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SmartNS

SMARTPHONE NOISE SUPPRESSION

Context

Heart failure is responsible for millions of deaths every year, and one of the main physiopathology mechanism associated to that condition is pulmonary congestion, characterized by the accumulation of fluid in the lungs, often detected on physical examination by pulmonary auscultation. Crackles are characteristic sounds that may be present in one or both lungs, frequently heard during inspiration.

The application proposed uses an electronic stethoscope (Fig1.) that is connected to the smartphone, collects and analyzes lung sounds.

Problem

After analyzing the signal correspondent to the auscultations collected with this method, a major problem came up: noise. This factor, distorts the signal making the crackles detection with success much harder. This means that for a successful project, noise suppression or filtering techniques were fundamental.

Methods

The first thing necessary was to characterize both crackles and noise:

Fig1. Electronic Stethoscope.

Crackles are short, explosive, non-musical sounds. There are two types of crackles: fine and coarse, and their theoretical behavior is expressed in the Figure 2.

Noise, what are the causes?
The noise comes from the friction between the stethoscope membrane and the skin. That phenomenon can be explained in a simple manner: during inspiration, the area of skin that is in direct contact with the membrane is larger than it is during expiration, and the noise comes exactly from that transition.

Furthermore there is the ambient noise, e.g., people talking, objects moving.
The next thing to do, was to implement a preprocessing stage:
Before trying to detect crackles in the

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Features

- Remote Monitoring System
- Lung Sound recording
- Crackles automatic detection
- Early diagnosis

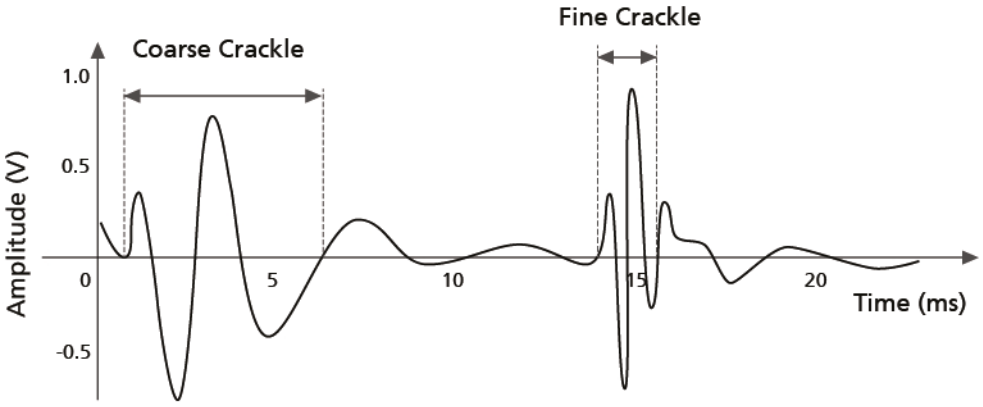

Fig2. Coarse and fine crackles signal.

auscultation, a previous signal processing was required in order to attenuate the noise, and enhance the crackles.

A differentiator filter followed by the cross correlation method were applied.

In a third and final phase, is the crackles detection:
Once the signal is "cleaner", it is possible now to run the automatic crackles detection with more success. An algorithm involving signal smoothing, first derivative and analysis of interesting regions of the signal was implemented (based on Vannuccini et al.).

Results and discussion

A preliminary assessment of the results shows improvements when comparing the efficiency of the automatic crackles detection before and after applying the preprocessing stage, but we believe there is a greater margin for improvement.

Modifications to the applied methods shall be made, not only in the preprocessing phase, but also in the automatic detection phase, in order to improve the sensitivity and specificity of the solution.

Future work

Gather a larger, structured database of crackles samples.

Implement other automatic method for crackles detection.

Reevaluate the methods in the preprocessing stage.

Integrate the solution in an Android Application.