Distinguishing Electronic Devices Using Harmonic Radar

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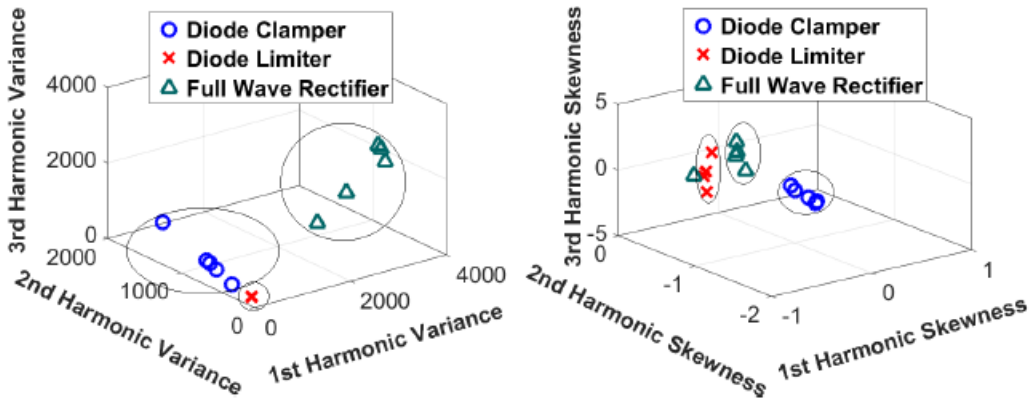
Predominantly most man-made targets show nonlinear characteristics that they re-radiate electromagnetic wave at the harmonic frequencies of the incident wave. Nonlinear or harmonic radar is an important topic for detecting, tracking and classifying man-made targets in clutter rich environments. It exploits the harmonic response of the re-radiated electromagnetic wave from nonlinear targets. Echoes, reflected from sea, ground, tree and etc, in other word clutter do not perform nonlinear behavior, but occurs at the frequency of the transmitted signal. Thus, prominent advantage of a nonlinear radar is high clutter rejection. Furthermore, compared to linear radar, nonlinear radar provides more information with higher order frequencies that shall be exploited for feature extraction as well. Therefore, it yields more information regarding the target. However, it requires high transmit powers to enhance signal-to-noise ratio (SNR) since the received powers at the harmonics are low.

Nonlinearity is also a fundamental phenomenon in all electronic circuits. Almost all electronic circuits present nonlinear response to an incident electromagnetic wave, and this occurs due to the existence of nonlinear circuit components such as semiconductors, diodes, transistors, amplifiers, mixers, etc.

In this seminar, a new approach to distinguishing electronic circuits using nonlinear/harmonic radar is presented. The radar transmits a single tone signal to the electronic circuits, consisting of nonlinear components, and exploits received harmonic response for separation. The transmitted signal power is swept within a determined range so that the received powers at each harmonic are analyzed to capture the nonlinear characteristics. To predict the behavior of the nonlinear circuits such as diode clamper, diode limiter and full wave rectifier, certain statistical features of the received powers are analyzed. The information related to the frequency content, which is the Fourier Transforms of the received harmonics, are analyzed. We show that frequency content also can be used to classify various nonlinear electronic devices. We show that the received power at the harmonics are distinctive for each circuit using Euclidean distances of features in feature space.



(b) Variance (c) Skewness

Statistical features of the first, second and third harmonics of the circuits.

BIOGRAPHY

Asst. Prof. Harun Taha Hayvaci received the M.S. and Ph.D. degrees from the University of Illinois at Chicago (UIC) in 2010 and 2012, respectively, in electrical and computer engineering. He joined the TOBB University of Economics and Technology, in 2012. Since then, he has been a faculty member in the Department of Electrical and Electronics Engineering of the TOBB University of Economics and Technology, Ankara, where he is currently an Assistant Professor. He has been at University of Naples at Federico II as visiting scholar in the Summer 2015. Prof. Hayvaci is working on Electromagnetic applications on defense industry, electromagnetic warfare and radar technologies. He is serving as the observer of many defense projects coordinated with the Scientific and Technological Research Council of Turkey (TUBITAK) in Turkey.