

## Time Varying Electric Circuits Of Enhanced Sensitivity Based On Exceptional Points Of Degeneracy

Tech ID: 33929 / UC Case 2021-705-0

### BRIEF DESCRIPTION

Sensors are used in a multitude of applications from molecular biology, chemicals detection to wireless communications. Researchers at the University of California Irvine have invented a new type of electronic circuit that utilizes exceptional points of degeneracy to improve the sensitivity of signal detection.

### FULL DESCRIPTION

The ability to detect very weak signals is desirable in a variety of sensor applications, including biological sensors (for proteins in blood or other fluid samples), chemical sensors (for detecting toxins in drinking water), and physical sensors (to detect pressure, temperature, acceleration, and frequency changes). Many standard sensors are based on a circuit whose resonance shifts when a physical, chemical or biological perturbation occurs. The invented electronic circuits that forms the electronic reading part of a sensor operates at an exceptional points of degeneracy (EPD), where at least two or more eigenmodes have the same resonance frequency. The use of EPD lend greater sensitivity to detect changes in system perturbations. For this reason, running circuits at EPDs improves the detection of small fluctuations in sensor inputs. EPD circuits based on parity-time (PT) symmetry (balanced circuits with the same number of inductive and capacitive components) must include two identical coupled resonators that have symmetric gain and loss settings. Therefore, PT circuits can be more complex and therefore more expensive to produce than the one invented at UCI. Indeed, this invention has a simple resonating circuit comprised of at least one resonator and a time-modulated component (such as a capacitor or inductor) and the frequency of EPDs in the circuit can be set by altering the frequency of such modulation frequency and depth.

### SUGGESTED USES

- » Medical diagnostics and monitoring
- » Industrial process control
- » Automotive safety and performance monitoring
- » Environmental monitoring

### ADVANTAGES

- » **Sensitivity:** improved over standard resonance-based sensors
- » **Manufacturability:** easy to make
- » **Affordability:** as current sensors
- » **Simplicity:** this invention uses the most basic circuit that can support EPD based on a single resonant circuit with a time-varying element
- » **Wide Applicability:** these circuits can be used to measure small perturbations in applications like biological sensors for blood protein levels, or physical sensors for pressure and heat, among others

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### OTHER INFORMATION

#### CATEGORIZED AS

- » **Computer**
  - » Hardware
- » **Sensors & Instrumentation**
  - » Biosensors
  - » Environmental Sensors
  - » Medical
  - » Other
  - » Physical Measurement
  - » Position sensors

#### RELATED CASES

2021-705-0

» **Scalability:** components of the circuit be implemented in chip technology as well

## PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,921,136	03/05/2024	2021-705

## RELATED MATERIALS

» Experimental demonstration of exceptional points of degeneracy in linear time periodic systems and exceptional sensitivity. H. Kazemi, M.Y. Nada, A. Nikzami, F. Maddaleno, F. Capolino, *Journal of Applied Physics* 131 (14), 2022.

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