

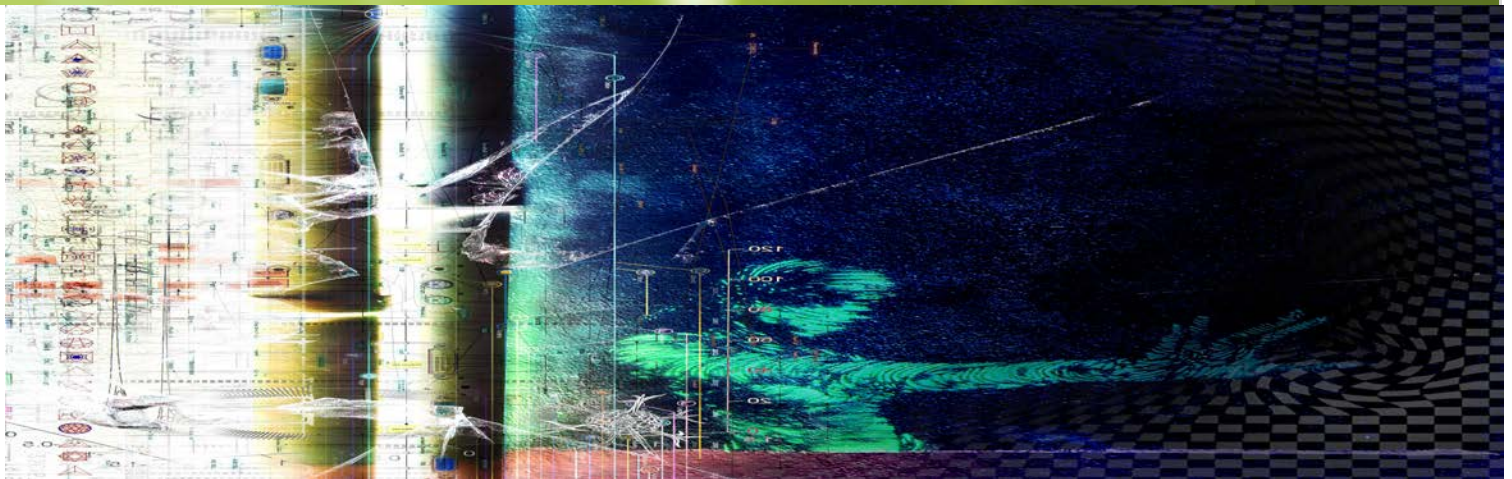
DATA ANALYSIS OF ACOUSTICAL HEART SIGNALS

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Abstract: The project is based on a large number of acoustic recordings from clinical trials regarding coronary artery disease. The aim is to analyze these acoustic recordings and verify evidence that the recordings are useful in diagnosing coronary artery disease and that the developed algorithms for that purpose work satisfactorily. Analyses are conducted based on the data alone and based on the existing developed techniques.

COLOPHON

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This publication is the result of an innovation project, an instrument to strengthen the cooperation between knowledge institutions and private companies. The primary goal is to promote innovation by combining accessible/existing research and technologies with creative uses in order to facilitate the creation of new products, services or experiences. Innovation projects are mainly short term feasibility studies conducted on a pre-competitive level.

PREFACE

This publication is the result of an innovation project entitled DATA ANALYSIS OF ACOUSTICAL HEART SIGNALS. The project is financed by the Danish Sound Innovation Network through a grant from the Danish Agency for Science, Technology and Innovation. The project is completed in the period July 2012 to March 2013 and managed by DTU, project manager Jan Larsen. Additional project participants are: Mikkel N. Schmidt, Claus Christensen, Peter Samuelsen, and Samuel Schmidt.

INTRODUCTION

BACKGROUND

Acarix A/S has worked with acoustic diagnosis of coronary artery disease in collaboration with Aalborg University since 2007 and has conducted clinical trials in collaboration with Rigshospitalet. A large corpus of acoustical recordings of the heart beats are available and diagnostic methodology has been developed.

OBJECTIVE

It was the objective of the work defined in the contract to validate the methodology developed by solely one researcher at the University of Aalborg. Further it was the objective to investigate if there could be more features in the heart signals from the diastolic period of the heart beat cycle that could contribute to an improved algorithm of the diagnostic system and finally it was a good opportunity for evaluating new potentials for future collaborations.

IMPACT/EFFECT

Assessing, confirming, and suggesting improvements to the current methodology for acoustic diagnose of coronary artery disease.

METHODS AND RESULTS

METHOD

In the first phase of the project, the existing experimental data was independently analyzed in order to examine the attainable diagnostic accuracy using standard statistical machine learning techniques. In the second phase of the project, the existing software pipeline was examined in order to assess possible issues with robustness and overfitting.

RESULTS

Using standard statistical machine learning techniques, diagnostic accuracy on par with the existing results or even significantly beyond random was not attainable. Reproducing parts of the existing software pipeline, prediction results appeared to be beyond random, although not on par with existing results. Results were somewhat sensitive to particular parameter settings and choices, suggesting that there could be issues with overfitting in the existing software pipeline.

CONCLUSION

Based on the analysis it was suggested that:

- Further data should be gathered, and all existing data from different experimental settings should be pooled for joint analysis.
- Manually configured constants such as frequency cut-offs, band widths, etc. incorporated in the diagnostic pipeline should be evaluated for robustness, cross validated, or automatically learned from data.
- More features should be considered and validated for robustness, and automatic feature selection/extraction methods should be examined.

Further details are given in [1].

Overall the innovation project contributed to increasing the knowledge level of Coloplast and Acarix concerning the feasibility of using acoustical heart signals for diagnosing coronary artery diseases. The innovation project furthermore contributed to reducing risk and increasing the robustness of primarily Acarix's business concept. This has among other positive outcomes helped Acarix in achieving additional venture capital in December 2012. Also, as a result of the innovation project modifications have been applied to essential algorithm that has been converted from Matlab to a C-Code now being calculated automatically on the diagnostic equipment. Further the experimental data have been expanded with 120 additional patients. Lastly, the innovation project has led to ideas about potential future development projects and collaborations concerning new features and new areas of application.

REFERENCES

1. Classification of CAD from diastolic heart sounds, Mikkel N. Schmidt, Technical University of Denmark, DTU-Informatics, March 20, 2013 (confidential)

APPENDIX

www.acarix.com

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