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Abstracts for Summer 2015 REU research projects

Vivaldi Wire Antenna with Direct-Write Technology

Abstract: Research into the process of printing a Vivaldi wire antenna on a flexible polyimide substrate. This project will be a proof of concept design on using direct write technology focusing on Vivaldi wire antennas with and without resistive loading.

Automatic Control of the System Interface for Wind Turbines

Abstract: When operating in extreme wind conditions, wind turbines generate excess amounts of energy. This eventually leads to catastrophic failure, and the turbine becomes inoperable. To combat this, software was created to automatically check wind conditions. When wind velocity hits a critical level, the software shuts down the turbine. Thus, the turbine avoids failure without depending of manual oversight.

Development of a Low-Cost Multispectral Imager

Abstract: Multispectral imagers are cameras that take images in multiple areas of the electromagnetic spectrum and then use them to construct a composite image with data that cannot be seen by the human eye. These systems typically cost tens of thousands of dollars; however, a recent release of a cost effective long wave infrared camera has made the construction of a cheaper multi-spectral imager for less than a thousand dollars possible. The body of the camera system was 3D printed for optimal functionality. The software was written in Java and Python to make it user accessible and multi-functional.

Automation of a 3-Phase AC Motor and Assembly Line Using Allen-Bradley MicroLogix 1000 Programmable Logic Controllers (PLCs)

Abstract: The automation of factory machines is commonly done using programmable logic controllers (PLCs). Hands-on PLC training stations are helpful to train students how to use and program PLCs. Two different PLC training setups have been designed, one automating a 3-phase AC motor-generator set and the other automating a portion of an assembly line. Both of these machines are automated using Allen-Bradley MicroLogix 1000 PLCs which have been programmed with ladder logic control programs.

The Mechanization and Analysis of a Proton Exchange Membrane Hydrogen Fuel Cell

Abstract: Fuel cell technology is a strong candidate for future alternative energy, and is thus being researched and developed by many different groups for various purposes. The purpose of this study was to explore the reality of working with fuel cell technology by continuing the work of South Dakota School of Mines and Technology alumni Steve Gates, whose senior design project was the mechanization of a Ballard® Proton Exchange Membrane (PEM) Hydrogen Fuel Cell Stack. At the completion of Gates' project, the mechanization of the stack was not complete, thus this study focused on completing the unfinished aspects of making the stack functional, along with assessing the strengths and weaknesses of the stack. This required implementing tubing for gas/liquid flow, reviewing and finalizing the system electronics that Gates applied for sensing, adding power electronics so that the stack output is properly managed, and implementing a gas monitor for safe operation of the stack.

Adaptive Control System Design for Propulsion Systems used during Near-Earth Asteroid Capture Missions

Abstract: NASA's Asteroid Redirect Mission (ARM) is a robotic mission concept that aims to return near-Earth asteroids (NEAs) to a safe and stable orbit in cislunar space (situated between the Earth and the Moon) for the purposes of asteroid mining, scientific study, and planetary defense. Once captured, NASA proposes to employ a solar-electric propulsion (SEP) system to direct NEA's from solar orbit to cislunar space. This study investigates and develops a control system structure that may be used for the NEA/SEP system. Additionally, due to the difficulties associated with accurately characterizing the mass and density distribution of target near-Earth asteroids, this research looks primarily to investigate a means by which the SEP/NEA system dynamics may be experimentally characterized once a target NEA is captured by the SEP system. After system characterization, a predictive control scheme is employed to direct a captured NEA to a stable cislunar orbit.

Modeling the Relationship of Frequency, Temperature, and Resistivity of Vanadium Dioxide

Abstract: This report investigates the relationship of resistivity and frequency of a thin film of vanadium dioxide, VO_2, on a sapphire substrate as temperature changes and implements data to simulate an antenna utilizing thin films VO_2. Six 3D models were created from the VO_2 measured. Four models, two for resistivity and two for resistance, as temperature increases from 30°C to 100°C and as temperature decreases from 100°C to 30°C were made. Another two models were created for the imaginary for the same temperature ranges. From the data present on the models, an antenna using VO_2 was simulated using IE3D and compared to prior research done on a bowtie antenna with VO_2.