Arterial Pulse Velocity Instrument

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EXTENDED ABSTRACT

The propagation velocity of the pressure wave created by the arterial pulse is known as the pulse wave velocity, or PWV. The PWV can be measured non-invasively on a continuous beat-to-beat basis using a variety of methods that detect the pulse at two consecutive locations and use the resulting transit time and travel distance to calculate the pulse wave velocity. Current research shows that the PWV correlates to a variety of important health indicators, including a direct correlation to a patient's blood pressure. In addition, a pulse wave velocity instrument can be constructed to be both portable and accessible to the average home user.

The goal of the project was to design, build, and test a prototype instrument that measures and displays the PWV in blood traveling between the brachial and radial arteries. The measurements had to be taken continuously on a beat-to-beat basis and displayed to the user every fifteen seconds with a precision of 100 mm/s and an accuracy of +/- 5%. The device was required to be as small and as light as possible to maximize portability. The instrument was also required to be safe, reliable, and easy to use.

In order to achieve this goal, the design was split into three major components: transducer, signal processing, and storage media portions. The final transducer design uses two infrared emitting diodes and a phototransistor for its high emitter power coupled with a balanced power consumption, cost, and spectral efficiency. The final processing design is a digital comparator design that leverages the advantages of software to minimize the amount of hardware needed. The design uses a PIC microcontroller to pole both the brachial and radial signals for a pulse and measure the time between the two pulses. The selected storage media design uses an FTDI chip that automatically allows any personal computer to read EEPROM using a standard USB port. The FTDI design takes advantage of the widespread accessibility of USB and the simplicity of EEPROM. The prototype was constructed on printed circuit boards and placed in a small portable and arm-mounted processing case along with two transducer bands. The final cost for constructing the design was $108.11.

Modular testing was used to make sure each piece of the design was operational. Tests included validating that the signal and filter spectrums were aligned and that the resulting analog and digital signals contained the PPG information. These tests were carried out using oscilloscope testing, fast Fourier transforms, and digital-to-analog verification of the digital signal. The power and memory storage media were also tested, verifying that the voltage and current outputs were within specifications and that the processor could successfully store information on the EEPROM in a USB-accessible fashion. Finally, system-wide testing was conducted to ensure that the device was integrated successfully and that reported measurements met the accuracy and precision requirements.