402 - 15 - Excellence - PacerSim - Executive Summary

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Simulation is a powerful educational tool in the healthcare setting. Medical simulators, ranging from low-fidelity mannequins to high-fidelity computer programs, all aid in training and maintenance of a physician's skills. Unfortunately, present high fidelity training tools are almost prohibitively costly and have limited functionality. Currently, medical students learning to adjust pacemakers, do so mainly from observation. The first time they attempt to adjust a pacemaker on their own is on a patient. The Pacerman, a simulator currently on the market, is expensive, has limited portability and can only generate a restricted range of training signals. To improve the training that medical students receive, we designed an interface between the clinically used temporary pacemaker, a hospital monitor and an Android application that generates a customizable ECG waveform.

The instructor can fully adjust the ECG signal on an Android tablet by changing parameters, such as wave intervals and amplitudes, and setting a minimum threshold that must be met by the pacemaker output in order for the ECG to be corrected. These parameters are sent from the Android tablet over Bluetooth to our device's Raspberry Pi. The Raspberry Pi then outputs multiple forms of the ECG voltage signal using Digital to Analog (DAC) converters to the hospital monitor and Atria and Ventricle inputs of the pacemaker. The student adjusts the pacemaker in response to the ECG shown on the hospital monitor. The pacemaker then reacts to the Atria and Ventricle inputs supplied by the Raspberry Pi and DAC. The spikes are quantitated by our device's Arduino connected to our Raspberry Pi and overlaid on the ECG signal on the hospital monitor through the monitor's three-lead system. If the pacemaker input meets the threshold set by the instructor the ECG will be corrected to give positive feedback to the student. If the threshold is not met, the student will continue to see an irregular ECG on the hospital monitor.

Results are shown in multiple tests between the pacemaker and circuitry showing accurate measurement of pacemaker signal, as well as qualitative tests showing proper communication between the multiple components. The Arduino is able to quantitate signals from the pacemaker and consistently send those values through USB to the Pi, the Pi can successfully send data over Bluetooth to the tablet, and the Pi can consistently generate ECG signals that can be displayed on the hospital monitor.

Our device will be tested with medical students at UW-Hospital and improvements will be made based on their feedback. There is also potential for this device to be manufactured in bulk as it is a low-cost and more versatile alternative to competitors. Our simulator will greatly improve skills acquisition, especially in emergency clinical settings, and better prepare medical students for the challenges to come.