

Air quality measurement and logging in taxi ranks and inside of taxis

Willem Cornelis Rossouw
22823700

Report presented in partial fulfilment of the requirements of the module Project (E) 448 for the degree Baccalaureus in Engineering (Electrical and Electronic) in the Faculty of Engineering at Stellenbosch University.

Supervisor: Prof. MJ (Thinus) Booysen

May 2023

Acknowledgements

I would like to thank my supervisor Thinus Booysen for giving me this skripsie topic and for his enthusiasm in his work. I would also like to thank my friend and co-(soon-to-be)-engineer Phillip, for keeping me sane for most of my degree.

Plagiaatverklaring / *Plagiarism Declaration*

1. Plagiaat is die oorneem en gebruik van die idees, materiaal en ander intellektuele eiendom van ander persone asof dit jou eie werk is.

Plagiarism is the use of ideas, material and other intellectual property of another's work and to present it as my own.

2. Ek erken dat die pleeg van plagiaat 'n strafbare oortreding is aangesien dit 'n vorm van diefstal is.

I agree that plagiarism is a punishable offence because it constitutes theft.

3. Ek verstaan ook dat direkte vertalings plagiaat is.


I also understand that direct translations are plagiarism.

4. Dienooreenkomstig is alle aanhalings en bydraes vanuit enige bron (ingesluit die internet) volledig verwys (erken). Ek erken dat die woordelike aanhaal van teks sonder aanhalingstekens (selfs al word die bron volledig erken) plagiaat is.

Accordingly all quotations and contributions from any source whatsoever (including the internet) have been cited fully. I understand that the reproduction of text without quotation marks (even when the source is cited) is plagiarism

5. Ek verklaar dat die werk in hierdie skryfstuk vervat, behalwe waar anders aangedui, my eie oorspronklike werk is en dat ek dit nie vantevore in die geheel of gedeeltelik ingehandig het vir bepunting in hierdie module/werkstuk of 'n ander module/werkstuk nie.

I declare that the work contained in this assignment, except where otherwise stated, is my original work and that I have not previously (in its entirety or in part) submitted it for grading in this module/assignment or another module/assignment.

| | |
|--|--|
| 22823700 Studentenommer / <i>Student number</i> |  Handtekening / <i>Signature</i> |
| W.C. Rossouw Voorletters en van / <i>Initials and surname</i> | April 4, 2023 Datum / <i>Date</i> |

Abstract

English

The English abstract.

Afrikaans

Die Afrikaanse uittreksel.

Contents

| | |
|----------------------------------|----------|
| Declaration | ii |
| Abstract | iii |
| List of Figures | v |
| List of Tables | vi |
| Nomenclature | vii |
| 1. Introduction | 1 |
| 1.1. Background | 1 |
| 1.2. Problem Statement | 1 |
| 1.3. Scope | 1 |
| 1.4. Objectives | 1 |
| 1.5. Report Overview | 1 |
| 2. Summary and Conclusion | 2 |
| Bibliography | 3 |
| A. Project Planning Schedule | 4 |
| B. Outcomes Compliance | 5 |

List of Figures

List of Tables

Nomenclature

Variables and functions

| | |
|---------------------------------------|--|
| $p(x)$ | Probability density function with respect to variable x . |
| $P(A)$ | Probability of event A occurring. |
| ε | The Bayes error. |
| ε_u | The Bhattacharyya bound. |
| B | The Bhattacharyya distance. |
| s | An HMM state. A subscript is used to refer to a particular state, e.g. s_i refers to the i^{th} state of an HMM. |
| \mathbf{S} | A set of HMM states. |
| \mathbf{F} | A set of frames. |
| \mathbf{o}_f | Observation (feature) vector associated with frame f . |
| $\gamma_s(\mathbf{o}_f)$ | A posteriori probability of the observation vector \mathbf{o}_f being generated by HMM state s . |
| μ | Statistical mean vector. |
| Σ | Statistical covariance matrix. |
| $L(\mathbf{S})$ | Log likelihood of the set of HMM states \mathbf{S} generating the training set observation vectors assigned to the states in that set. |
| $\mathcal{N}(\mathbf{x} \mu, \Sigma)$ | Multivariate Gaussian PDF with mean μ and covariance matrix Σ . |
| a_{ij} | The probability of a transition from HMM state s_i to state s_j . |
| N | Total number of frames or number of tokens, depending on the context. |
| D | Number of deletion errors. |
| I | Number of insertion errors. |
| S | Number of substitution errors. |

Acronyms and abbreviations

| | |
|-------|---|
| AE | Afrikaans English |
| AID | accent identification |
| ASR | automatic speech recognition |
| AST | African Speech Technology |
| CE | Cape Flats English |
| DCD | dialect-context-dependent |
| DNN | deep neural network |
| G2P | grapheme-to-phoneme |
| GMM | Gaussian mixture model |
| HMM | hidden Markov model |
| HTK | Hidden Markov Model Toolkit |
| IE | Indian South African English |
| IPA | International Phonetic Alphabet |
| LM | language model |
| LMS | language model scaling factor |
| MFCC | Mel-frequency cepstral coefficient |
| MLLR | maximum likelihood linear regression |
| OOV | out-of-vocabulary |
| PD | pronunciation dictionary |
| PDF | probability density function |
| SAE | South African English |
| SAMPA | Speech Assessment Methods Phonetic Alphabet |

Chapter 1

Introduction

1.1. Background

The majority of South Africa's public sector uses taxis as a means of transport. Millions of commuters use taxis frequently and depend on them for all of their mobility needs [1]. Instead of using expensive and inconvenient formal public transportation like buses and trains, they offer an accessible and affordable substitute. As a result, the effects of air quality in taxis on human health and the impact of taxi exhaust emissions are issues unique to South Africa.

1.2. Problem Statement

Despite the popularity and importance of taxis in South Africa, there is a lack of research on the air quality inside and outside of these vehicles. Air quality is a crucial factor for human health and well-being, especially for commuters who spend long hours in taxis exposed to various pollutants. Moreover, taxi emissions contribute to the overall air pollution in urban areas, which affects the environment and the quality of life of the residents. Therefore, there is a need for a comprehensive study on the air quality in taxis and its impacts on human health and the environment.

1.3. Scope

1.4. Objectives

1.5. Report Overview

Chapter 2

Summary and Conclusion

Bibliography

- [1] “Public transport,” <https://www.transport.gov.za/public-transport>, 2023, accessed: 2023-03-12.

Appendix A

Project Planning Schedule

This is an appendix.

Appendix B

Outcomes Compliance

This is another appendix.