Docket #: S20-303

Coupling-independent, Real-time Wireless Resistive Sensing through Nonlinear PT-symmetry

Technology Reference
CZ Biohub ref. no. CZB-177S
Stanford ref. no. S20-303

Researchers at Stanford have developed a method for real-time wireless resistive sensing using non-linear PT-symmetry.

Fully passive sensors are lower cost and less complex than their active sensor counterparts. Indeed, fully passive sensors consist of two primary components: an inductor and a sensing element. Sensing elements are either a capacitor or a resistor whose value fluctuates in response to a measurable parameter. This measurable parameter is read in fully passive sensors by magnetically coupling a primary or reader coil to the sensor coil. Sensor measurement is performed by detecting fluctuations in the impedance profile (the effective resistance of an electric circuit or component to alternating current) of the reader coil that corresponds to variations in the sensor. Measuring these fluctuations proves difficult due to the necessity of sizeable lab equipment and the fact that measurements are prone to errors when performed at different distances and orientations. However, when a resonant reader (inductive-capacitive) is tuned to the same resonant frequency as the sensor, it improves the sensitivity of the sensor to fluctuations. This results in impedance fluctuations with sharper features, allowing for more accurate measurements.

Stage of Research
The inventors establish a sensing method that enables robust measurement in a real-time, distance immune fashion. This system uses fully passive resistive sensors for coupling independent, powerful wireless sensing. This invention removes the

need for sweeping, which allows the system to convey real-time, single point sensing. Self-oscillation remarkably simplifies the reader and is achieved through a fast-settling nonlinearity. This fast-settling nonlinearity has a voltage amplitude that is proportional to the sensor's resistance. Additionally, system analysis is generalized to arbitrary operating conditions through a dual time-scale theoretical framework. Finally, detuning from PT-symmetric conditions by an order of magnitude allows for a robust correction strategy that reduces errors in the system. This technology is largely applicable to health care innovations, specifically wearable, bedside, or point of care health monitoring and sensing due to its cost effective and light-weight properties.

Stage of Development
Research- *in vitro*

Applications

- Development of a point-of-care system to measure metrics such as heart rate, temperature, and blood pressure
- Development of health care consumer devices for simple, handheld measurement of a user's health conditions
- Potential for use in a home healthcare device that could interface to the cloud via legacy technologies such as WiFi or BLE to enable healthcare providers to access real time metrics on their patients' vitals and health records

Advantages

- Sensing using this system is able to be performed in real time
- Sensing using this system is distance and orientation agnostic
- This system is lighter and more cost effective than other similar systems available

Publications

- Siavash Kananian, George Alexopoulos, and Ada S.Y. Poon. "Coupling-Independent Real-Time Wireless Resistive Sensing Through Nonlinear PT

Symmetry" Phys. Rev. Applied 14, 064072 – Published 28 December 2020.

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