Rui Filipe Cantarino Valente de Almeida

Master of Science

A Very Long and Impressive Thesis Title With a Line Break

Thesis plan submitted in partial fulfillment
of the requirements for the degree of

Doctor of Philosophy in
Biomedical Engineering

Adviser: Pedro Vieira, Auxiliar Professor,
NOVA University of Lisbon

FACULDADE DE
CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

August, 2019

Abstract

The dissertation must contain two versions of the abstract, one in the same language as the main text, another in a different language. The package assumes that the two languages under consideration are always Portuguese and English.

The package will sort the abstracts in the appropriate order. This means that the first abstract will be in the same language as the main text, followed by the abstract in the other language, and then followed by the main text. For example, if the dissertation is written in Portuguese, first will come the summary in Portuguese and then in English, followed by the main text in Portuguese. If the dissertation is written in English, first will come the summary in English and then in Portuguese, followed by the main text in English.

The abstract shoul not exceed one page and should answer the following questions:

- What's the problem?
- Why is it interesting?
- What's the solution?
- What follows from the solution?

Keywords: Keywords (in English) ...

Resumo

Independentemente da língua em que está escrita a dissertação, é necessário um resumo na língua do texto principal e um resumo noutra língua. Assume-se que as duas línguas em questão serão sempre o Português e o Inglês.

O *template* colocará automaticamente em primeiro lugar o resumo na língua do texto principal e depois o resumo na outra língua. Por exemplo, se a dissertação está escrita em Português, primeiro aparecerá o resumo em Português, depois em Inglês, seguido do texto principal em Português. Se a dissertação está escrita em Inglês, primeiro aparecerá o resumo em Inglês, depois em Português, seguido do texto principal em Inglês.

O resumo não deve exceder uma página e deve responder às seguintes questões:

- Qual é o problema?
- Porque é que ele é interessante?
- Qual é a solução?
- O que resulta (implicações) da solução?

E agora vamos fazer um teste com uma quebra de linha no hífen a ver se a LaTeX duplica o hífen na linha seguinte...

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Sim! Funciona! :)

Palavras-chave: Palavras-chave (em Português) ...

Contents

List of Figures

List of Tables

Listings

Glossary

aliquam	tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.
computer	An electronic device which is capable of receiving information (data) in a particular form and of performing a sequence of operations in accordance with a predetermined but variable set of procedural instructions (program) to produce a result in the form of information or signals.
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Acronyms

AP	Air Pollution
DOAS	Differential Optical Absorption Spectroscopy
EPA	Environmental Protection Agency (United States)
PM	Particulate Matter
RQ	Research Question
WHO	World Health Organization

Symbols

*

Chapter 1

Introduction

1.1 Contextualization

- NGNS and FFF;
- Clients asked for a solution to monitor air pollution;
- In January 2016 starts the ATMOS project;
- Artificial light source idea;
- Tomography idea

1.1.1 Background

1.1.2 The Problem

Air Pollution (AP) is one of the grave concerns of modern day western society, with many decades worth of research proving that it can have a pronounced negative effect on human, animal and plant life, as shown in Section 1.2. On humans, it has been shown to significantly increase risk of cardiovascular, pulmonary and even neuropsychiatric diseases [1–3]. Its implications on ecosystems are remarkably complex and difficult to quantify, but nonetheless extremely important, and have a huge impact on biodiversity [4].

Knowing all this brings us the responsibility of at least trying to mitigate some of these adverse consequences of the spectacular progress that we have achieved in the few last centuries. But we cannot act unless we also know what we must do; and to know this, we must have measurements.

1.1.3 Objectives

The overarching goal of this thesis was to theorize and design a bidimensional mapping tool for trace atmospheric pollutants such as NO_x and SO_x, using Differential Optical

Absorption Spectroscopy (DOAS) as the measurement technique. During the research, several "micro-objectives"appeared regularly. Some were kept and incorporated in the workplan, others discarded after initial exploration. The main secondary objectives, which had a very heavy influence over the adopted methods, were:

- To use a tomographic approach for the mapping procedure;
- To use a single collection point, minimizing material costs for the technology.

This thesis is thus subject to the Research Question (RQ): **How to design a single collection, tomographic mapping, DOAS atmospheric monitoring system?**

1.1.4 Methods

To answer this question, I

1.1.5 Results

1.1.6 Conclusions

1.2 Theoretical Background

1.2.1 Air Pollution

Air Pollution (AP) is a very important topic of discussion in the current days, with scientists and researchers around the globe being very well aware of the potential effects it can have on the health of individuals and populations across all ecosystems. Not to mention its implications on climate change, which are generally regarded as one of the capital threats to life on Earth's survival (on par with a nuclear apocalypse). Defining AP can be a challenge. In fact, its effects and presence is so all-encompassing, that it would be fair to say that its definition changes with the angle with which one looks upon it. Nonetheless, it is important to at least try to define it, in order to approach it in some way [2, 4].

The United States Environmental Protection Agency (EPA) defined Air Pollution (AP) as "*the presence of contaminants or pollutant substances in the air that interfere with human health or welfare, or produce other harmful environmental effects*" [5]. This is (perhaps intentionally) a very broad definition, too broad to avoid vagueness. It does introduce a key concept: the term *pollutant*, which needs be discussed in order to complete the definition above.

It would be very hard to find someone who did not have an almost instinctive idea of what a pollutant is. We know something is amiss when we notice our air is full of smoke or smells strange, but our senses are not enough. There are many chemical components that are untraceable by unaided humans, and some that are only detected by our noses and eyes at concentration levels which are above the threshold where

they can damage our health. This makes the task of separating pollutants from non-pollutants a non-trivial one. If we cannot rely solely on our senses to detect them, then it is up to the scientists and engineers to create methods that allow us to do so. Whats more, we must also rely on them to understand how can a normally harmless substance be a pollutant, depending on the circumstance. For instance, nitrous compounds are traditionally beneficial to the soils and cultures, but they can and do cause pulmonary and cardiovascular complications in humans [1–3].

Context matters to pollutants. The toxic nature of a certain chemical only is revealed when someone or something gets exposed to it. Even then, there are exposure levels which do not bear any effects, good or bad. At these levels, a pollutant is but an impurity. There too many potential pollutants in our modern day world to list here, but the World Health Organization (WHO) states that there are six major air pollutants:

- Particle Matter (PM);
- Ground level ozone (O_3);
- Carbon monoxide (CO);
- Sulfur Oxides (SO_x);
- Nitrous Oxides (NO_x);
- Lead (Pb).

Exposure to these pollutants have different effects on humans, ranging in seriousness from skin irritation to neuropsychiatric complications, depending on dose and on the time the exposure lasts. In the next subsections, I will address each of the major pollutants enumerated and briefly describe the physiological mechanisms behind their toxicity.

1.2.1.1 Particle Matter

1.2.1.2 Ground Level Ozone

1.2.1.3 Carbon Monoxide

1.2.1.4 Sulfur Oxides

1.2.1.5 Nitrous Oxides

1.2.1.6 Lead

1.3 Literature Review

Chapter 2

ThesisDIFCTNL User's Manual

2.1 Introduction

Chapter 3

A Short LaTeX Tutorial with Examples

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Appendix A

Appendix 1 Lorem Ipsum

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Appendix B

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