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

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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.

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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.

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Abstract

English

The English abstract.

Afrikaans

Die Afrikaanse uittreksel.

Contents

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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]. The South African government has recognized the impact of taxi emissions on air quality and has taken steps to address the issue. In 2006, the government gazetted regulations that required taxi operators to convert their vehicles to run on cleaner fuels, such as liquefied petroleum gas (LPG), compressed natural gas (CNG), or diesel with lower sulfur content [2]. However, the implementation of these regulations has been slow and often ineffective as seen in the extract below in figures 1.1, 1.2 and 1.3, resulting in continued poor air quality in many areas. 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.

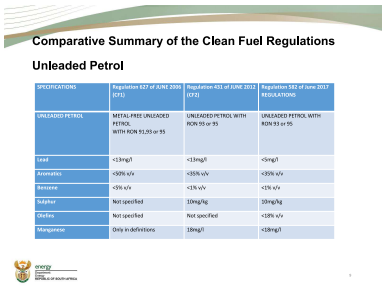

Figure 1.1: Unleaded

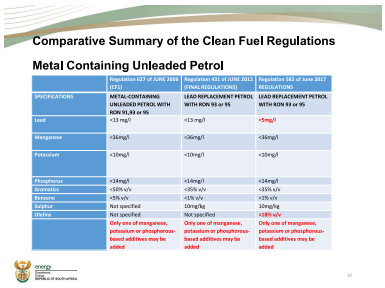

Figure 1.2: Metal+ Unleaded

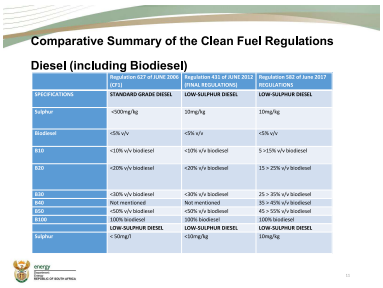

Figure 1.3: Diesel

Charts provided by [2]

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 crowded spaces(in this case taxi ranks), which affects the environment and the quality of life of the passers by. The closest studies being that of inside single cab taxis [3], road based pollution [4] and general pollution [5]. Therefore, there is a need for a comprehensive study on the air quality in taxis and taxi ranks and its impacts on human health and the environment.

1.3. Objectives

The objective of the study will be as follows:

- To measure and compare the levels of CO2, VOC, particulate matter and NOx both inside taxis and in taxi ranks to that of a known baseline.
- Identify the primary sources of air pollution in taxi ranks and within taxis and evaluate the impact of environmental factors, such as traffic congestion and weather conditions.
- To investigate the potential health risks associated with exposure to air pollution in taxi ranks and within taxis, particularly for passengers, drivers and potential third parties.
- To evaluate the effectiveness of current measures in place to reduce air pollution from taxis, such as emission standards and regulations.
- Propose potential strategies to mitigate the impact of from taxis on public health and the environment such as implementing new technologies.

1.4. Scope

The scope of the project encompasses only the following:

- Building of base station and portable sensor module
- Development of communication network for satellite module and base station as well as data storage and backup
- Deployment of sensor and network
- Analysis of data gathered

1.5. Report Overview

Chapter 2

Literature Study

Chapter 3

System Overview

Chapter 4

Analysis and Data

Chapter 5

Summary and Conclusion

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Appendix A

Project Planning Schedule

This is an appendix.

Appendix B

Outcomes Compliance

This is another appendix.