ASSESSMENT OF A REAL-TIME OPTIMAL COUPLING FREQUENCY MEASUREMENT SYSTEM IN COMPLEX ELECTRONIC DEVICES

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MASTER OF SCIENCE

by
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ABSTRACT

The work provided in this thesis focuses on the development of an at-range technique to identify optimal resonant frequencies of complex electronic devices. Prior to this work, the technique had shown promise at effectively measuring electrical resonant frequencies in a laboratory environment. In addition to improving the process, the feasibility of the technique in a real-time noisy environment is evaluated to determine its effectiveness in specific real-world applications.

The technique under examination is a type of excitation and measurement method where radiated electromagnetic waves are emitted via an antenna and then couples to the target device. The device reemits the coupled energy as electromagnetic backscatter at the device's resonance frequency which is measured. The interrogation signal used to couple to the device is derived from a predetermined bandwidth with a constant amplitude over said bandwidth to provide equal distribution of spectral density across the desired frequency spectrum. Initial measurements of this backscatter typically return seemingly arbitrary spectral content so to effectively hone into the dominant resonant frequencies the process is iterated multiple times. For every iteration the backscattered signal is time reversed which leads to power convergence on the incident target. Over multiple iterations the primary resonant frequencies become much more apparent due to the repetitive concentration of energy onto the specific frequency.

This iterative signal processing system was built and continuously improved to increase the capabilities of the process. Equipment was upgraded to allow for resonances to be measured at further distances and to allow for improved spectral bandwidth coverage. The system went through a verification test, measuring the resonance of a known wire acting as a dipole antenna to ensure accuracy. To evaluate the feasibility of the technique, the electrical resonance of a specific complex electronic device was identified multiple times considering many factors including orientation of the device, power status and range. In addition, the relationship between effective distance to the target device and initial emitted power was characterized. Finally, the technique was repeated in multiple environments with varying levels of noise and obstacles to explore the techniques robustness.

The work described in this thesis advances the understanding of dominant resonant frequencies for electronically complex devices. Whether or not the remote resonance measuring system has the potential to be viable in a real time practical environment is assessed.

The remainder of this thesis will be submitted

to the Defense Technical Information Center (DTIC)

Please contact Dr.Travis Fields at fieldstd@umkc.edu

for more information related to the content of this thesis

APPROVAL PAGE

The faculty listed below, appointed by the Dean of the School of Science and Engineering, have examined a thesis titled "Assessment of a Real-Time Optimal Coupling Frequency Measurement System in Complex Electronic Devices," presented by Ethan W. Gasta, candidate for the Master of Science degree, and hereby certify that in their opinion it is worthy of acceptance.

Supervisory Committee

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VITA

Ethan W. Gasta was born on January 5, 1996 in Hartford, CT. He attended South Windsor High School and Graduated in 2014. He then attended Tulane University in New Orleans, LA, graduating in 2018 with a Bachelor's of Science in Engineering Physics. Prior to graduation he worked at the engineering firm Black & Veatch as an Autonomy Integration Engineer. Since then, he has worked under Dr. Travis Fields in the Parachute and Aerial Vehicle Systems laboratory. Ethan's research has focused on testing the effects of high-powered microwaves on sUAV and developing unmanned aircraft vehicle path planning algorithms for wargaming scenarios. He will continue his career in the industry by designing and manufacturing specialized unmanned drones.