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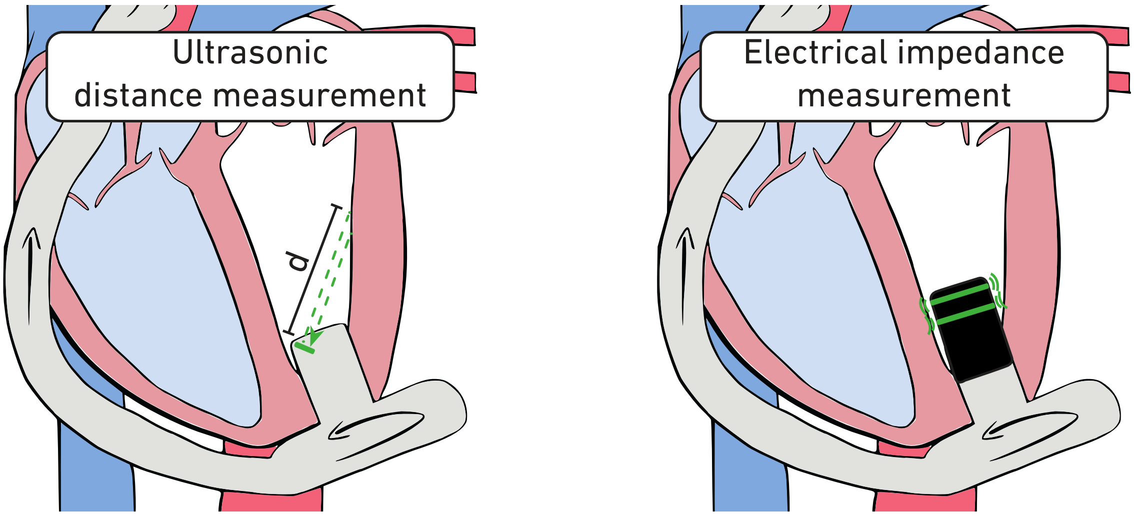
Licensing Opportunity

Physiological control of blood pumps based on active intracardiac volume measurements



The volume sensors fit on the inflow cannula of the heart pump. Volume measurements are based on ultrasound and/or electrical impedance.

Application

A blood pump adjusts its output to the patient's perfusion needs based on the volume of the heart chamber at maximum filling. The volume sensors can be integrated into the inflow cannula of commercially available pumps.

Features & Benefits

- Re-establishing the natural Frank-Starling mechanism of the heart in blood pump patients
- Improving the patients' quality of life and survival
- Different active sensing technologies available

Publications

- "Dual-modality Volume Measurement integrated on a Ventricular Assist Device," IEEE Transactions on Biomedical Engineering (2021) https://doi.10.1109/TBME.2021.3115019
- "Ultrasonic sensor concept to fit a ventricular assist device cannula evaluated using geometrically accurate heart phantoms," Artificial Organs. 2019;43:467–477 https://doi.org/10.1111/aor.13379

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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 occur and contribute to the occurrence of complications such as pump thrombosis, collapse of the heart chamber or insufficient opening of the aortic valve. Sensors and control algorithms play a vital role in enabling next generation blood pumps that automatically adjust their blood output to the physical activity of the patient and can detect and counteract abnormal pump-induced cardiac behavior.

Invention

A blood pump adjusts its output to the patient's perfusion needs based on the volume of the heart chamber at maximum filling. This end-diastolic heart volume is determined from a volume-related signal measured by intracardiac sensor implants. This can be achieved by different sensor technologies: Example 1: An electrical conductance sensor indicates the tissue composition in the proximity of the sensor (emitting electromagnetic waves). Example 2: An ultrasound sensor directly measures the dimensions of the ventricle at a given point in time (emitting mechanical waves). Both types of sensors can be integrated directly onto the inlet cannula of the pump. A controller regulates the blood pump output to achieve a target heart volume. This strategy is inspired by the Frank-Starling law describing the heart's natural behavior to change its stroke volume depending on the volume of blood filling the heart. The controller thus implements a linear function between the determined end-diastolic volume and the blood output provided by the blood pump.