First and Higher-Order PT-Symmetric Telemetric Sensing Systems

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Telemetric sensing using passive wireless micro/nano-sensors is one of the most viable ways to continuously measure miscellaneous quantities (e.g., pressure, temperature, and chemical reactions) in many medical, automotive, and industrial applications, where the wired connection between the sensor and the data-acquisition system is not accessible. Despite rapid progress in micromachined and nanotechnological LC sensors, the wireless readout method basically remained unchanged over past decades. Still, Q-factor and poor sensitivity of wireless LC microsensors are usually hindered by power dissipations in these electrically small devices. In this talk, we will discuss a novel parity (P)-time (T)-symmetric telemetric system to enhance the Q-factor and sensitivity (including modulation depth and spectral response) of wireless LC microsensors. The proposed PT-symmetric telemetric sensing system consists of an MEMS-based wireless pressure sensor (RLC tank) that is detected by an active interrogator (-RLC tank) via inductive coupling. We will present our recent experimental results that show significantly enhanced Q-factor compared to that of the passive system. Moreover, around the exceptional point of this PT-symmetric telemetric system, the frequency shift due to capacitance perturbations (i.e., caused by changes in applied pressure) can be quite drastic. Further, we extend the first-order PT-symmetric telemetric system to the higher-order one, which comprises multiple active and passive RLC tanks. We found that by increasing the order of PT-symmetric system, it is possible to enhance the level of eigenfrequency bifurcation under capacitive perturbations, implying that a greater sensitivity can be obtained. In addition, the required inductive coupling strength can be reduced by increasing the order of PT system. Our results may have an impact on versatile compact wireless LC sensors with many medical, industrial and environmental applications, including the rapidly emerging internet-of-things (IoTs).