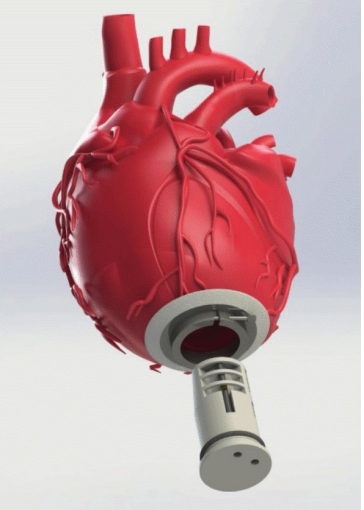
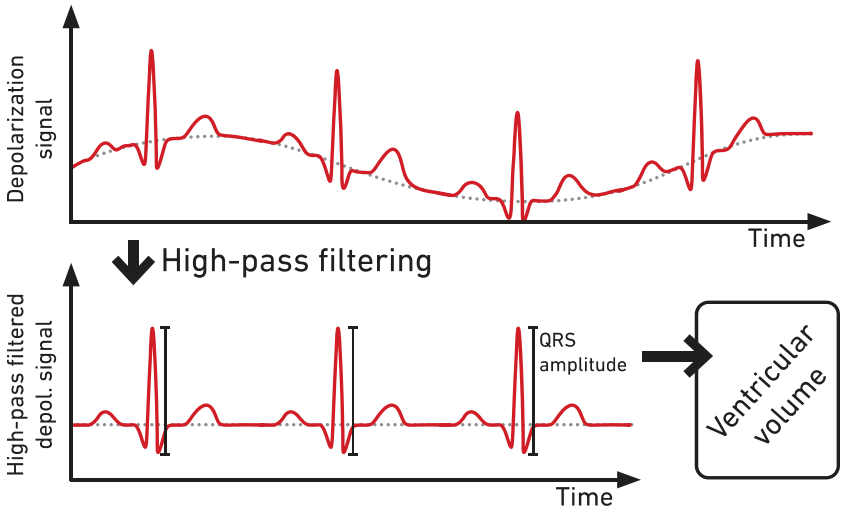
ETH zürich

Licensing Opportunity

Fully implantable ECG system to measure left ventricular volume





(left) Cannula prototype with integrated electrodes, (right) ECG signal with artifacts before and extraction of the R-wave amplitude after filtering.

Application

An implantable electromyography system determines the volume of the left ventricular heart chamber based on the electric field of the heart muscle. Continuous monitoring of ventricular volume enables better clinical decision making and physiological control of cardiac devices such as pacemakers and blood pumps.

Features & Benefits

- Continuous monitoring of the left ventricle (Brody effect)
- No signal distortions due to electric inhomogeneities or movement of the patient's body
- Retains conventional cannula geometry

Publications

- "Real-time ventricular volume measured using the intracardiac electromyogram," ASAIO Journal 2021, https://doi.org/10.1097/MAT.0000000000001444
- "Unipolar amplifier enabling measurement of far-field intra-cardiac electromyogram for blood pump control," Proceedings of the 14th Interna Joint Conference on Biomed. Eng. Systems and Technologies - BIODEVICES, 40-48, 2021

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Technology Readiness Level

Background

Commercially available implantable blood pumps do not adapt their output to the patient's changing perfusion needs, which depend, for example, on his or her physical activity. As a result, overpumping and underpumping can occur and contribute to the degradation of the heart's mechanical integrity. Direct measurement of the ventricular volume is the most direct metric for optimizing the heart-pump interaction. Nowadays, however, cardiac volume measurements are only possible on an ambulatory basis with external equipment.

Invention

The invention relates to an intracardiac electromyography system, which is embedded in a cardiac device and determines the left ventricular volume based on the heart's electric depolarization field. 1) A single electrode is placed in the blood pool within or in close proximity to the heart to measure the depolarization signal. 2) A filter removes low-frequency components of the signal to mimic an infinite reference potential which is subtracted from the measured signal. 3) Specific features of the processed signal are extracted to calculate the ventricular volume based on the Brody effect (e.g. using the correlation of the R wave amplitude with the end-diastolic left ventricular volume). This method of signal processing allows the depolarization signal to be recorded without the disturbances of the electric field caused, for example, by breathing or movement of the patient, that make it impossible to exploit the Brody effect with conventional, external ECG measurement. It also eliminates the need for an external reference electrode not affected by the depolarization field, thus enabling the integration into fully implantable cardiac devices.