

Page Layout The text width is reduced to improve readability and make space for the margins, where any sort of elements can be displayed.

Chapter Headings As opposed to Tufte-Latex, we provide a variety of chapter headings among which to choose; examples will be seen in later chapters.

Page Headers They span the whole page, margins included, and, in twoside mode, display alternatively the chapter and the section name.[1]

Matters The commands \frontmatter, \mainmatter and \backmatter have been redefined in order to have automatically wide margins in the main matter, and narrow margins in the front and back

[1]: This is another departure from Tufte's design.

2: Sidenotes (like this!) are numbered while marginnotes are not

Figure 1.1: The Mona Lisa. https://commons.wikimedia.org/ wiki/File:Mona_Lisa,_by_Leonardo_ da_Vinci,_from_C2RMF_retouched.jpg

matters. However, the page style can be changed at any moment, even in the middle of the document.

Margin text We provide commands \sidenote and \marginnote to put text in the margins.[2]

Margin figs/tabs A couple of useful environments is marginfigure and margintable, which, not surprisingly, allow you to put figures and tables in the margins (*cfr.* Figure 1.1).

Margin toc Finally, since we have wide margins, why don't add a little table of contents in them? See \margintoc for that.

Hyperref hyperref is loaded and by default we try to add bookmarks in a sensible way; in particular, the bookmarks levels are automatically reset at \appendix and \backmatter. Moreover, we also provide a small package to ease the hyperreferencing of other parts of the text.

Bibliography We want the reader to be able to know what has been cited without having to go to the end of the document every time, so citations go in the margins as well as at the end, as in Tufte-Latex. Unlike that class, however, you are free to customise the citations as you wish.

The order of the title pages, table of contents and preface can be easily changed, as in aly LATEX document. In addition, the class is based on KOMA-Script's scrbook, therefore it inherits all the goodies of that.

COORDINATE FRAMES, EQUATIONS OF MOTIONS AND ENVIRONMENTAL MODELLING
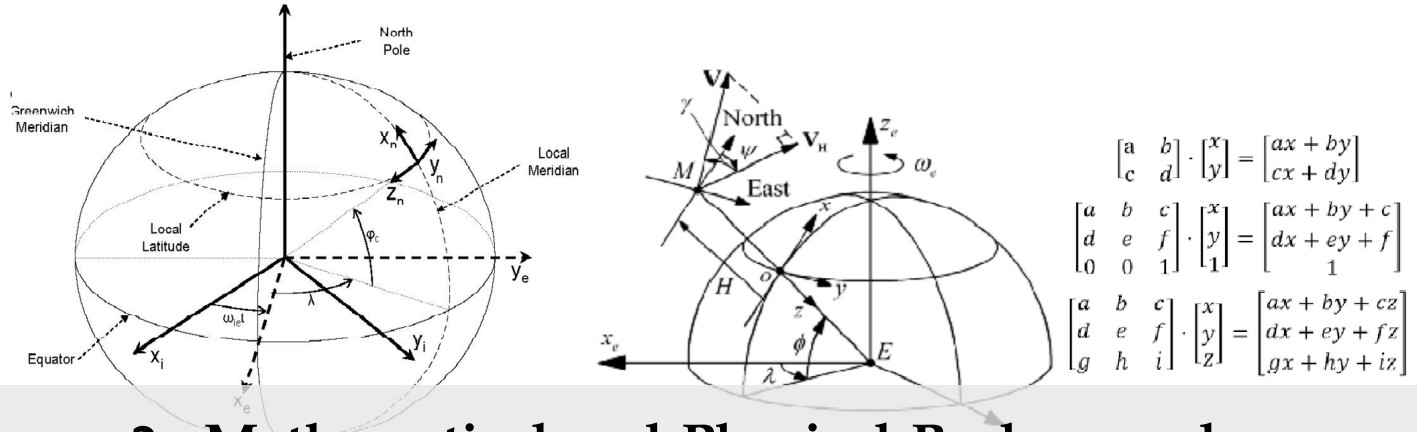
2 Mathematical and Physical Background

In this chapter I will describe the most common options used, both the ones inherited from scrbook and the kao-specific ones. Options passed to the class modifies its default behaviour; beware though that some options may lead to unexpected results...

2.1 Linear Algebra

[Introduction Linear Algebra]

Matrices

[Matrices]

Matrix Operation

[Determinant] [Matrix multiplication]

2.2 Reference Coordinate Frames

Cartesian Coordinates

Spherical Coordinates

Earth Centered Inertial - ECI

The Earth Centered Inertial - short ECI - is usually the frame of choice as inertial reference system. The point of origin is the center of the target body, with the z axis pointing to the north pole an the x axis pointing towards the point of Aries. Hence this coordinate frame is non-rotating.

Figure 2.1: Earth Centered Intertial.

Earth Centered Earth Fixed - ECEF

The Earth Centered Earth Fixed - short ECEF - coordinate frame has its point of origin at the target body's center and is rotating with the rotational period of the target body (e.g. for Earth the rotational period would be 24 hours). The z-axis is pointing towards the north pole and the x-axis towards the Greenwich Meridian (or Zero meridian). That makes ECI and ECEF almost identical systems. The only difference is the rotation around their common z-axis that is causing an angle between the zero meridian and the point of Aries.

The ECEF frame is most commonly used to give the geographic position of the spacecraft with respect to the target body. Furhtermore, it is common to use spherical coordinates for this frame with the following elements:

▶ Longitude
▶ Latitude
▶ Radius or Altitude (with respect to a mean surface radius)
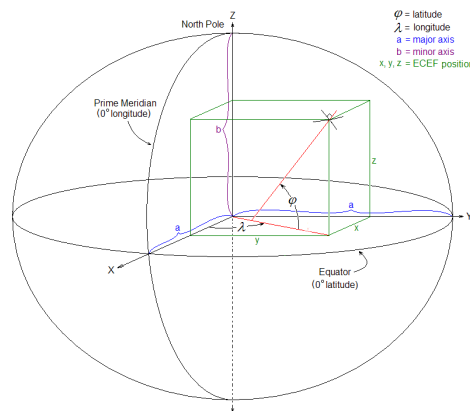
Figure 2.2: Earth Centered Earth Fixed. The spherical Coordinates Longitude λ, Latitude ϕ and Radius show the geographical position of the spacecraft. Less commonly used but also possible is to express the position in spherical coordinates x,y,z.

Reference Body

Note that Earth Centered Inertial as well as Earth Centered Earth Fixed come inherently the strong implication that the reference body is indeed Earth. The basic principle of these coordinate frames however can be applied to any arbitrary planetary body. Since the

abbreviation is quite prominent it is common to use ECI and ECEF even if the reference body is not Earth. In the context of this book ECI does not always necessarily refer to Earth.

North East Down - NED

Aerodynamic Frame - A

Bodyfixed Frame - B

2.3 Coordinate Frame Transformation

Spherical to Cartesian Coordinates

Cartesian to Spherical Coordinates

ECI to ECEF

B to NED

2.4 Equations of Translational Motion

2.5 Equations of Rotational Motion

2.6 External Forces
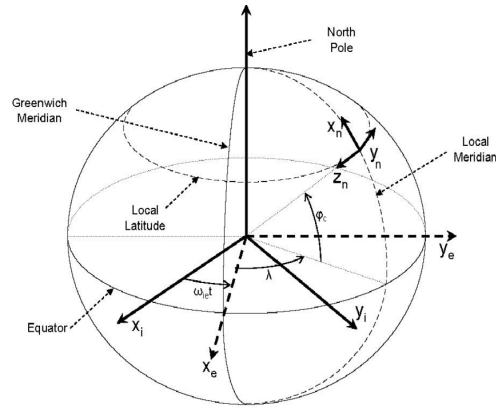
Gravitational Forces

Aerodynamic Forces

3 Figures and Tables

3.1 Normal Figures and Tables

Figures and tables can be inserted just like in any standard LaTeX document. The graphicx package is already loaded and configured in such a way that the figure width is equal to the textwidth and the height is adjusted in order to maintaini the original aspect ratio. As you may have imagined, the captions will be positioned. . . well, in the margins. This is achieved with the help of the floatrow package.

Here is a picture of Mona Lisa (Figure 3.1), as an example. The captions are formatted as the margin- and the side-notes; If you want to change something about captions you can use the command \captsetup from the caption package. Remember that if you want to reference a figure, the label must come *after* the caption!

Figure 3.1: It's Mona Lisa again. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

The credits for the image above the chapter title go to: Bushra Feroz — Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=68724647

While the format of the caption is managed by `caption`, its position is handled by the `floatrow` package. Achieving this result has been quite hard, but now I am pretty satisfied. In two-side mode, the captions are printed in the correct margin.

Tables can be inserted just as easily as figures, as exemplified by the following code:

```
\begin{table}
\begin{tabular}{ c c c c }
    \toprule
    col1 & col2 & col3 & col 4 \\
    \midrule
    \multirow{3}{4em}{Multiple row} & cell2 & cell3 & cell4\\ &
    cell5 & cell6 & cell7 \\ &
    cell8 & cell9 & cell10 \\
    \multirow{3}{4em}{Multiple row} & cell2 & cell3 & cell4 \\ &
    cell5 & cell6 & cell7 \\ &
    cell8 & cell9 & cell10 \\
    \bottomrule
\end{tabular}
\end{table}
```

which results in the useless Table 3.1.

Table 3.1: A useless table.

col1	col2	col3	col 4
Multiple row	cell2	cell3	cell4
	cell5	cell6	cell7
	cell8	cell9	cell10
Multiple row	cell2	cell3	cell4
	cell5	cell6	cell7
	cell8	cell9	cell10

I don't have much else to say, so I will just insert some blind text. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

3.2 Margin Figures and Tables

Marginfigures can be inserted with the environment `marginfigure`. In this case, the whole picture is confined to the margin and the caption is below it. Figure 1.1 is obtained with something like this:

```
\begin{marginfigure}
    \includegraphics{monalisa}
    \caption[The Mona Lisa]{The Mona Lisa.}
    \labfig{marginmonalisa}
```

```
5  \end{marginfigure}
```

There is also the `margintable` environment, of which Table 3.2 is an example. Notice how you can place the caption above the table by just placing the `\caption` command before beginning the `tabular` environment. Usually, figure captions are below, while table captions are above. This rule is also respected for normal figures and tables: the captions are always on the side, but for figure they are aligned to the bottom, while for tables to the top.

Marginfigures and tables can be positioned with an optional offset command, like so:

```
1  \begin{marginfigure}[offset]
2      \includegraphics{images/seaside}
3  \end{marginfigure}
```

Offset ca be either a measure or a multiple of `\baselineskip`, much like with `\sidenote`, `\marginnote` and `\margintoc`. If you are wondering how I inserted this orange bubble, have a look at the `todo` package.

Table 3.2: Another useless table.

col1	col2	col3
Multiple row	cell2	cell3
	cell5	cell6
	cell8	cell9

Improve this part.

3.3 Wide Figures and Tables

Figure 3.2: A wide seaside, and a wide caption. Credits: By Bushra Feroz — Own work, CC BY-SA 4.0, `https://commons.wikimedia.org/w/index.php?curid=68724647`

With the environments `figure*` and `table*` you can insert figures which span the whole page width. The caption will be positioned below or above, according to taste.

You may have noticed the full width image at the very beginning of this chapter: that, however, is set up in an entirely different way, which you'll read about in Chapter **??** on page ??. Now it is time to tackle hyperreferences.

APPENDIX

A

Heading on Level 0 (chapter)

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

A.1 Heading on Level 1 (section)

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Heading on Level 2 (subsection)

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Heading on Level 3 (subsubsection)

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text,

you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Heading on Level 4 (paragraph)   Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

A.2 Lists

Example for list (itemize)

- First item in a list
- Second item in a list
- Third item in a list
- Fourth item in a list
- Fifth item in a list

Example for list (4*itemize)

- First item in a list
  - First item in a list
    - First item in a list
      - First item in a list
      - Second item in a list
    - Second item in a list
  - Second item in a list
- Second item in a list

Example for list (enumerate)

1. First item in a list
2. Second item in a list
3. Third item in a list
4. Fourth item in a list
5. Fifth item in a list

Example for list (4*enumerate)

1. First item in a list
   a) First item in a list
      i. First item in a list
         A. First item in a list
         B. Second item in a list
      ii. Second item in a list
   b) Second item in a list
2. Second item in a list

Example for list (description)

First item in a list
Second item in a list
Third item in a list
Fourth item in a list
Fifth item in a list

Example for list (4*description)

First item in a list
   First item in a list
      First item in a list
         First item in a list
         Second item in a list
      Second item in a list
   Second item in a list
Second item in a list

Greek Letters with Pronounciation

Character	Name	Character	Name
α	alpha *AL-fuh*	ν	nu *NEW*
β	beta *BAY-tuh*	ξ, Ξ	xi *KSIGH*
γ, Γ	gamma *GAM-muh*	o	omicron *OM-uh-CRON*
δ, Δ	delta *DEL-tuh*	π, Π	pi *PIE*
ϵ	epsilon *EP-suh-lon*	ρ	rho *ROW*
ζ	zeta *ZAY-tuh*	σ, Σ	sigma *SIG-muh*
η	eta *AY-tuh*	τ	tau *TOW (as in cow)*
θ, Θ	theta *THAY-tuh*	υ, Υ	upsilon *OOP-suh-LON*
ι	iota *eye-OH-tuh*	ϕ, Φ	phi *FEE, or FI (as in hi)*
κ	kappa *KAP-uh*	χ	chi *KI (as in hi)*
λ, Λ	lambda *LAM-duh*	ψ, Ψ	psi *SIGH, or PSIGH*
μ	mu *MEW*	ω, Ω	omega *oh-MAY-guh*

Capitals shown are the ones that differ from Roman capitals.