Simulator for the Development of Electromagnetic Heart Assist Devices

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Abstract

Every year, in the United States alone, more than 40,000 infants are born with congenital heart defects (CHD) and an additional 550,000 adults are diagnosed with heart failure. Every year, $110 billion is spent on treating heart attacks and $20-39 billion on heart failure in the US. The need for a better solution to assisting patients with heart failure is significant. While many companies are working to create better and smaller devices, they mainly use turbines, placing them at a high risk for complications. Electromagnetic pumping systems for use in heart assist devices show great promise, but they are complicated and costly to develop using current research approaches. Current approaches rely heavily on animal models and the development of a robust electromagnetic drive system takes multiple iterations, resulting in very high costs.
The goal of this project is to show that the AC/DC Module in the COMSOL Multiphysics® software can be used to create a simulator that represents the left ventricle (LV) of the heart. This simulator can then be used to test a high number of different electromagnetic drive system parameters at a very low cost. The resulting simulator can provide the researcher with detailed information about the interaction occurring in the electromagnetic drive system as it is tested on the virtual LV.
The goal was met to the degree that a useful simulator for the development of an electromagnetic pumping system can be created in COMSOL®. While this simulator is far from a perfect representation of the LV on the human heart, it does provide a very useful tool in testing parameters. The simulator can be adapted to represent any heart by changing the LV parameters to match those found experimentally. Then the parameters of the drive system can be tuned to match up with the needs of the heart and custom drive components can be built in the lab. This simulator can save countless hours and dollars by allowing a team to perfectly tune the parameters before a single wire is wound into a coil. This simulator can help to accelerate the development of an effective electromagnetic drive system for heart assist devices in a timely and cost-effective manner. The result will be the development of the next generation of heart assist devices that will offer heart failure patients unprecedented freedom and quality of life with drastically lower risks when compared to current solutions.