Marta Pereira Neves

TÍTULO DA TESE (MÁXIMO 130 CARACTERES)

THESIS TITLE (MAX 130 CHARACTERS)

DOCUMENTO PROVISÓRIO

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Licenciatura em Engenharia Biomédica, realizada sob a orientação científica da Doutora Susana Brás, Professora Associada do Departamento de Eletrónica, Telecomunicações e Informática da Universidade de Aveiro.

o júri / the jury

presidente / president   Prof. Doutor João Antunes da Silva
                                  professor associado da Universidade de Aveiro

vogais / examiners committee   Prof. Doutor João Antunes da Silva
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**agradecimentos /
acknowledgements**

Agradeço toda a ajuda a todos os meus colegas e companheiros.

palavras-chave   texto livro, arquitetura, história, construção, materiais de construção, saber tradicional.

resumo   Um resumo é um pequeno apanhado de um trabalho mais longo (como uma tese, dissertação ou trabalho de pesquisa). O resumo relata de forma concisa os objetivos e resultados da sua pesquisa, para que os leitores saibam exatamente o que se aborda no seu documento.

Embora a estrutura possa variar um pouco dependendo da sua área de estudo, o seu resumo deve descrever o propósito do seu trabalho, os métodos que você usou e as conclusões a que chegou.

Uma maneira comum de estruturar um resumo é usar a estrutura IMRaD. Isso significa:

- Introdução

- Métodos

- Resultados

- Discussão

Veja mais pormenores aqui:
`https://www.scribbr.com/dissertation/abstract/`

keywords   textbook, architecture, history, construction, construction materials, traditional knowledge.

abstract   An abstract is a short summary of a longer work (such as a thesis, dissertation or research paper).

The abstract concisely reports the aims and outcomes of your research, so that readers know exactly what your paper is about.

Although the structure may vary slightly depending on your discipline, your abstract should describe the purpose of your work, the methods you've used, and the conclusions you've drawn.

One common way to structure your abstract is to use the IMRaD structure. This stands for:

- Introduction

- Methods

- Results

- Discussion

Check for more details here:
`https://www.scribbr.com/dissertation/abstract/`

acknowledgement of use of AI tools

Recognition of the use of generative Artificial Intelligence technologies and tools, software and other support tools.

I acknowledge the use of [insert AI system(s) and link] to [specific use of generative artificial intelligence or other tasks]. I acknowledge the use of [software, codes or platforms] to [specific use software, codes or platforms or to other tasks].

Example 1: I acknowledge the use of ChatGPT 3.5 (Open AI, https://chat.openai.com) to summarise the initial notes and to proofread the final draft and the use of Office365 (Microsoft, https://www.office.com) for text writing and productivity.

Example 2: No content generated by AI technologies has been used in this Thesis.

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Glossário

ECG	Electrocardiogram		**CPT**	Cold Pressor Test
			NPS	Numerical Pain Scale

CHAPTER 1

Introduction

A short description of the chapter.
A memorable quote can also be used.

1.1 Acrónimos

Primeira e seguintes referências: Electrocardiogram (ECG), Cold Pressor Test (CPT), Numerical Pain Scale (NPS)

Plural, acrónimo expandido e curto: **h2o!**s (**h2o!**s), **h2o!**, **h2o!**

Com citação[1]: **adsl!** (**adsl!**), **adsl!**

1.2 Fontes

- Tiny
- Scriptsize
- Footnotes
- Small
- Normal
- large
- Large
- LARGE
- huge
- Huge

1.3 Unidades

Utilizando o pacote `siunitx` é possível utilizar unidades do Sistema Internacional. Exemplo: a aceleração da gravidade é de $9.8\,\mathrm{m\,s^{-2}}$ e um ficheiro ocupa $1\,\mathrm{MiB}$.

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[1] Necessária entrada na bibliografia

1.4 Code Blocks

Uma listagem pode ser apresentada com o ambiente `listing`, que é um float (objeto flutuante, tal como uma figura ou uma tabela).
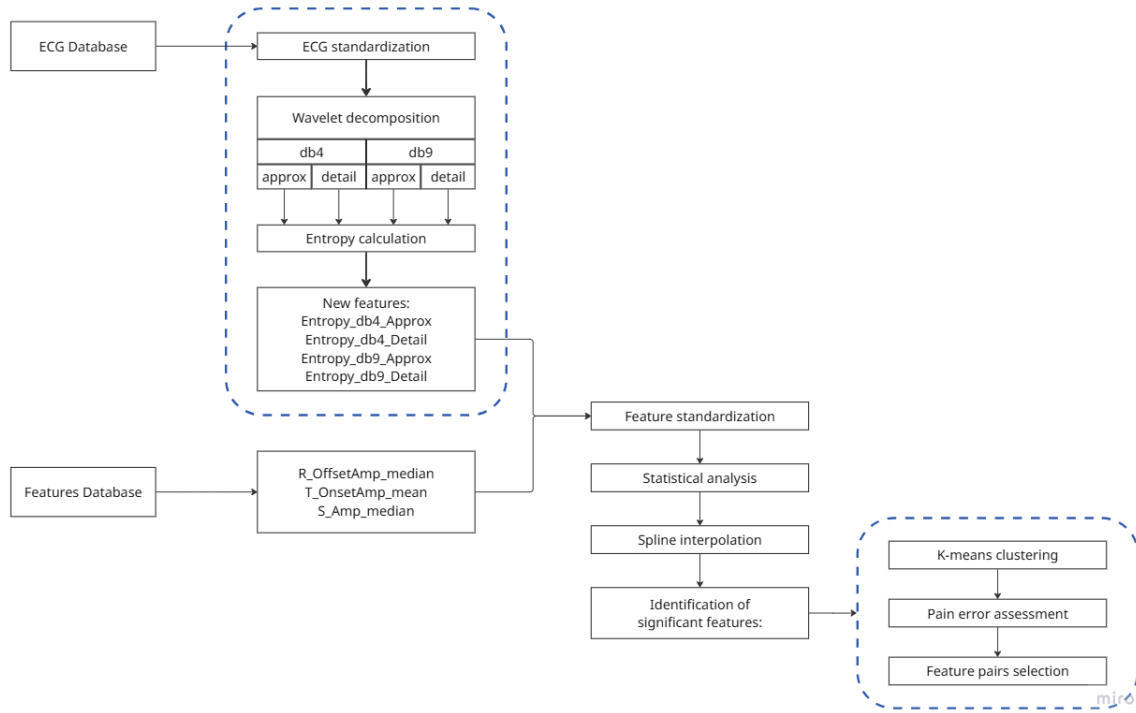
A listagem em Código **??** mostra um exemplo em C.

1.5 Citações

Algumas formas distintas de citar:

- **Apenas referência**: **rfc44**
- **Apenas data**: **rfc44**
- **Apenas ano**: **rfc44**
- **Apenas autor**: **rfc44**
- **Apenas editor:rfc44**
- **Autor e referência:rfc44**

Methods and Results

In figure 2.1, the processing pipeline for this project is shown.

Figure 2.1: Processing pipeline.

2.1 DATABASE ACQUISITION

In this project, two databases were used: one has data from an ECG signal while the other contains features extracted from that ECG, as described in the article by Bruna et al [1].

The protocol that was carried out to create the databases began with a 5-minute baseline period, during which only physiological signals were collected while participants sat in a

relaxed position without any stimuli. Next, participants viewed a 10-minute video composed of segments from comedy, horror or documentary films to elicit positive, negative or neutral emotional states, respectively. After the video, another 5-minute stimuli-free period was conducted. Following this, participants immersed their non-dominant hand in a tank of cold water (7 ± 1°C), inducing pain through a Cold Pressor Test(CPT), and reported their pain using the NPS at four key points: before immersing their hand, when pain was first felt (Pain Threshold), when the pain became unbearable (Pain Tolerance) and 3 minutes after removing their hand from the water. The CPT section ended when the limit of pain tolerance was reached, or after 2 minutes if the participant didn't reach theirs before that. Finally, the 5-minute period with no stimuli was repeated, being characterized as a rest period. This process is depicted in figure.

During the study, three physiological signals were recorded, more precisely, ECG, EDA and EMG from trapezius and triceps muscles. The ECG was recorded in a database, that was later used in this project. Following up in the article, heart rate (HR), the amplitude of wave peaks, the amplitude of onsets and offsets of the waves (???), the distance between consecutive onsets and offsets and the distance between consecutive peaks were extracted in the form of time series, using 10-second windows with 50% overlap. Then, for all of these, statistical metrics, like the mean, median and variance, were computed for each window, resulting in 237 features that were later processed. These are all included in the features database, also used in this project.

2.2 FEATURE EXTRACTION

In the aforementioned article, the features of the ECG that can be used to best describe pain are defined. Hence, the top four features were selected for analysis, namely, the median of the R wave offset amplitude, the median of the T wave onset amplitude, and the mean and median of the S wave peak amplitude.

2.3 DATA ANALYSIS

To do the optimal processing of the features, five participants were selected at random, while ensuring the videos watched by them were different. Once this was done, graphics of the features in function of time were plotted for each participant. An example can be seen in figure 3, in which a clear change can be seen when the participant dips their hand in water, feeling pain.

References

[1] B. Alves, S. Brás, and R. Sebastião, "Decoding pain: Prediction under different emotional contexts through physiological signals", *International Journal of Data Science and Analytics*, Oct. 2024, ISSN: 2364-415X. DOI: 10.1007/s41060-024-00649-z.

Additional content