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Abstracts for Summer 2014 REU research projects

Design and Fabrication of Experiments for Automated System Identification

Abstract: An accurate system identification (SYSID) is crucial to understanding and controlling systems. Unfortunately, to understand the dynamics of a plant, one must take the system to its limits. Pioneering non-linear, time varying automated system identification requires simple systems to be created that can be altered and extended to their limits without permanently damaging or altering the dynamics of their behavior. To meet this requirement, a second generation coaxial rotational pendulum is being be designed and built. After construction, data will be collected to verify that the system is ready for research.

Distribution of Degeneracy in the Phenotypic Search Space of Grammatical Evolution Algorithms

Abstract: Grammatical evolution has been used to solve optimization problems and to mathematically model dynamic systems. A key element of grammatical evolution is its grammar. However, a method to quantitatively analyze the degeneracy of grammars has not been proposed. The purpose of this study is to explore the degeneracy of common grammars and to show the distribution of phenotypes in the phenotypic search space. MATLAB was used to program grammars, generate genes, collect similar phenotypes, and display the distribution of phenotypes. This research has produced a new method for analyzing degeneracy and shown the uneven distribution of phenotypes.

Recognition of Textural Differences in Infrared and Ultraviolet Imagery Using Fractal Characteristics

Abstract: This project utilized an algorithm written by Troy Thielen that is used to estimate the fractal dimension and lacunarity of gray-scale images. New ultraviolet and infrared images were taken throughout the project and analyzed using this algorithm. The fractal characteristics of these images were then analyzed to recognize textural differences within imagery, a useful method when attempting to recognize objects or locate targets. Differences between ultraviolet, infrared and visual imagery were analyzed, and additional implications of the recognition of textural differences were explored.

Implementation of a Linear Inverted Pendulum System for University Laboratory Instruction and System Identification Research

Abstract: Linear inverted pendulum systems are often used for controls research because they are well understood, easy to take measurements from, and are very nonlinear from a mathematics perspective. In addition, they can represent other systems, which allows new control techniques, such as nonlinear control theories, to be tested on such systems before moving to larger and more complex systems. In addition, examples with linear inverted pendulums can be found in any controls engineering or control theory textbook. To allow the study this classic example both at the university level, and for the Office of Naval Research, a belt-driven linear inverted pendulum system will be implemented. The system will use hardware-in-the loop and will use full-state feedback. It will be capable of reading position, angle, how they change with respect to time, and will apply corrections to itself according to that data. The system dynamics will be identified using system identification, and tested using a linear approximation of the system's dynamics. This will prove the functionality of the software and hardware that comprise the system.

Examination of Crosstalk on Transmission Lines

Abstract: Crosstalk is any phenomenon by which a signal transmitted on one circuit or channel of a transmission system creates an undesired effect in another circuit or channel. Electrical engineers have known of the existence of crosstalk since shortly after the advent of electronic circuits but instead of publishing how to identify it, what it looks like, and how it's created, what has been published is how to avoid and/or reduce its effects. This study will intentionally create circuit boards with varying degrees and types of crosstalk in an effort to educate future electrical engineering students on its appearance on an oscilloscope and other measurement devices.

Experimental Implementation of Spectrum Sensing for Cognitive Radio

Abstract: Cognitive radio (CR) is designed to detect available frequency bands/channels. Spectrum sensing plays a critical role in CR with energy detection being the most common method. In our project, we implement energy detection using GNU Radio and USRP boards as a test-bed. Specifically, energy detection is performed by using blocks in GNU Radio Companion (GRC) to calculate the energy of a present signal and compare it against a threshold to determine whether or not the channel is occupied by a signal. Extensive experiments are conducted and sensing performance including false alarm and misdetection is analyzed as well.

Performance of Vertically Polarized Half-Rhombic Antennas Fabricated with Direct-Write Technology

Abstract: This work presents performance results the testing of vertically polarized, half-Rhombic antennas fabricated with direct write technology. Antennas were built with conductive ink traces printed with nScrypt 600-3Dn-HP direct-write technology on a Kapton HPP-ST substrate. Chip resistors were soldered to the non-feed end of each antenna to act as a resistive termination. Antennas with a variety of included angles and resistor values were built. Measurements were taken by mounting antennas to a SMA connector on a ground plane. Performance was quantified by comparing the measured input impedance of each antenna with values obtained by numerical simulation.

Finite-Difference Time-Domain (FDTD) Models Evaluation using Staircased Wire Monopole Antennas

Abstract: This work presents results of research on a variety of staircased, i.e., repeated right angle bends, wire monopole antennas in order to assess the performance and accuracy of finite-difference time-domain (FDTD) models. The FDTD numerical method is used for electromagnetic simulations of many problems and geometries, e.g., wire antennas and ground penetrating radars. A vector network analyzer is used to measure the S-parameter S11 and input impedance of the antennas. This allows the change in the apparent velocity of wave propagation along the experimental staircased wire monopole antennas to be examined and compared to results from FDTD models.