A College of Engineering Freshman Project: Automatic Blood Pressure Measurement

Objectives: You will be developing an electronic medical instrument – specifically an automatic blood pressure measurement device. In doing so, you will: experience the general engineering design & development process; consider engineering tradeoffs by contrasting competing approaches; and learn about sensors, analog electronics, digital processors and more.

Multi-Disciplinary Content: To design and develop an effective automatic blood pressure measurement device, your design team must have expertise in the following fields of study: human cardiac physiology, fluid dynamics, health care, sensors & analog electronics, and digital processors. Through four labs, and interactive lectures with experts in these fields, you will learn how these expertise contribute to the successful development of a device. Concerning broader applicability, sensors, analog electronics, and digital processors are used in all fields of engineering – whenever a physical structure or process is monitored and/or controlled automatically.

Blood Pressure Measurement (BPM): You are probably familiar with having your blood pressure measured manually by a health care clinician. As depicted in Fig. 1, a manual stethoscope approach is used, during which an arm cuff is inflated/deflated, and sound from the stethoscope is used to determine when to read cuff pressure off a pressure gauge.

An automatic device, illustrated in Fig. 2, is a less accurate but often more convenient alternative. To mimic the manual approach, you will develop an automatic device using a pressure cuff and pressure sensor along with a signal used to determine when to read cuff pressure off the pressure sensor. Your team will consider one of three approaches to determine when to read pressure, using a pulse signal derived from either: a stethoscope sensor, a finger-pulse sensor, or an oscillometric signal.

Lab 1: Manual BPM – lead by a medical doctor, you will perform the task manually, and thereby appreciate the challenge of building an automatic device.
Lab 2: Signal Processing of Pulse/Pressure Signals – you will explore what a digital processor must be designed to do in order to automatically compute a BPM using cuff pressure and pulse signals.
Lab 3: Sensors and Analog Electronics – you will build and test an analog electronic circuit used in the oscillometric BPM approach. In Fig. 3 you can see the circuit you will build (lower right) and the test configuration you will set up to test it.
Lab 4: Automatic BPM – your team will be formed, and assigned sensor and digital processor types to be used to develop an automatic device. Your team will first learn to acquire & process signals from your sensors. You will then use analog electronics to interface your sensors to your digital processor. In culmination, you will process your sensor signals using your digital processor to automatically derive BPMs.

For more information, feel free to contact Professors Kevin Buckley (kevin.buckley@villanova.edu) and Lunal Khuon (lunal.khuon@villanova.edu).