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Blood Flow Estimator of the Left Ventricular Assist Device Based in Look-Up-Table: In vitro Tests

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Abstract : This work presents a blood flow estimator based in Look-Up-Table (LUT) for control of Left Ventricular Assist Device (LVAD). This device has been used as bridge to transplantation or as destination therapy to treat patients with heart failure (HF). Destination Therapy application requires a high performance LVAD; thus, a stable control is important to keep adequate interaction between heart and device. LVAD control provides an adequate cardiac output while sustaining an appropriate flow and pressure blood perfusion, also described as physiologic control. Because thrombus formation and system reliability reduction, sensors are not desirable to measure these variables (flow and pressure blood). To achieve this, control systems have been researched to estimate blood flow. LVAD used in the study is composed by blood centrifugal pump, control, and power supply. This technique used pump and actuator (motor) parameters of LVAD, such as speed and electric current. Estimator relates electromechanical torque (motor or actuator) and hydraulic power (blood pump) via LUT. An in vitro Mock Loop was used to evaluate deviations between blood flow estimated and actual. A solution with glycerin (50%) and water was used to simulate the blood viscosity with hematocrit 45%. Tests were carried out with variation hematocrit: 25%, 45% and 58% of hematocrit, or 40%, 50% and 60% of glycerin in water solution, respectively. Test with bovine blood was carried out (42% hematocrit). Mock Loop is composed: reservoir, tubes, pressure and flow sensors, and fluid (or blood), beyond LVAD. Estimator based in LUT is patented, number BR1020160068363, in Brazil. Mean deviation is 0.23 ± 0.07 L/min for mean flow estimated. Larger mean deviation was 0.5 L/min considering hematocrit variation. This estimator achieved deviation adequate for physiologic control implementation. Future works will evaluate flow estimation performance in control system of LVAD.

Keywords : blood pump, flow estimator, left ventricular assist device, look-up-table
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