Portable Cardiac Stimulator for Electrophysiological Studies

Andrew Amick, Larry Feldman, Paula Kleyman, Amanda Marques, and Shireen Khayat

Heart function can be characterized and analyzed using electrophysiology (EP), a branch of biology that pertains to the propagation of ion current in the heart. EP studies utilize cardiac stimulators, a device that outputs programmed electrical pulses, to initialize and study impulse propagation through different areas of the heart by inducing arrhythmias. When combined with quantification or visualization of the changing electric potential in the heart, EP studies provide insight on disease pathologies. EP studies can also be used to assess the effects of different substances on heart function, including environmental toxins and newly developed pharmaceuticals. Current cardiac stimulators are very large, bulky devices that are difficult to move between rooms and high cost, making it undesirable, but necessary to have to purchase a separate device for each room. Due to the significant impact these studies have, there is a need to increase the usability and portability of the cardiac stimulator while making them affordable and efficient. To do so, we have created a prototype of a portable external cardiac stimulator that mirrors and improves the functionality of the cardiac stimulator currently used at Children's National Hospital by utilizing a microcontroller as a more cost effective and intuitive alternative. Our device is compacted to allow for quick transport, thereby eliminating the need and costs associated with having multiple devices. It maintains the basic, most used functions of current cardiac stimulators, allowing user regulation of different pulse parameters and offering an option for synchronized pulsing that utilizes real-time ECG data to determine ideal pulse intervals. The device includes user interface software usable on any personal computer that regulates a microprocessor controlled electrical output. The output is designed to interface with a stimulus isolator that isolates, modifies, and delivers the precise signal through leads that attach to the heart. The microprocessor is also able to read in the pulses it outputs, as well as the surface electrocardiogram signals provided by an amplifier. It then can send the values to the interface for real-time plotting. Our portable cardiac stimulator will make EP studies more accessible and less laborious for researchers and clinicians.