



Department of Mechanical Engineering
Dynamics and Control section

Impact-Aware Learning From Teleoperation for Versatile Robotic Manipulation

Master thesis

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Abstract

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Nomenclature

Groups, algebras, and sets

\mathbb{C}	The set of complex numbers
\mathbb{R}	The set of real numbers
\mathbb{R}^+	The set of non-negative real numbers

Roman symbols

t	Global time
x	State variable

Greek symbols

Δt	Time interval of a time-step
δ	Dirac delta function
δ_k	Kronecker delta function

Subscripts and superscripts

$\dot{(\cdot)}$	First time derivative
$\ddot{(\cdot)}$	Second time derivative
$\hat{(\cdot)}$	Estimated or approximate variable
$\bar{(\cdot)}$	Mean or expected value

Chapter 1

Introduction

In logistics, robots are not yet able match humans in versatility and speed when it comes to object manipulation. Consider a conveyor belt with packages to be picked up: while humans inherently have the ability to handle packages of various geometries and inertias, significant engineering effort on a case-to-case basis is required for robots to perform the varying picking tasks – occasionally to the point where the usage of robots becomes infeasible. Furthermore, while a human’s bodily structure and sense of touch allow for careful yet swift grabbing of objects, hardware and software for object manipulation are still lacking on this front. In an impact, i.e., a change in velocity due to collision between two objects, the contact force peaks. This peak is more pronounced for higher velocities. Therefore, to prevent disruption or damage to robots and packages, the control approach in a picking task often involves slowing down prior to making contact.

1.1 Template usage

This template is intended as an initial setup for any user Master thesis and is contained in this single .tex file. However, to function it requires a folder named “graphics”, containing the graphics referenced in this report and a “references.bib” file for your bibliography. While all is contained in this single .tex file, one can choose to separate it into several .tex files, called using “\input{example.tex}”.

1.2 Overleaf integration

File synchronization Synchronization with your local environment, for example to automatically upload locally generated figures to Overleaf, is possible via Dropbox. To this end, click the ”Menu” button in the top-left corner and select “Sync → Dropbox”. Once connected, your overleaf projects are contained in your Dropbox, which can be synchronized locally by installing Dropbox’s app.

Mendeley synchronization If using Mendeley for reference management, your references can be synced automatically with overleaf. To achieve this, click the “New File” button on the left and select “From Mendeley”. After connecting your accounts, you can add a .bib file containing all your references automatically.

1.3 General rules for Master theses

1.3.1 Abbreviations and Acronyms

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Do not use abbreviations in the title or heads unless they are unavoidable.

1.3.2 Chapters

Make sure chapters always start on an uneven page, such that, when printed, all your chapters start on a right page. Empty pages can be added to ensure this condition. Also make sure to end your main chapters with a summary. Always refer to specific chapters, sections, figures and tables with a capital, such as Chapter 1. However, do not use capital when referring to chapters, etc., in general such as in the sentence “In the remaining chapters, ...”.

1.3.3 Units

- Use SI as primary units. English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as 3.5-inch disk drive.
- Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.
- Do not mix complete spellings and abbreviations of units: Wb/m² or webers per square meter, not webers/m². Spell out units when they appear in text: ... a few henries, not ... a few H.
- Use a zero before decimal points: 0.25, not .25. Use cm³, not cc.
- To avoid mistakes, the [siunitx](#)-usepackage might help you, though the declaration is quite verbose. Commonly used units (or variables) might also be declared preemptively.

1.3.4 Equations

Number equations consecutively. Equation numbers, within parentheses, are to position flush right, as in (1.1), using a right tab stop. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in

$$\alpha + \beta = \chi. \tag{1.1}$$

Note that the equation is centered using a center tab stop. Be sure that the symbols in your equation have been defined before or immediately following the equation. Use (1.1), not Eq. (1.1) or equation (1.1), except at the beginning of a sentence: Equation (1.1) is ...

1.3.5 Some Common Mistakes

- When using preceding apostrophes, such as ‘this’, or “double apostrophes”, make sure to use back-ticks (‘) instead of an apostrophe (’).
- TU/e standard English is American English, not British English. Thus, it is suggested to write “color”, instead of “colour”. In any case, make sure to be at least consistent (i.e., avoid having both neighbour and neighbor in the same document)
- In American English, commas, semi-/colons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
- A graph within a graph is an inset, not an insert. The word alternatively is preferred to the word alternately (unless you really mean something that alternates).
- Do not use the word essentially to mean approximately or effectively.
- In your paper title, if the words “that uses” can accurately replace the word “using”, capitalize the u; if not, keep using lower-cased.
- Be aware of the different meanings of the homophones affect and effect, complement and compliment, discreet and discrete, principal and principle.
- Do not confuse imply and infer.
- The prefix non is not a word; it should be joined to the word it modifies, usually without a hyphen.
- There is no period after the et in the Latin abbreviation et al..
- The abbreviation i.e. means that is, and the abbreviation e.g. means for example.
- Always use a comma after a declaration of time or space. For example, use: “In this chapter, ...”, “In 1954, ...”.
- Figures have a title and a description. See Figure 1.1 for reference.
- The word data is plural, not singular.

1.3.6 Figures and tables

1.3.6.1 Positioning

Place figures and tables at the top and bottom of a page. Avoid placing them in the middle of the page. Figure captions should be below the figures; table captions should appear above the tables. Insert figures and tables after they are cited in the text. See Figure 1.1a and also Figure 1.1b for an example of subfigures. See Figure 1.1 for an example of a single figure. See Table 1.1 for a table example. In general, leave the brackets after “`\begin{table}`” empty, or use “b”, “t”, “h”, “p” for forcing its position at bottom, current place in text, top or on a special page, respectively. For additional information, see [this documentation](#).

Table 1.1: Table title.

Text	Text	Text
Text	Text	Text
Text	Text	Text

1.3.6.2 Figure labels

Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity Magnetization, or Magnetization, M, not just M. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write Magnetization (A/m), not just A/m. Do not label axes with a ratio of quantities and units. For example, write Temperature (K), not Temperature/K.

1.3.7 Citations

You can refer in text to other works, see [1]. Do not start a sentence with a citation. It is also possible to include the authors in more verbal citation, as shown by Leine and Wouw [1].

1.4 Sample section

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1.4.1 Sample subsection

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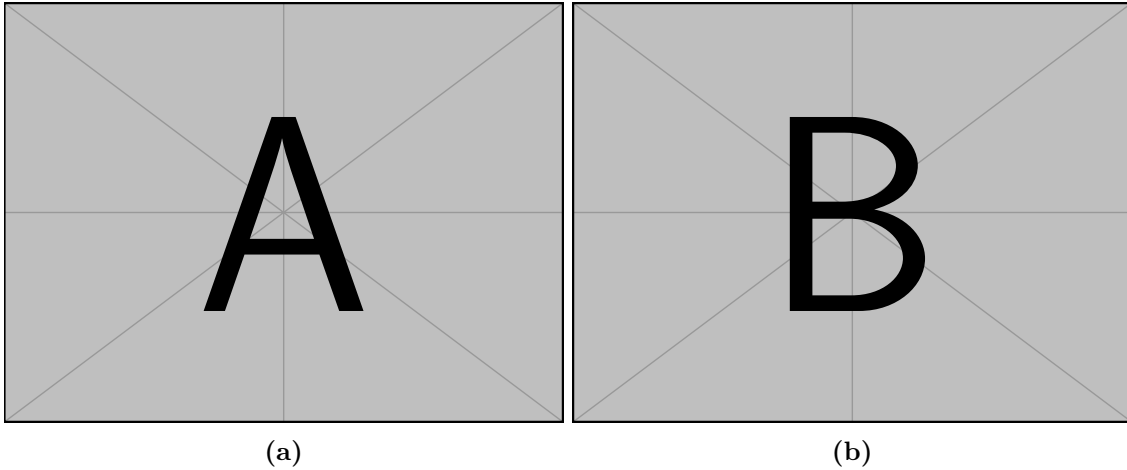


Figure 1.1: Figure title. Caption referring to left figure (a) and caption referring to right figure (b).

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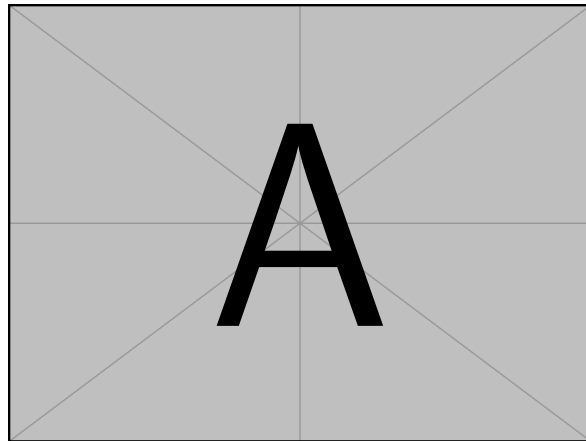


Figure 1.2: Main explanation. Further explanation.

Chapter 2

Name of Chapter 2

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Chapter 3

Conclusion and recommendations

3.1 Conclusion

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3.2 Recommendations

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References

- [1] R. Leine and N. van de Wouw, *Stability and convergence of mechanical systems with unilateral constraints* (Lecture notes in applied and computational mechanics), English. Germany: Springer-Verlag Berlin Heidelberg, 2008.

Appendix A

Appendix A Title

Appendixes should appear after your conclusions and bibliography.

A.1 Section of the first appendix

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Appendix B

Appendix B Title

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B.1 A section Title

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