A Portable Bioimpedance Spectroscopy Measurement System for Management of Congestive Heart Failure

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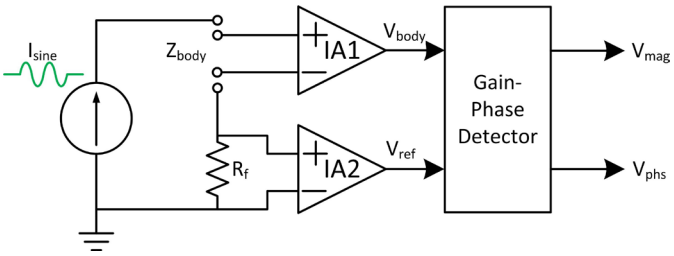
Sponsorship: MEDRC, Analog Devices, Inc.

An estimated five million people are currently diagnosed with congestive heart failure (CHF) in the United States, with over 400,000 new diagnoses annually. Almost one in two patients will be readmitted to the hospital within four to six months of discharge. Readmissions can occur when the patient becomes fluid-overloaded due to poor medication and/or diet compliance, among other reasons. Up to 50% of these early re-admissions may be prevented if symptoms are recognized early enough and medication and diet compliance improve.

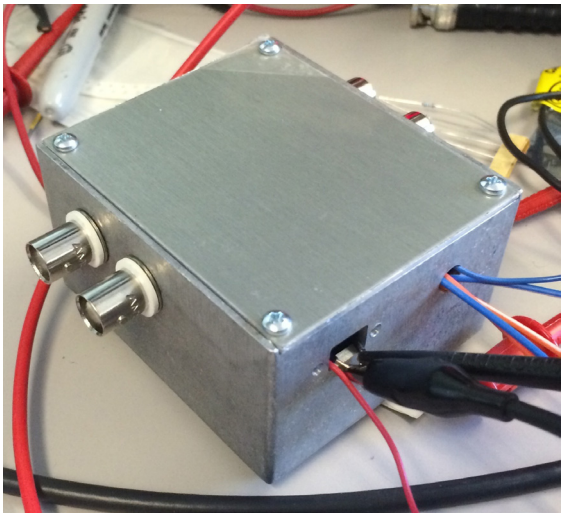
CHF is frequently associated with significant fluid retention in the lungs and legs. Bioimpedance techniques can be used to estimate the fluid levels in a patient non-invasively. These measurements have been shown to be predictive of heart failure decompensation up to 14 days before an event occurs.

We have developed a portable bioimpedance system that can measure body impedance from 1 kHz to 1 MHz. The system uses the magnitude-ratio and phase-difference detection (MRPDD) method to calculate the magnitude and phase of the measured impedance (see Figure 1). The system is enclosed in aluminum box (see Figure 2) and can be used with four co-axial cables. Data from the device is transmitted over Bluetooth to an iOS device.

The device has been tested with RC networks and with two healthy participants at MIT's Clinical Research Center. The device will be tested in the hemodialysis unit at Massachusetts General Hospital in 2016.



▲ Figure 1: A schematic overview of the MRPDD method. A fixed sinusoidal current is driven through the body and a sense resistor. The voltage is amplified and measured by a gain-phase detector chip (AD8302).



▲ Figure 2: The portable bioimpedance spectroscopy measurement system inside the enclosure.

FURTHER READING

- M. Delano and C. G. Sodini, "A Long Term Wearable Electrocardiogram Measurement System," *Body Sensor Networks Conference,* pp. 1-6, May 2013.
- E. Winokur, M. Delano, and C. G. Sodini, "A Wearable Cardiac Monitor for Long-Term Data Acquisition and Analysis," *IEEE Transactions on Biomedical Engineering*, vol. 60, pp. 189-92, Jan. 2013.
- D. He, E. S. Winokur, and C. G. Sodini, "An Ear-worn Vital Signs Monitor," *IEEE Transactions on Biomedical Engineering*, vol. 62, no. 11, pp. 2547-2552, November 2015.