P08

Proximal Guide wire Audio Sensing - The Sound of Vessel Perforation

A. Illanes[1], I. Maldonado[1], N. Mahmoodian[1], A. Schaufler[1], A. Boese[1], M. Friebe[1]
[1]Otto-von-Guericke Universität Magdeburg, Institut für Medizintechnik, Magdeburg, Germany

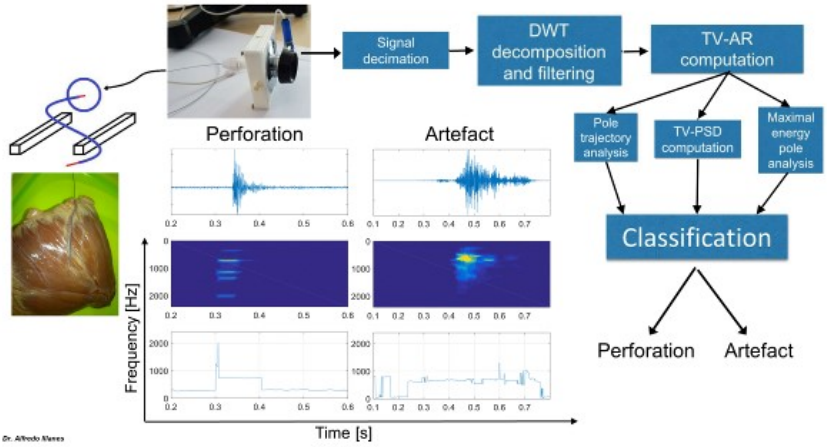
Introduction: Perforation of the vessel walls during guide wire applications is a serious patient risk with an occurrence during percutaneous coronary intervention in the range of 0.1% to 4.0%. To minimize the impact it is crucial for the surgeon to detect such a perforation very early. In planar X-ray imaging the vasculature and the vessel walls cannot be seen however and consequently a perforation is not always recognized or detected, a clear unmet clinical need to be adressed. In this work we propose a new approach for monitoring vessel perforation using acoustic emission (AE) data acquisition from the proximal end of a guide wire to extract dynamical characteristics of the interaction between the distal tip and the vessel wall.

Materials and methods: A stethoscope equipped with a microphone connected to a computer was directly and firmly attached to the proximal end of a 0.014-inch guide wire via a 3D printed adapter. An audio database was implemented to evaluate the performance of the proposed approach. 560 audio signal of 30 seconds duration each were recorded during the perforation of coronary arteries belonging to 5 ex-vivo pork hearts using the tip of the guide wire. Since the main objective of the created database was to analyse performances on classifying the audio signals as a perforation or as an artefact, 315 additional recordings with different types of induced guide wire audio artefacts were performed, including friction between the guide wire and the artery wall and tiny guide wire bumps. Two advanced signal processing methods, time-varying auto-regressive (TVAR) modeling and Bispectral Analysis (BSA), were used to extract acoustic signatures in the signal. Several features were extracted from the TVAR and BSA of the signal and then Support Vector Machine (SVM) was used to classify a signal as a perforation or as an artifact.

Results: Both signal processing methods resulted in valuable features allowing a perforation to be clearly identifiable from other occurring events. A perforation leaves a clear audio signal trace in the time-frequency domain. Quantitative results using SVM showed that both methods, TVAR and BSA, allow a correct classification of a perforation with more than 90% of accuracy.

Conclusions: The presented approach shows that interactions starting at the tip of a guide wire can be picked up at its proximal end providing a valuable additional information that could be used during a guide wire procedure.

Figure 1:


Signal decimation
DWT decomposition and filtering
TV-AR computation
Pole trajectory analysis
TV-PSD computation
Maximal energy pole analysis
Classification
Perforation
Artefact
Perforation
Artefact
Frequency [Hz]
Time [s]
Dr. Alfredo Nunes