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Strong Signals

We've all felt the negative effects of radio interference, which has been with us since the days of the telegraph. It can show up as a minor annoyance such as radio static or as a major problem that renders wireless systems completely unusable. Society's growing reliance on electronics has only amplified the issue because the number of potential sources of interference grows by the day.

Loai Salem, an assistant professor in the Department of Electrical and Computer Engineering (ECE) at UC Santa Barbara, has proposed an innovative solution to silence the interference. His project, centered around his own invention, has so much potential that it piqued the interest of the U.S. Department of Defense (DoD). As a result, the DoD's Defense Advanced Research Projects Agency (DARPA) has presented Salem with its prestigious Young Faculty Award.

"I am very grateful to receive the award," said Salem, who joined UC Santa Barbara in September 2018. "This will allow me to contribute to future generations with technologies I believe will greatly improve society and our quality of life."

The DARPA Young Faculty Award program seeks to identify and engage rising research stars in junior faculty positions in an effort to develop the next generation of scientists who will address national security challenges. Award winners receive up to three years of grant funding and mentorship opportunities with DoD contacts.

"We are extremely proud of Professor Salem, and we congratulate him on this recognition of his outstanding research that could benefit anyone with a handheld

device," said Rod Alferness, dean of UC Santa Barbara's College of Engineering. "He reflects the college's strong tradition of hiring the best junior faculty, who go on to be recognized for their innovative research that addresses society's biggest challenges."

Salem's research focuses on power management, radio frequency circuits and their applications. Power management integrated circuits (ICs) are responsible for regulating the direction and flow rate of electrical power taken from the platform battery in portable and wireless devices.

Radio interference remains prevalent because all electronic devices emit a certain amount of electromagnetic radiation. Interference occurs when one device's radiated energy is unintentionally picked up by another, creating an audible noise or a compromised connection. Some interference is caused by components in a device that do not adequately shield the noise. Devices transmitting on or near the same frequency of the spectrum have the same effect. The end result in either case is crossed signals, where a device is listening for one signal at a specific frequency but hearing another.

Current techniques for reducing the effects of interference center around narrow-band filtering, which isolates a smaller band of frequencies from a wider bandwidth signal. These methods have a limited ability to suppress interference, and they drain batteries because they require a significant amount of power for feedback.

To combat the interference more efficiently and effectively, Salem intends to create the first fully integrated, self-adaptive radio receiver to facilitate high-quality communication. The key to the technology is Salem's own invention, a novel two-port electric element that automatically adapts its response to reject all undesired signals. Salem believes that the technology will revolutionize wireless communication.

"Imagine two people communicating with each other while a third person is shouting in the background," Salem said. "The people communicating would not be able to hear each other because of the interference. That's what we experience today. My invention will allow transceivers to hear each other, even if a loud noise source is transmitting over the same communication channel."

Salem submitted his DARPA proposal just two months after he started working at UC Santa Barbara. He said the encouragement he received from senior faculty in the

ECE department and in the College of Engineering played significant roles.

“I believe the secret to junior faculty’s success at UCSB is the ultimate belief by senior faculty here that they are hiring science and engineering rock stars. It is a self-fulfilling prophecy,” said Salem, who specifically praised ECE Professor James Buckwalter for his continuous encouragement and Dean Alferness for his support. “The senior faculty’s positive energy encourages you to raise your performance and work toward your dreams.”

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.