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Zurich Heart
TECHNOLOGY OFFER

Licensing opportunities for patented sensing and control technologies from 10+ years in the field of mechanical circulatory support

Dear innovators and entrepreneurs,

Over 10 years ago we initiated the Zurich Heart Project – a joined, interdisciplinary effort of almost 20 research groups across institutions to accelerate the improvement of existing mechanical circulatory support (MCS) technology.
Now it is time to make our innovations available to the patients in need and transfer the most promising technologies from years of explorative research to commercial products.

In this brochure, we present our patent portfolio in the field of continuous monitoring of patients and smart, physiologic pump control. We see our inventions as enablers for more informed clinical decision making and blood pumps that adapt to the patient´s perfusion need, preventing the typical complications of todays devices.

Our patents ensure the commercial exploitability of various technologies for the measurement of intracardiac volumes, pressures and flow, and the control of pump output based on this sensor data. We believe that the use of these technologies will allow your company to develop more reliable products that will make MCS therapy available to patients who today must rely on drug therapy or heart transplantation. Please get in touch if you would like to discuss possible licensing.

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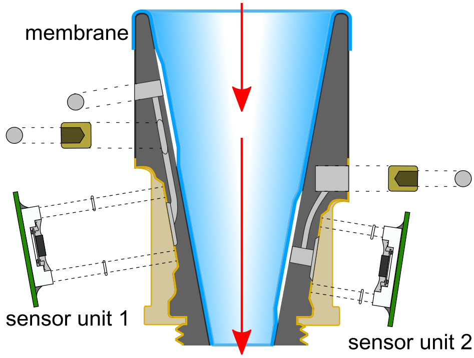
Licensing Opportunity

Technology Readiness Level
1 2 3 4 **5** 6 7 8 9

online version

Integration of combined total pressure and flow sensor for monitoring and control of blood pumps

Patent package (US10974039B2 (granted), additional patent pending)



(left) The HeartMate 3 by Abbott with modified inflow cannula, (right) cannula with two embedded pressure sensors

Application

An implanted sensor system provides total pressure and flow rate waveforms as the input signal for controllers that match the pump speed of blood pumps to the physiological needs of the patient. The sensor system is an add-on to existing ventricular assist devices, which seamlessly integrates into the inflow cannula of the pump.

Invention

The invention relates to the integration of pressure sensor system into the walls of a blood carrying tubular structure and the manufacturing thereof. The sensing interface is provided by a polymer coating of the tubular structure, that forms a freely suspended diaphragm over a small opening of a cavity within the walls. The cavity contains a piezoelectric pressure sensor and is filled with a pressure transmission fluid. The invention covers a sealing mechanism and diaphragm shapes that reduce sealing- and temperature- induced overpressure on the membrane and consequent signal drift. Multiple of such sensors of static pressure can be placed at different cross sections within the tubular structure where they experience different flow velocities. This induces pressure differences between the sensors and allows to calculate a flow-independent total pressure and the flow rate from at least two static pressure sensors.

Features

- Real-time monitoring of the blood pressure in the heart chamber and blood flow through the pump
- Seamless integration into the cannula walls with no effect on blood flow
- Measurement of flow-independent total pressure
- Miniaturization to retain conventional cannula geometry

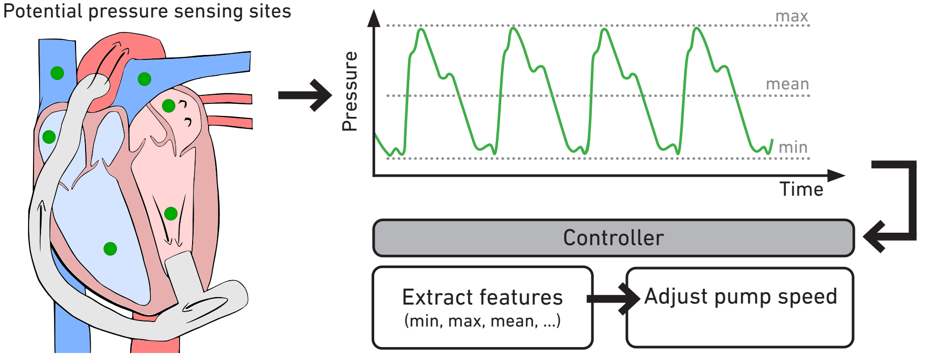
Licensing Opportunity

Technology Readiness Level
1 2 3 4 **5** 6 7 8 9

online version

Multi-mode physiological controller for blood pumps based on implanted pressure sensors

Patent granted (EP 3423125, US 11045640, JP 6947411)



(left) Heart with an inflow cannula and possible placements of pressor sensors, (right) simplified control scheme for a Ventricular Assist Device (VAD) based on the blood pressure of the patient.

Application

A blood pump adjusts its output according to the patient's perfusion needs based on blood pressures measured by implanted sensors. The system is flexible with respect to the placement of sensors at different locations in the cardiovascular system, as the controller can switch between multiple placement-dependent pre-sets.

Invention

A physiological controller for blood pumps can operate on pressure signals from different locations in the cardiovascular system. The pressure sensors can be placed in the left or right ventricle, the pulmonary arterial circulation, the left or right atrium or the pulmonary or systemic vein and can transmit pressure data and position identifiers wirelessly to the controller. The controller runs a pre-set algorithm depending on the location of the pressure sensors. The algorithm extracts different metrics from the pressure signal such as the preload of the heart based on the minimum pressure, the maximum pressure, the mean pressure or the pressure at a specific point in time during one cardiac cycle. The controller includes several signal filters and regulates the pump output in a linear relationship to the estimated preload. It can furthermore superimpose a periodic modulation of the pump output synchronized to the heart beat.

Features

- Flexibility of pressure sensor positioning
- Implementation of various control rationales (min, max, mean or other characteristics of pressure waveform)
- Re-adjustment of pump operation after each heart beat

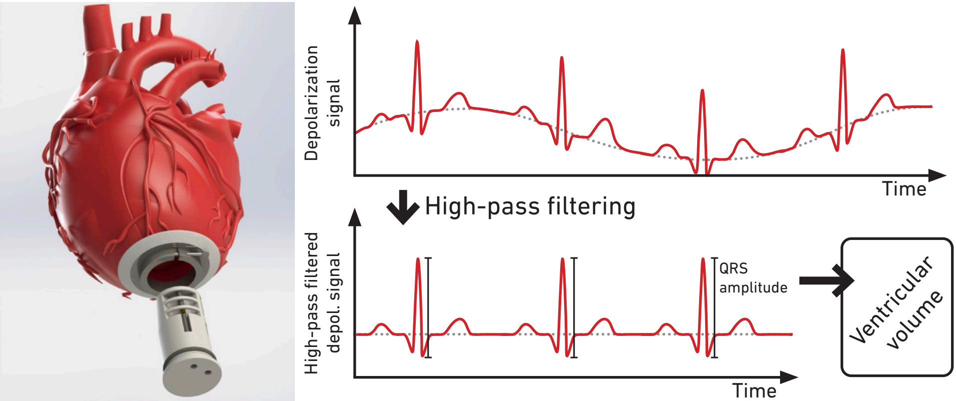
Licensing Opportunity

Technology Readiness Level
① ② ③ ④ ❺ ⑥ ⑦ ⑧ ⑨

online version

Fully implantable ECG system to measure left ventricular volume

Patent pending (EP 20713907.2, US 17/602,858)



(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 ventricle 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.

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.

Features

- 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

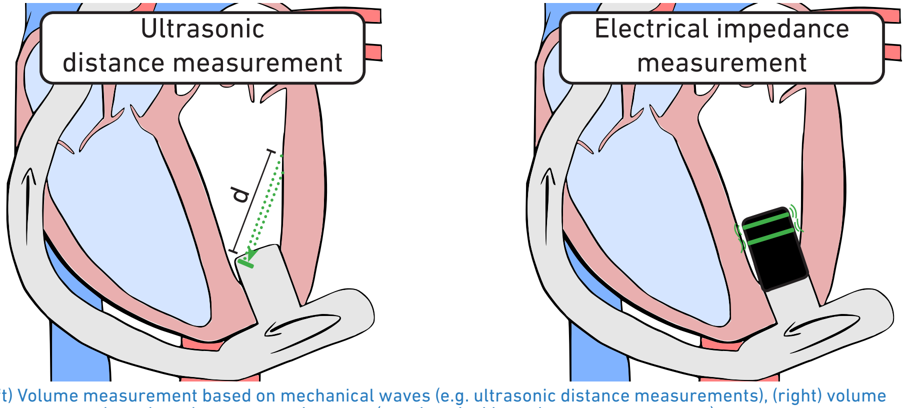
Licensing Opportunity

Technology Readiness Level
1 2 3 4 **5** 6 7 8 9

online version

Physiological control of blood pumps based on active intracardiac volume sensing

Patent granted (EP 2988795, US 9669147)



(left) Volume measurement based on mechanical waves (e.g. ultrasonic distance measurements), (right) volume measurements based on electromagnetic waves (e.g electrical impedance measurements).

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.

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.

Features

- 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