

University of Southern Queensland  
Faculty of Engineering & Surveying

## **Iterative Optimization of Widget Design**

A thesis submitted by

A. Person

in fulfilment of the requirements of

**Master of Engineering Research/Doctor of Philosophy**

Submitted: November, 2010

# Abstract

This is where the abstract is placed. It should normally be one page only (two pages at the most), comprising several paragraphs. This is a particularly important part of the thesis.

This is the second paragraph of the abstract. It is really only filling in time and space in order to make up a second paragraph. Note that  $\text{\LaTeX}$  ignores extra inter-word spaces, and that a paragraph is delimited by one or more blank lines. Take care with the use of quotes – opening quotes like this “ are a different pair of characters to closing quotes like this ”. Note also the use of single dashes - double dashes – and triple —. Each is comprised of one, two or three “minus” or “dash” signs, with each giving a slightly longer line.

The style file `usqthesis.sty` was adapted by John Leis (email [john.leis@usq.edu.au](mailto:john.leis@usq.edu.au)), Faculty of Engineering & Surveying, University of Southern Queensland, from `utthesis.sty`. The latter was written by Dinesh Das, Dept. of Computer Sciences, The University of Texas at Austin.

# Associated Publications

The following publications were produced during the period of candidature:

Person, A., “An Incremental Approach to Small Widget Optimization”, *International Journal of Widgets*, Vol. 3, No. 6, 2009, pp 34-38.

Person, A. and Bloggs, F., “Experimental Widget Optimization”, *International Conference on Widgets*, SomePlace, May 2009.

# Certification of Dissertation

I certify that the ideas, designs and experimental work, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

A. PERSON

00512345678

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Signature of Candidate

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Date

ENDORSEMENT

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Signature of Supervisor/s

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Date

# Acknowledgments

This thesis was typeset using L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> . Your acknowledgements would be placed here. Try not to be excessively dramatic, but do think hard about the help you have received and do not forget non-technical support from your spouse, friends, etc.

Write your own acknowledgement — do not use any of the above text!

A. PERSON

*University of Southern Queensland*

*November 2010*

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# Notation

$n$	Normalized time or sample index
$s(n)$	Signal sample at time $n$
$e(n)$	Residual error sample at time $n$
$s(n - k)$	Sample at time $n - k$ (delay of $k$ samples)
$N$	Fixed quantity (for example, window length)
$\mathbf{x}$	Column vector
$\mathbf{x}^T$	Transpose of vector
$\mathbf{X}, \boldsymbol{\mu}$	Matrices in math bold font
$a_m$	Filter coefficient $m$
$\langle y(k) \rangle$	Mathematical expectation of $y(k)$
$y'$	Prime indicates updated quantity in algorithms.
$\hat{s}(n)$	Estimated value of signal $s$ at time $n$
$R_n(j)$	Autocorrelation with lag $j$ at time instant $n$
$\mathbb{C}$	Vector codebook (matrix composed of codevectors, one per row)
$\mathcal{R}^n$	$n$ -dimensional real vector space
$z^{-k}$	Delay of $k$ samples
$Z(\cdot)$	$Z$ -Transform operator applied to a sequence

# Acronyms & Abbreviations

ABS	Analysis-by-Synthesis closed-loop speech coder family
CELP	Code Excited Linear Prediction
GLA	Generalized Lloyd Algorithm for VQ training
GMM	Gaussian Mixture Model
GSM	Groupe Speciale Mobile
LBG	Linde-Buzo-Gray VQ training algorithm
LP	Linear Prediction
LPC	Linear Predictive Coding or Linear Predictive Coder
LZW	Lempel-Ziv-Welch lossless compression algorithm
MSVQ	Multi-Stage Vector Quantizer (Quantization)
MTF	Move-to-Front compression algorithm
PPM	Prediction by Partial Matching algorithm
SQ	Scalar Quantization (Quantizer)
SVQ	Split Vector Quantizer (Quantization)
VQ	Vector Quantization (Quantizer)

# Chapter 1

## Introduction

You can use `pdflatex` to process this document, to generate a PDF file directly. If you do this, all graphics included via `includegraphics` must be either JPEG or PDF format.

You must run  $\text{\LaTeX}$  to perform the initial compilation,  $\text{BiBTeX}$  to incorporate the references (in the .bib file), and run  $\text{\LaTeX}$  *twice* more to resolve all the cross-references.

If you don't do this,  $\text{\LaTeX}$  will not be able to resolve all the references, and will leave references and citations as a question mark “?”. That is, it needs to format the document once, and then do another pass to work out that, say, the section labelled “Design” is on page 3 (or whatever). For more information on the formatting of references, see one of the recommended tutorials.

Don't be concerned about the “overfull hbox” warnings  $\text{\TeX}$  issues.

The files you need to edit are:

- usqthesis.tex This file. Rename it too whatever you wish.
- usqthesis.bib The bibliography file. See the “bibliography” command at the end.
- xxxx.tex The files for each Chapter.

Note that your dissertation uses:

1. An 11 point font;

2. One-and-a-half line spacing, and
3. Margins as prescribed in the USQ thesis guidelines.

In addition, the graphics files from whatever mathematical or drawing software packages you use should be in this directory. Use either Encapsulated PostScript (file.eps) if using `latex-dvips`, or PDF/JPEG if using `pdflatex`.

You might wish to include papers as in Appendix A.

Do not confuse figure and table references using `\ref{}` and bibliography citations using `\cite{}`.

When the final PDF document is produced, be sure to check the page size in Acrobat. It should be A4 size – 210mm × 297mm.

## 1.1 Using this Template

This template aims to be consistent with the USQ document “Guidelines for the Preparation of Research Dissertations”, available at <http://www.usq.edu.au/resources/45.pdf>. However, final responsibility for the finished document rests with the candidate. If in doubt, consult your supervisor.

Students should also consult the Office of Research website <http://www.usq.edu.au/research/>.

Policies and guidelines for preparation and examination are available at <http://www.usq.edu.au/research/students/candidature/default.htm>

Notes on the preparation of undergraduate dissertations may also be useful; these are available at <http://www.usq.edu.au/users/leis/notes/latex/bengdis.html>

For further advice on L<sup>A</sup>T<sub>E</sub>X in general, see <http://www.usq.edu.au/users/leis/notes/latex/>

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## 1.2 A Word on Citing

Some examples of how you can correctly use citations (referencing a work in the bibliography or list of references) are given in the following paragraph.

Much research has been carried out into computationally efficient basket weaving algorithms (Wikipedia 2010, Frigo & Johnson n.d.). It has been proven that the sky is blue (IEEE 754 Group 2004). Rosenfeld & Kak (1982) described an experiment to measure the temperature of the sun<sup>1</sup>.

Entering URLs and email addresses is a bit tricky, as  $\text{\LaTeX}$  may misinterpret the special characters used. For this reason, you have to use the `\url` environment as shown in the bibliography, e.g. `\url{http://www.usq.edu.au/users/leis/}`, which when run through  $\text{\LaTeX}$  comes out like this: `http://www.usq.edu.au/users/leis/`. Note that the latter is hyperlinked in the PDF version, and you can click on it to follow the link.

For citing Wikipedia, see `http://en.wikipedia.org/wiki/Citing_Wikipedia`

Do not confuse figure and table references using `\ref{}` and bibliography citations using `\cite{}`.

If you want to cite a particular page in a reference, use a construct something like `\cite[page]{bibkey}`, where “page” is the page you want to reference, and “bibkey” is the key used in the “.bib” file for that particular reference. When formatted, it will come out something like this (Hsu 1993, 34).

If you need to cite a source as part of a figure or table caption, use the `protect` command as shown in Section 2.1 on page 7. This is typeset in the source as (for example), `“(adapted from~\protect\cite{aref})”`.

Finally, make sure you use an unbreakable space `~` before citations and references, for example `blah blah~\cite{thing}` or `blah blah~\ref{whatever}`. This stops a line-wrap at the end of the line, after the word “Figure” but before the actual figure number, and enhances the readability of the text.

---

<sup>1</sup>He got sunburnt doing this.

### 1.2.1 A Subsection

This is a sub-section. Try not to use too many small sub-sections, as they can become rather tedious to the reader. Note that L<sup>A</sup>T<sub>E</sub>X has automatically reduced the font size for the subsection headings as compared to the section headings.

This is a reference to Figure B.1 in Appendix B.

## 1.3 Overview of the Dissertation

This dissertation is organized as follows:

**Chapter 2** describes the basic problem etc etc

**Chapter 3** discusses the development of the widget and numerical simulations. Note that the “description” environment used here automatically wraps and formats the paragraph as you see here.

**Chapter x** something about all the other chapters.

**Chapter 8** concludes the dissertation and suggests further work in the area of ‘z’.

# Chapter 2

## Design of the Widget

### 2.1 Chapter Overview

Insert a section which describes what this chapter is about.

Don't worry about excessive whitespace – as more text is added, it will fill out the document and L<sup>A</sup>T<sub>E</sub>X will “float” the figures and tables accordingly to fill the available page space.

And here is some mathematics:

$$x(t) = A \sin \omega t \tag{2.1}$$

The label is Equation 2.1. If you want aligned equations, do this:

$$\begin{aligned} x(t) &= A \sin \omega t \\ \frac{dx(t)}{dt} &= A \omega \cos \omega t \end{aligned} \tag{2.2}$$

The rotation matrix is defined as

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} \tag{2.3}$$

Table 2.1: Summary of some information. Note that captions for tables are *above* the table itself, in a smaller font and have a slightly smaller width than the normal text.

Something	8000
size	160 samples
rate	50 frames
more things	1,2,3
Total	\$2500
Total Rate	$1 \times 2 \neq 4$

where  $\theta$  is the angle of rotation. Equation 2.3 may be used to determine the new co-ordinates  $(x', y')$ .

A table of useful results is shown in Table 2.1. Figure 2.1 shows an interesting plot. It is actually on Page 7. The utility `epstopdf` may be used to convert EPS into PDF format graphics.

## 2.2 Figure and Table Placement

Tables and figures are called “floats” in  $\text{\LaTeX}$ . They are termed floats because  $\text{\LaTeX}$  uses an algorithm to move or “float” them around to find the optimal placement. This is confusing at first. The rules guarantee that if a float is referenced in the text, then the float itself appears on or after the page on which the reference occurs. The objective of the placement algorithm is to minimize the amount of whitespace appearing on all pages. This can be adjusted using judicious placement of the `\clearpage` command and/or using the “here” placement specifier in the figure environment. Just use `\begin{figure}[h]` – ‘h’ meaning “here if possible please”. Note that this should be done only *after* the text has been completed, as it is likely the default placement method will be appropriate in most cases.

If *exact* placement is required, the `float` package may be used by adding the line `\usepackage{float}` to the document preamble, and specifying the [H] option to the figure placement environment. This is interpreted as “absolutely here”.

Peaks

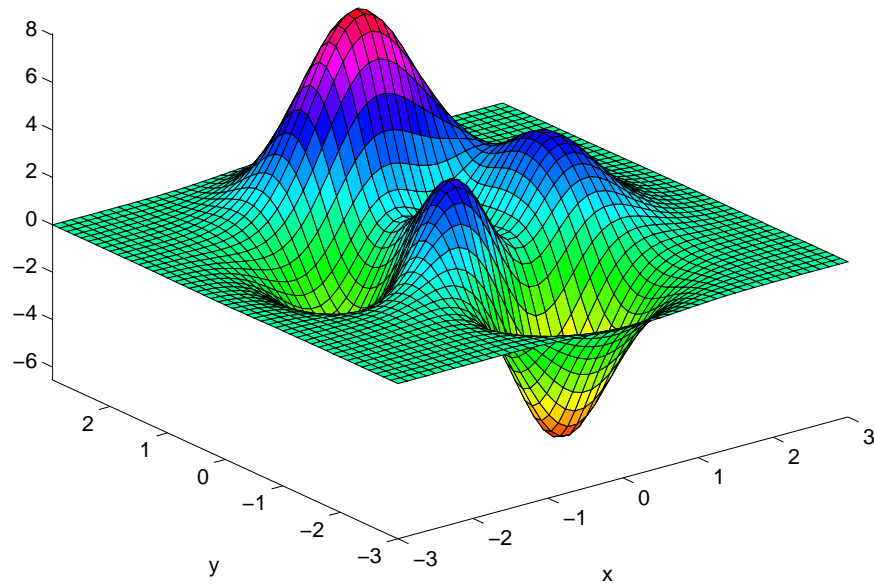


Figure 2.1: A figure which shows something. Note that captions for figures are *below* the figure itself, in a smaller font and have a slightly smaller width than the normal text. The text in the figure should be no smaller than shown here. If the figure comes from elsewhere, you should cite it correctly, for example (not really adapted from (Wikipedia 2010)).

Note also that the `\label` must come *after* the `\caption` (or section or equation, or whatever the label is to refer to).

**2.3 Chapter Summary**

A summary at the end of each chapter is useful to the reader. The `\clearpage` command above makes it start on a new page by itself, if desired.

## Chapter 3

# Conclusions and Further Work

This will always be the last chapter. The  $\text{\LaTeX}$  automatic numbering system will number all chapters and appendices for you.

### 3.1 Conclusions

The following objectives have been addressed:

**Overview of Widget Design Methods** Chapter 2 presented a summary of recent approaches to widget design.

**Comparison of Computational Efficiency** This aspect was addressed by doing some simulations.

### 3.2 Further Work

There is far too much to be done.

# References

Frigo, M. & Johnson, S. G. (n.d.), 'FFTW – Fastest Fourier Transform in the West',  
<http://www.fftw.org>.

Hsu, H. P. (1993), *Analog and Digital Communications*, Schaum's Outline Series,  
McGraw-Hill.

IEEE 754 Group (2004), 'IEEE 754: Standard for Binary Floating-Point Arithmetic',  
<http://grouper.ieee.org/groups/754/>.

Rosenfeld, A. & Kak, A. C. (1982), Reconstruction, *in* 'Digital Picture Processing', 2nd  
edn, Academic Press.

Wikipedia (2010), 'Gamma Functions — Wikipedia, the free encyclopedia', [http://  
en.wikipedia.org/wiki/Gamma\\_function](http://en.wikipedia.org/wiki/Gamma_function). [Online; accessed July-2010].

# Bibliography

Hsu, H. P. (1993), *Analog and Digital Communications*, Schaum's Outline Series, McGraw-Hill.

Rosenfeld, A. & Kak, A. C. (1982), Reconstruction, *in* 'Digital Picture Processing', 2nd edn, Academic Press.

## Appendix A

# Papers Published in Connection with this Research

You may wish to include any papers published during your candidature here.

Use the *pdfpages* package if necessary.

## Appendix B

# Some Supporting Information

This is a second appendix. It may contain, for example, some raw data, circuit schematics, mechanical drawings or software listings. Note how the `\clearpage` command was used to start on a new page.

## B.1 Introduction to this Appendix

This is often helpful, especially when the information following is not text.

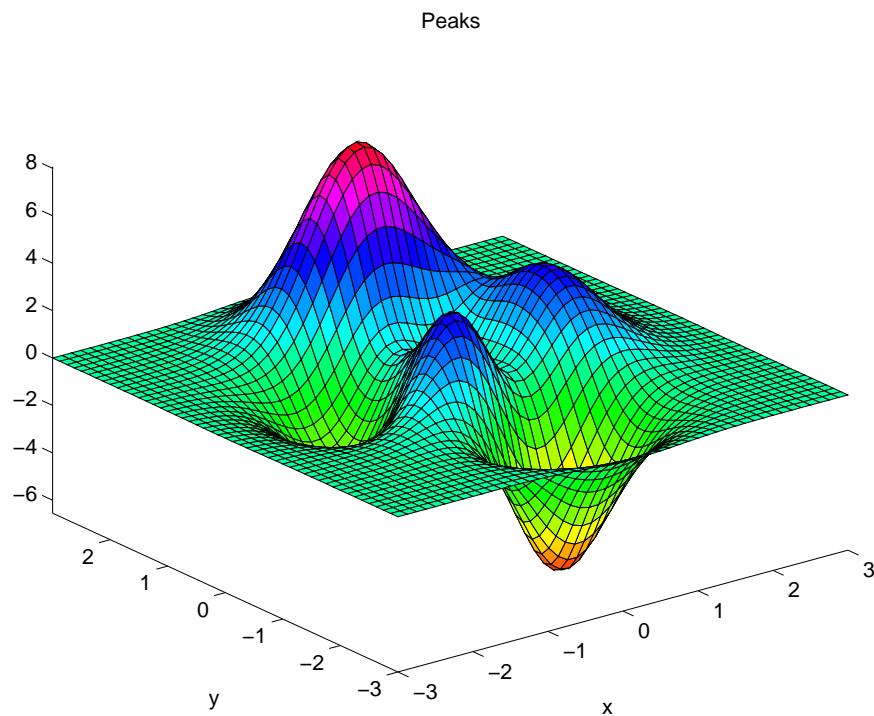


Figure B.1: This is a figure.

## B.2 Another Section in this Appendix

Another appendix sub-section might be used when there are several software listings in the same appendix.