Heart Sound Classification Using Gaussian Mixture Models

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Introduction

- Heart auscultation: the primary tool for screening and diagnosis in primary health care
- Stethoscopes to capture heart sound
- Heart sound as PhonoCardioGram (PCG) data for diagnostic purposes
- Goal: Diagnose murmur from Normal heart sound

Data

One or more heart sound recordings for 1568 patients from auscultation locations

Pulmonary valve (PV),
Aortic valve (AV),
Mitral valve (MV),
Tricuspid valve (TV),
And other (Phc)

The recordings were collected sequentially (not simultaneously) from different auscultation locations using a digital stethoscope.

The number, location, and duration of the recordings vary between patients.

Data Preprocessing

PCG data were originally sampled to 4000 Hz

Each PCG was resampled to 1000 Hz

- To reduce the data size
- It also maintain useful information

Band-pass filtered between 25 Hz and 400 Hz

- 0-100 Hz,
- 100-200 Hz,
- 200-300 Hz,
- 300-400 Hz.

And then pre-processed to remove any spikes in the PCG

Data Preprocessing

There are 5 channels per patients

Min length 7 seconds

Max length>30 seconds

We produced 4 band-pass filters per each channels

Therefore, 20 recording per patient (at most)

For each recording, it is split into windows of 1 second length with 0.25 second overlap

Feature extractions

We use two class of features extracted from 20 recordings and multiple windows (LibRosa library were used for feature extraction)

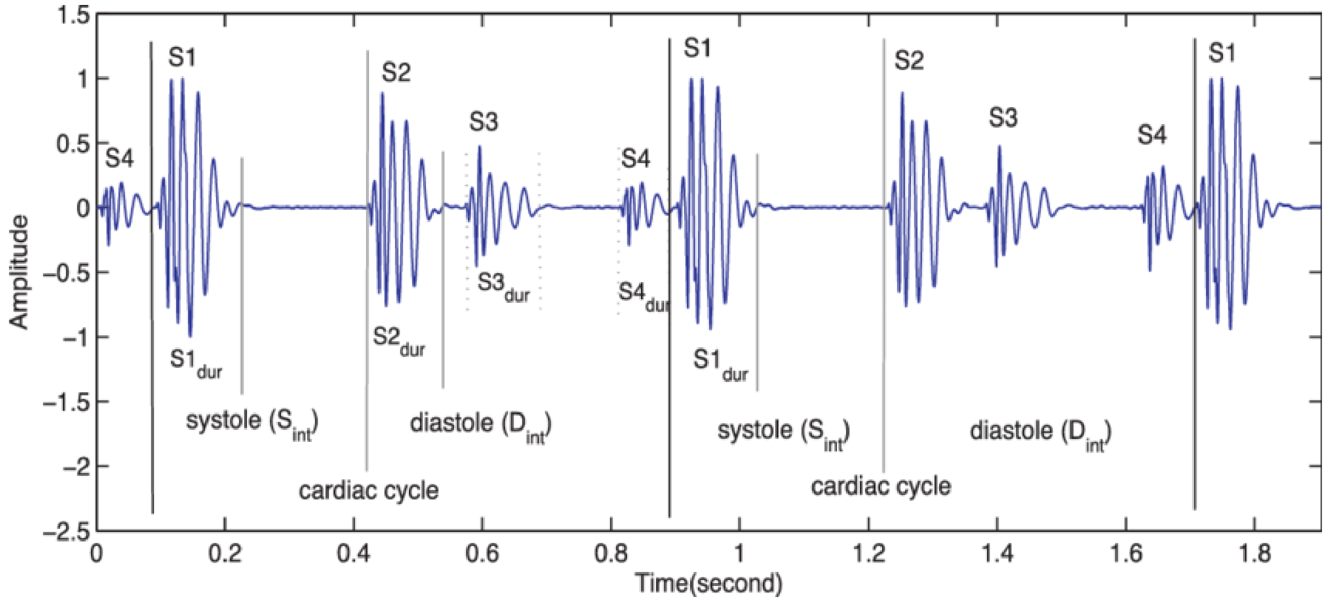
Time Domain Features

Frequency Domain Features

Time-domain Features

Mean and standard deviation (SD) of the following parameters were used as time-domain features (36 features):

- PCG intervals:
  - RR intervals,
  - S1 intervals,
  - S2 intervals,
  - systolic intervals,
  - diastolic intervals,
  - ratio of systolic interval to RR interval of each heart beat,
  - ratio of diastolic interval to RR interval of each heart beat,
  - ratio of systolic to diastolic interval of each heart beat.



Time-domain Features (Cont.)

- Average and STD of PCG amplitudes:
  - ratio of the mean absolute amplitude during systole to that during the S1 period in each heart beat,
  - ratio of the mean absolute amplitude during diastole to that during the S2 period in each heart beat,
  - skewness of the amplitude during S1 period in each heart beat,
  - skewness of the amplitude during S2 period in each heart beat,
  - skewness of the amplitude during systole period in each heart beat,
  - skewness of the amplitude during diastole period in each heart beat,
  - kurtosis of the amplitude during S1 period in each heart beat,
  - kurtosis of the amplitude during S2 period in each heart beat,
  - kurtosis of the amplitude during systole period in each heart beat,
  - kurtosis of the amplitude during diastole period in each heart beat

Frequency-domain Features

- The power spectrum was estimated using a Hamming window and the discrete-time Fourier transform.
- The median power across 4 frequency bands was calculated.
- Then, the mean of the median power of the 4 frequency bands were used as frequency-domain features.
- Additionally, mel-frequency cepstral coefficient (MFCC) were extracted

The next step

Use extracted features from 20 recordings and several windows as input of Gaussian Mixture Model

Report the results

Analyze the findings and results