MANCHESTER 1824
The University of Manchester

A data reduction algorithm incorporating a low power continuous wavelet transform for use in wearable electroencephalography systems

A thesis submitted to the University of Manchester for the degree of
Doctor of Philosophy
in the Faculty of Science and Engineering

2024

Alexander J. Casson
School of Engineering
Department of Electrical and Electronic Engineering

Contents

Word count: 1576

List of figures

List of tables

List of publications

Publications go here.

Abstract

Abstract goes here

Declaration of originality

I hereby confirm that no portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

Copyright statement

i. The author of this thesis (including any appendices and/or schedules to this thesis) owns certain copyright or related rights in it (the "Copyright") and s/he has given The University of Manchester certain rights to use such Copyright, including for administrative purposes.

ii. Copies of this thesis, either in full or in extracts and whether in hard or electronic copy, may be made *only* in accordance with the Copyright, Designs and Patents Act 1988 (as amended) and regulations issued under it or, where appropriate, in accordance with licensing agreements which the University has from time to time. This page must form part of any such copies made.

iii. The ownership of certain Copyright, patents, designs, trademarks and other intellectual property (the "Intellectual Property") and any reproductions of copyright works in the thesis, for example graphs and tables ("Reproductions"), which may be described in this thesis, may not be owned by the author and may be owned by third parties. Such Intellectual Property and Reproductions cannot and must not be made available for use without the prior written permission of the owner(s) of the relevant Intellectual Property and/or Reproductions.

iv. Further information on the conditions under which disclosure, publication and commercialisation of this thesis, the Copyright and any Intellectual Property and/or Reproductions described in it may take place is available in the University IP Policy (see http://documents.manchester.ac.uk/DocuInfo.aspx?DocID=24420), in any relevant Thesis restriction declarations deposited in the University Library, The University Library's regulations (see http://www.library.manchester.ac.uk/about/regulations/) and in The University's policy on Presentation of Theses.

Acknowledgements

Acknowledgements go here.

Chapter 1

Introduction

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim aeque doleamus animo, cum corpore dolemus, fieri tamen permagna accessio potest, si aliquod aeternum et infinitum impendere malum nobis opinemur. Quod idem licet transferre in voluptatem, ut postea variari voluptas distinguique possit, augeri amplificarique non possit. At.

Chapter 2

Literature review

2.1 Introduction

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim aeque doleamus animo, cum corpore dolemus, fieri tamen permagna accessio potest, si aliquod aeternum et infinitum impendere malum nobis opinemur. Quod idem licet transferre in voluptatem, ut postea variari voluptas distinguique possit, augeri amplificarique non possit. At.

2.2 Example display items

This is an example of providing a cross-reference to Chapter 3. Similarly, this is an example cross-reference to a sub-section, Section 3.2.

This is an example of adding references [1], [2], [3]. If you want the author name, or similar, you can use: A. J. Casson, E. Luna, and E. Rodriguez-Villegas in 2009 introduced a really good idea. (This is for when you primarily use numbered citations, but occasionally need an author's name. If using author names as the reference everywhere, change style=ieee in the biblatex setup above to whatever reference style you want, and then just use the cite command.)

For adding *emphasis* use the emph command or underscores such as *emphasis*.

An example table is given in Table 2.1. Note that the headings are inside a table.header environment to tell screen readers which cells are headers and which cells have the table content. Also, at the moment the template only adds the top horizontal line to the table. The others are added by hand in the table definition below. Ideally the template should detect the end of the

header, and the end of the table, and add these horizontal lines automatically, but this doesn't work yet.

Table 2.1. Probe results for design A.

Participant	Number (%)		Duration (%)	
	Prime dresses	Non-prime dresses	Prime dresses	Non-prime dresses
1	33.33	33.91	20.83	18.42
2	13.04	17.50	04.93	07.62
3	22.73	20.10	13.00	08.20
4	31.34	21.88	10.57	11.09
5	08.47	19.32	03.04	09.73
Mean	16.4	16.5	07.8	07.5
Standard deviation	09.7	06.6	05.4	03.3

This is an example equation in text $2 \sin \omega t$. (2.1) is an example of a displayed equation.

$$a^2 + b^2 = c^2 \tag{2.1}$$

Note that numbers are displayed differently in the text depending on how they are entered. Compare for example 123456 vs. 123456. Entering numbers directly, such as 1955, should be used for *text mode* numbers. That is, those representing text (dates, page numbers, and similar). Numbers representing maths, or variables or similar, should be entered inside $ $ so they are typeset in the same way as they appear in an equation. (This requires a bit of discipline, but helps ensure consistent use of number styles throughout.)

This is an example of a quote in text "*The electroencephalogram (EEG) is a classic non-invasive method for measuring a person's brainwaves*" [3]. Below is an example of a displayed quote.

"*Electrodes are placed on the scalp to detect the microvolt-sized signals that result from synchronized neuronal activity within the brain.*" [3]

Fig. 2.1 is an example figure. Sub-figures are not currently supported by the temp;ate. There is an example commented out below which uses the subpar package, however the way subpar re-labels the captions is incompatible with how they've been re-labelled already in the template. The commented out example gets relatively close to being correct, but isn't perfect. This will need to be re-visited in a future release.

Fig. 2.1. Example figure. Full caption goes here. Often a short caption in [] is used as well as the main caption to keep the list of figures tidy; it gets messy if there are long captions going over more than one line.

An example code listing is given below. Code in the body of the text can be included as `for` or `while` or `main`. This is just using the built in Typst functionality which is fairly limited. Could look at https://typst.app/universe/package/codly/ or similar to give more functionality such as line numbers, ability to link to a piece of code, and similar.

```
import numpy as np

def my_filter(in,f_obj):
    y = filter(f_obj,in)

    return y
```

2.3 Summary

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim aeque doleamus animo, cum corpore dolemus, fieri tamen permagna accessio potest, si aliquod aeternum et infinitum impendere malum nobis opinemur. Quod idem licet transferre in voluptatem, ut postea variari voluptas distinguique possit, augeri amplificarique non possit. At.

Chapter 3

Really good work

3.1 Introduction

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim aeque doleamus animo, cum corpore dolemus, fieri tamen permagna accessio potest, si aliquod aeternum et infinitum impendere malum nobis opinemur. Quod idem licet transferre in voluptatem, ut postea variari voluptas distinguique possit, augeri amplificarique non possit. At.

3.2 Content

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim aeque doleamus animo, cum corpore dolemus, fieri tamen permagna accessio potest, si aliquod aeternum et infinitum impendere malum nobis opinemur. Quod idem licet transferre in voluptatem, ut postea variari voluptas distinguique possit, augeri amplificarique non possit. At.

3.2.1 Introduction

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim aeque doleamus animo, cum corpore dolemus, fieri tamen permagna accessio potest, si aliquod aeternum et infinitum impendere malum nobis opinemur. Quod idem licet transferre in voluptatem, ut postea variari voluptas distinguique possit, augeri amplificarique non possit. At.

3.2.2 Detail

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim aeque doleamus animo, cum corpore dolemus, fieri tamen permagna accessio potest, si aliquod aeternum et infinitum impendere malum nobis opinemur. Quod idem licet transferre in voluptatem, ut postea variari voluptas distinguique possit, augeri amplificarique non possit. At.

3.2.3 More detail

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim aeque doleamus animo, cum corpore dolemus, fieri tamen permagna accessio potest, si aliquod aeternum et infinitum impendere malum nobis opinemur. Quod idem licet transferre in voluptatem, ut postea variari voluptas distinguique possit, augeri amplificarique non possit. At.

3.2.4 Summary

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim aeque doleamus animo, cum corpore dolemus, fieri tamen permagna accessio potest, si aliquod aeternum et infinitum impendere malum nobis opinemur. Quod idem licet transferre in voluptatem, ut postea variari voluptas distinguique possit, augeri amplificarique non possit. At.

3.3 Summary

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim aeque doleamus animo, cum corpore dolemus, fieri tamen permagna accessio potest, si aliquod aeternum et infinitum impendere malum nobis opinemur. Quod idem licet transferre in voluptatem, ut postea variari voluptas distinguique possit, augeri amplificarique non possit. At.

Chapter 4

Conclusions

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magnam aliquam quaerat voluptatem. Ut enim aeque doleamus animo, cum corpore dolemus, fieri tamen permagna accessio potest, si aliquod aeternum et infinitum impendere malum nobis opinemur. Quod idem licet transferre in voluptatem, ut postea variari voluptas distinguique possit, augeri amplificarique non possit. At.

References

[1] A. J. Casson, E. Luna, and E. Rodriguez-Villegas, "Performance metrics for the accurate characterisation of interictal spike detection algorithms," *J. Neurosci. Meth.*, vol. 177, no. 2, pp. 479–487, 2009.

[2] A. J. Casson and E. Rodriguez-Villegas, "Toward online data reduction for portable electroencephalography systems in epilepsy," *IEEE T. Biomed. Eng.*, vol. 56, no. 12, pp. 2816–2825, 2009.

[3] A. J. Casson, D. C. Yates, S. J. Smith, J. S. Duncan, and E. Rodriguez-Villegas, "Wearable electroencephalography," *IEEE Eng. Biol. Med. Mag.*, vol. 29, no. 3, pp. 44–56, 2010.

Appendices

Appendix A

First Appendix

A.1 Section in Appendix

Fig. A.1. Example figure in Appendix.

Appendix B

Second Appendix

B.1 Section in Appendix