Pyarelal Tanvar / Prof. P. C. Pandey and Prof. L. R. Subramanyan (Supervisors), "Arm Simulator for Blood Pressure Measurement", M. Tech. dissertation, Department of Electrical Engineering, Indian Institute of Technology Bombay, June 2013.

ABSTRACT

Arm simulator is an instrument for simulating behavior of the arm during noninvasive measurement of blood pressure (BP). It is used for testing and calibration of BP monitor and can also be used to train healthcare personnel in making correct BP measurements on patients with wide ranging cardiovascular conditions. Objective of this project is to develop an arm simulator for both auscultatory and oscillometric methods of BP measurement and with the facility of setting heart rate, systolic and diastolic pressures, pulse volume, and level of arrhythmia, over a full clinical range. The instrument is in the form of a cylinder around which the cuff of the BP monitor is wrapped. A controller card inside the cylinder senses the air pressure in the cuff and mimics the behavior of an arm by generating Korotkoff sounds and oscillations in the air pressure inside the cuff at each heart beat. A PC based graphical user interface is used to set simulation parameters through a serial port. The controller card is designed using a 16-bit microcontroller with on-chip ADC and DAC. It has a pressure sensor and a force sensor for dynamically sensing the air pressure in the cuff. The pressure sensor provides an accurate sensing, but it requires connection to the cuff tubing using a T-connector. The force sensor is located on the cylinder surface and it measures the force exerted by the cuff wall on its sensing area. Its output is used to obtain the value of the cuff pressure. It does not require a connection to the cuff tubing, but the sensed values of the cuff pressure may be relatively less accurate. The cardiac pulses are generated at the set heart rate, with arrhythmia simulated by a random variation in the heart beat interval. For BP measurement using auscultatory method, the Korotkoff sound pulses, pre-stored in the program memory of the microcontroller, are output through a small speaker at each heart beat in accordance with the sensed value of the cuff pressure. For oscillometric method, a linear actuator is used to apply force pulse against the cuff wall and thereby to generate pressure oscillations in the cuff. The amplitude of the Korotkoff sound and pressure oscillations are scaled in accordance with the set value of the pulse volume and the sensed value of the cuff pressure.