



Aalborg Universitet

AALBORG UNIVERSITY
DENMARK

Segmentation of heart sound recordings by a duration dependent Hidden Markov Model?

Schmidt, Samuel; Toft, Egon; Holst-Hansen, Claus; Graff, Claus; Struijk, Johannes

Publication date:
2009

Document Version
Publisher's PDF, also known as Version of record

[Link to publication from Aalborg University](#)

Citation for published version (APA):
Schmidt, S., Toft, E., Holst-Hansen, C., Graff, C., & Struijk, J. (2009). *Segmentation of heart sound recordings by a duration dependent Hidden Markov Model?*. Abstract from Danish Cardiovascular Research Academy, Summer Meeting, Sandbjerg, Denmark.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

Take down policy

If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.

Abstract 45

Segmentation of heart sound recordings by a duration dependent Hidden-Markov Model?

S. Schmidt¹, E. Toft¹, C. Holst-Hansen², C. Graff¹, and J.J. Struijk¹

¹Center for Sensory-Motor Interaction, Department of Health Science and Technology, Aalborg University, Aalborg Denmark; ²Department of Cardiology, Aalborg Hospital,

Århus University Hospitals, Aalborg, Denmark

E-mail: sschmidt@hst.aau.dk

Background Digital stethoscopes offer new opportunities for computerized analysis of heart sounds. Segmentation of heart sounds into periods related to the first and second heart sound (S1 and S2) is fundamental in the analysing process. However segmentation of heart sounds recorded with handheld stethoscopes in clinical environments is often complicated by recording and background noise.

Method A Duration-dependent Hidden Markov Model (DHMM) is proposed for robust segmentation of heart sounds. The DHMM identifies the most likely sequence of physiological heart sounds, based on duration of the events, the amplitude of the signal envelope and a predefined model structure. The DHMM model was developed and tested with heart sounds recorded bedside with a commercially available handheld stethoscope from a population of patients referred for coronary arterioangiography.

Results and Conclusion The DHMM identified 890 S1 and S2 sounds out of 901 which corresponds to 98.8% (CI: 97.8-99.3%) sensitivity in 73 test- patients and misplaced 13 sounds out of 903 identified sounds which corresponds to 98.6% (CI: 97.6-99.1%) positive predictivity. These results indicate that DHMM is an appropriate model of the heart cycle and suitable for segmentation of clinically recorded heart sounds.