Divergent Exceptional Points: A Promising Tool for Telemetric Sensing

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Telemetric sensing based on zero-power, maintenance-free wireless inductor-capacitor (LC) sensors is an intriguing and viable solution for continuous monitoring of miscellaneous quantities (e.g., temperature, pressure, humidity, and chemical reactions) in many industrial, medical, and automotive applications, especially when there is wired connection between the sensor and the data-acquisition system in, for example, rotary objects and harsh environments. Despite the rapid advent of design and manufacturing of wireless passive LC sensors, the wireless readout scheme has remained unchanged over past decades. In this talk, we will discuss new higher-order parity-time (PT)-symmetric telemetric systems with divergent exceptional points (DEPs) to significantly improve sensitivity of wireless sensors systems based on magnetically-coupled LC resonators. The proposed higher-order PT-symmetric telemetric sensing system exploits an active reader (-RLC oscillator) and one or more neutral intermediators (LC tnak) to contactlessly read a wireless sensor (RLC oscillator) via magnetic coupling. Due to the divergently bifurcating eigenvalues near DEPs, which occur only in higher-order PT-symmetric telemetric systems, the resonance frequency drift as a function of the sensor/actuator impedance can have a very large slope, implying an unprecedented sensitivity and resolvability. We found that by increasing the order of PT-symmetric system, it is possible to enhance the level of eigenfrequency bifurcation and to further reduce the critical magnetic coupling strength. We will present our recent theoretical and experimental results pertaining to the analysis, design, prototyping, initial characterization, and potential application scenarios of the proposed telemetric sensing method. We envision that our approach may have an impact on various zero-power wireless LC sensors that have been widely researched and deployed in harsh areas.