Pratt & Whitney
400 Main Street
East Hartford, CT 06108

PW2007-1

Pratt & Whitney
A United Technologies Company

NASA Space Grant Opportunity:

☒ Fellowship ☒ Project

Distributed Wireless Sensor Networks Software Radio

Available for: 1 student

Organization: Pratt & Whitney *Eagle Works*
Systems Engineering – Validation

Technical Lead: Mary Austin

P&W Space Grant Project Coordinator: Dr. William T. Cousins, 860-565-8589

Description

Software radio is the technique of getting code as close to the antenna as possible. It turns radio hardware problems into software problems. The fundamental characteristic of software radio is that software defines the transmitted waveforms, and software demodulates the received waveforms. This is in contrast to most radios in which the processing is done with either analog circuitry or analog circuitry combined with digital chips.

This work will require that the student explore the GNU radio, which is a free software toolkit for building software radios. The student will explore the use of the GNU radio, its capabilities, the interfaces to data acquistion systems and its scaleablility. A GNU radio simulation will be built demonstrating that the software is robust enough to support a wireless sensor network, is scaleable to thousands of sensors and can support data acquisition hardware. Hardware can be simulated if not available.

Skills Required

- The ideal candidate will have an interest in wireless sensor networks
- Computer programming skills in C/C++

Helpful Skills

- System simulation
- Graph theory and Python
- Computational Optimazation
- Experience with wireless systems, i.e. Bluetooth, UWB, GNU radio software etc. is a plus
- Implementing software on various processors such as DSPs and FPGAs
- Embedded skills are a plus
- Understanding of filters, modulation and demodulation schemes
- Digital signal processing and digital hardware
- Willingness to learn

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

PW2007-4

Pratt & Whitney
A United Technologies Company

NASA Space Grant Opportunity:

☒ Fellowship ☒ Project

Alternative Method for Reduction of Aluminum and Titanium Oxides

Available for: 1 student

Organization: Pratt & Whitney
Global Services Engineering

Technical Lead: Monika Kinstler

P&W Space Grant Project Coordinator: Dr. William T. Cousins, 860-565-8589

Description

Nickel base alloy turbine vanes in gas turbine engines operate in high temperature oxidizing environments that lead to formation of tight cracks. There are numerous diffusion braze processes, such as Pratt & Whitney's TURBOFIX[sm], that are capable of repairing these cracks and are known to the industry. However, for any of these processes to be successful, all oxides must be removed from the cracks to enable the repair material to infiltrate the crack. While some metal oxides, such as those of nickel and chromium are readily reduced by heat treatment in either hydrogen or vacuum, the oxides of aluminum and titanium are extremely stable and cannot be reduced by these methods.

The processes utilized throughout the industry to reduce aluminum and titanium oxides rely on either Teflon decomposition or HF gas combined with hydrogen, both performed at elevated temperature. However, while both processes successfully clean the parts, both cause some degree of surface attack to the overall component that can compromise the airworthiness of the part.

This project should examine alternate means of reducing aluminum and titanium oxides that exist in tight cracks of nickel base superalloy turbine vanes.

Being a newer and challenging area of study, the student working on this effort will work under the tutelage of the Technical Lead for this project; yet perform the work at their University location. Possible methods to approach the problem may include examination of other fluoride compounds, etc. A literature search in the area would also be appropriate.

Skills Required

- The ideal candidate will have an interest in chemical thermodynamics
- Interest in metallurgy

Helpful Skills

- A graduate student is preferred
- Good library skills

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

PW2007-5

Pratt & Whitney
A United Technologies Company

NASA Space Grant Opportunity:

☒ Fellowship ☒ Project

Determination of Swirl Flow Physics for Engine Inlets

Available for: Multiple students

Organization: Pratt & Whitney *Eagle Works*
Systems Engineering – Validation

Technical Lead: Dr. William T. Cousins

P&W Space Grant Project Coordinator: Dr. William T. Cousins, 860-565-8589

Description

Aircraft engine inlets are adversely affected by swirling flows. One swirl issue would be that of vortex ingestion from a ground vortex, upstream airframe component (such as a canard) that forms a vortex, or other "tight" vortex formed from some component.

A new industry recommended practice is being developed to describe swirl conditions and their effects on engine operation. In developing the mathematical relationships, it is necessary to determine some of the characteristics of what makes a tight vortex behave as it does in going from a free flowfield (open atmosphere) into an annulus (an engine inlet).

This project should examine the physical fluid mechanics of a vortex in one or more typical configurations of an engine inlet to determine some of the important parameters (i.e., static pressure distribution, closeness of the airframe to the inlet, shape of the inlet, etc.) that affect where the vortex "decides" to reside in the annulus once it is formed.

Being a newer and challenging area of study, the student working on this effort will work under the tutelage of the Technical Lead for this project; yet perform the work at their University location. Possible methods to approach the problem include wind tunnel tests with a basic setup, CFD solutions, etc. A literature search in the area would also be appropriate. Details of the proposed work should be discussed with the Technical Lead so that the project can be defined with the student's capability and resources.

Skills Required

- The ideal candidate will have an interest in the application of basic fluid mechanics
- Access to CFD software or lab facilities

Helpful Skills

- If CFD work is proposed, knowledge grid development and running a CFD code, such as Fluent
- Willingness to learn

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

PW2007-6

Pratt & Whitney
A United Technologies Company

NASA Space Grant Opportunity:

☒ Fellowship ☒ Project

Evaluate Applicability of Optical Strain Measurements Tool

Available for: 1 student

Organization: Pratt & Whitney *Eagle Works*
Systems Engineering – Validation

Technical Lead: Bruce Hockaday

P&W Space Grant Project Coordinator: Dr. William T. Cousins, 860-565-8589

Description

The lifetime of gas turbine engine airfoils are limited by vibratory fatigue. Evaluating peak strain as a function of vibration mode is imperative to insure flight safety. Present methods involve adhering resistive strain gages and wires to airfoils, which compromises the measurement by altering the structures mass and stiffness. Spatial data is cost prohibitive due to the expense of installing and removing large numbers of resistive strain gages.

A new optical strain measurement technique promises to generate data without altering the structures vibration characteristics. Adaptation of a “step and repeat” measurement system offers the opportunity to generate complete surface strain maps at minimal expense. Originally developed for static strain measurement, these techniques need to be adapted to dynamic strain to realize the full potential in aircraft engine airfoil validation.

This project will evaluate stroboscopic techniques to perform dynamic strain measurements with commercially available instruments. Accuracies issues will be examined as a function of vibratory frequency and airfoil curvature effects. A quantitative comparison will be made with resistive strain gage measurements when the dynamic optical strain measurements are viable.

It is anticipated that the student will perform the majority of this work at their University location. Dynamic evaluation could be performed at the industrial sponsors facility if required. This effort will include advisory input from the Technical Lead for this project.

Skills Required

- The ideal candidate will have a background, or interest, in optical instrumentation
- Image processing and laboratory testing

Helpful Skills

- Knowledge of photography regarding depth of focus as a function of f-stop
- Willingness to learn

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

PW2007-7

Pratt & Whitney
A United Technologies Company

NASA Space Grant Opportunity:

☒ Fellowship ☒ Project

Fiber Optical Sensor Evaluation

Available for: 1 student

Organization: Pratt & Whitney *Eagle Works*
Systems Engineering – Validation

Technical Lead: Bruce Hockaday

P&W Space Grant Project Coordinator: Dr. William T. Cousins, 860-565-8589

Description

Improvements in aircraft engine cycle efficiency are required to reduce fuel consumption. Advancements in engine performance necessitate better instrumentation to validate these performance gains. Immerging optical sensors for measuring pressure and temperature advertise an order of magnitude improvement in resolution.

This project will focus on evaluating the measurement uncertainty of commercially available fiber optic temperature sensors. These measurements will be performed with the instrument's signal conditioning equipment in an environmental chamber to control, or simulate, changes in ambient conditions. The sensor heads will be placed in temperature controlled reference baths providing the ability to separate sensor vs. signal conditioning errors.

It is anticipated that the student will perform this work at their University location. This effort will include advisory input from the Technical Lead for this project and help identifying sensor manufactures willing to have their equipment evaluated.

Skills Required

- The ideal candidate will have a background in instrumentation and laboratory testing
- Access to environmental test laboratory facilities

Helpful Skills

- LabView or other test automation software
- Willingness to learn

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

PW2007-9

Pratt & Whitney
A United Technologies Company

NASA Space Grant Opportunity:

☒ Fellowship ☒ Project

High Strength Composite Fatigue Project

Available for: 1 student

Organization: Pratt & Whitney
Compressions Systems Module Center

Technical Lead: Lisa McDaniel 860-344-4987/Jim Roach 860-704-7285

P&W Space Grant Project Coordinator: Dr. William T. Cousins, 860-565-8589

Description

This position offers the opportunity to develop a tool that predicts the damage evolution and ultimate life of a jet engine composite part.

This project will involve the implementation of a Strength Evolution Integral within a finite element code. The simulation will involve the use of laminated elements in order to predict how a jet engine component's stiffness and strength evolve over its use life.

Specifically, the project will be comprised of several milestones, beginning with the simulation of coupon specimens grounded to publicly-obtained material properties, moving up to sub-element geometry and ending with the successful simulation of an engine component. The position offers the experience of working, in a team environment, with engineers that deal both with jet engine technology and with composite material part design and analysis.

The student will be expected to document all work and be able to explain the results to their manager and to other engineers. A final presentation and review of the accomplishments will take place at the end of the session.

Skills Required

- Engineering background
- Familiarity with ANSYS or NASTRAN finite element analysis code and ability to run analysis code while at university.

Helpful Skills

- Familiarity with composite material classical laminate theory
- Exposure to Strength Evolution Integral concepts

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

PW2007-10

Pratt & Whitney
A United Technologies Company

NASA Space Grant Opportunity:

☒ Fellowship ☒ Project

Parametric CFD study of a Commercial Turbofan Bypass Duct

Available for: 1 student

Organization: Pratt & Whitney
Aerodynamics Engineering

Technical Lead: Bruce D. Reynolds

P&W Space Grant Project Coordinator: Dr. William T. Cousins, 860-565-8589

Description

Commercial aircraft engine bypass fan duct designs must find a balance between the desire to minimize engine length and weight and the risk of separating off the inner or outer walls and thus reducing performance of the system.

The recent development of advanced Computational Fluid Dynamics codes and computer hardware speed increases enables the engineer to study, using design of experiments techniques and/or automatic optimization applications the sensitivities that exist to design choice parameters such as axial length, radius change, curvature shape choices, etc. The project would be to take advantage of these recently developed capabilities to characterize the best design choices for a generic class of commercial fan bypass fan duct passages.

Being a very relevant area of study and one that would have certain impact to current and near-future engine programs, the student working on this effort will work under the tutelage of the Technical Lead for this project; yet perform the work at their University location. It is expected for the university to have a current version of the FLUENT CFD code installed and working on the campus computer system. A literature search in the area would also be appropriate.

Skills Required

- The ideal candidate will have an interest in the application of basic fluid mechanics
- Access to CFD software

Helpful Skills

- Because CFD work is proposed, knowledge of grid development and running a CFD code, such as Fluent
- Willingness to learn

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

PW2007-11

Pratt & Whitney
A United Technologies Company

NASA Space Grant Opportunity:

☒ Fellowship ☒ Project

Parametric CFD Study of Intermediate Case Designs

Available for: 1 student

Organization: Pratt & Whitney
Aerodynamics Engineering

Technical Lead: William D. Sprout

P&W Space Grant Project Coordinator: Dr. William T. Cousins, 860-565-8589

Description

Aircraft engine intermediate case designs must find a balance between the desire to minimize engine length and weight and the risk of separating the intermediate case flow and thus reducing efficiency of the system.

The recent development of advanced Computational Fluid Dynamics codes and computer hardware speed increases enables the engineer to study, using design of experiments techniques and/or automatic optimization applications the sensitivities that exist to design choice parameters such as axial length, radius change, curvature shape choices, etc. This project would be to take advantage of these recently developed capabilities to characterize the best design choices for a generic class of intermediate case passages.

Being a very relevant area of study and one that would have certain impact to current and near-future engine programs, the student working on this effort will work under the tutelage of the Technical Lead for this project; yet perform the work at their University location. It is expected for the university to have a current version of the FLUENT CFD code installed and working on the campus computer system. A literature search in the area would also be appropriate.

Skills Required

- The ideal candidate will have an interest in the application of basic fluid mechanics
- Access to CFD software

Helpful Skills

- Because CFD work is proposed, knowledge of grid development and running a CFD code, such as Fluent
- Willingness to learn

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

PW2007-12

Pratt & Whitney
A United Technologies Company

NASA Space Grant Opportunity:

☒ Fellowship ☒ Project

Research and Development of Innovative Energy Scavenging Methods

Available for: 1-3 student(s) (Ideally a multi-disciplinary team of 1-Mech. Eng, 1-Elec. Eng., and 1-Physics or Chemistry Student)

Organization: Pratt & Whitney
Measurement Center

Technical Lead: Justin R. Urban

P&W Space Grant Project Coordinator: Dr. William T. Cousins, 860-565-8589

Description

Development and validation of gas turbine engines requires acquisition of data from thousands of sensors per engine. Typically these sensors are connected to the data system via wires that have several failure modes and take a significant amount of time to route and connect.

Currently work is being carried out to transition to wireless sensors that will eliminate all of the failure modes associated with the wiring and eliminate all of the work required to route and make connections to data systems. These wireless sensors will require varying amounts of power for functions such as sensor excitation and data transmission. To date, most systems utilize batteries or power wires.

The issue with power wires is that the wiring has not been 100% eliminated. In the case of batteries, they need to be changed at some interval that is often too short relative to engine test schedules. In addition, some of the batteries will be extremely difficult or impossible to change.

The objective of this project would be to explore alternate methods of powering wireless sensors such as energy scavenging. Varying amounts of latent energy exists throughout operating engines as well as for some period after shutdown. Two obvious forms of this energy are vibrational and thermal.

The progression of work on this project would likely originate with a literature search to understand the current state of the art and follow with exploration and evaluation of promising technologies via experimentation and analysis. General power requirements will be provided by the technical lead and depending on the scope of the work chosen, collaboration with the technical lead can range from very little in the case of a research paper through weekly or monthly meetings to discuss experimental progress.

Skills Required

- The ideal candidate will have an interest in the application mechanical or electrical engineering or physics
- Understanding of basic thermodynamics and heat transfer
- Understanding of basic waves and oscillations

Helpful Skills

- Hands on ability to build and test simple systems for proof-of-concept
- Willingness to learn

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

PW2007-13

Pratt & Whitney
A United Technologies Company

NASA Space Grant Opportunity:

☒ Fellowship ☒ Project

Technology Search of Activities Related to the Use of Neutron Beams to Capture Gas Turbine-related Physical Data

Available for: 1 student

Organization: Pratt & Whitney *Eagle Works*
Systems Engineering – Validation

Technical Lead: Dudley Leggett

P&W Space Grant Project Coordinator: Dr. William T. Cousins, 860-565-8589

Description

The use of particle beams to look inside an operating gas turbine engine is not new. Cold neutron radiography was used back in 1979 to visualize oil jet performance on a Rolls Royce Gem engine; however, the high flux density required to make this technique real-time required the engine to be installed close to a reactor. Likewise, X-Ray test facilities were used at Pyestock in England and Middletown, CT to determine running clearances and axial movements but these clearly were a huge investment for such a limited test capability.

However, the Extreme Light Source (ELS) project at Wright-Patterson Air Force Laboratory has revived the vision of a particle beam test facility that can be used to capture the complete signature of a gas turbine throughout its operating regime.

So, it is envisaged that an extensive library search of all activities associated with the measurement of physical parameters relevant to the gas turbine industry would be performed. A summary report should be produced that defines the applicable research and identifies successes / limitations to the technology.

The ultimate goal of this initiative is to develop a “portable” neutron source that could be deployed in any test facility to enable the non-invasive measurement of gas turbine operating characteristics. The Technical Lead will discuss with the student researcher the boundaries of the project.

Skills Required

- An interest in the application of particle beams to measure physical data
- Web-based technical research and other library applications

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

PW2007-14

Pratt & Whitney
A United Technologies Company

NASA Space Grant Opportunity:

☒ Fellowship ☒ Project

Measurement Uncertainty Analysis Tools

Available for: 1 student

Organization: Pratt & Whitney *Eagle Works*
Systems Engineering – Validation

Technical Lead: Mary Austin

P&W Space Grant Project Coordinator: Dr. William T. Cousins, 860-565-8589

Description

Pratt and Whitney Eagle Works Systems Engineering and Validation group supports the advancement of validation of engine sensor data. Terabytes of sensor data is collected from engine tests. The purpose of collecting the engine parameter data is to numerically characterize the state or performance of the physical process of a running engine. Properly understanding the data from measurements requires a statement of uncertainty. To address the statement of uncertainty, software tools will be developed that can be integrated and used across various test systems to identify the uncertainty of the measurements.

The student will create a library of uncertainty tools and will then integrate the numerical uncertainty methods with various data formats and databases so the tool can be ported to different uses.

Skills Required

- The ideal candidate will have an interest in the application of uncertainty theory and mathematics
- Java, HTML, SQL , Oracle or other database experience

Helpful Skills

- Willingness to learn
- Statistics
- Building software programs with user interfaces

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

PW2007-15

Pratt & Whitney
A United Technologies Company

NASA Space Grant Opportunity:

☒ Fellowship ☒ Project

Benchmarking the Manufacturing of Gas Turbine Engine Components

Available for: 1 student

Organization: Pratt & Whitney - Manufacturing Engineering

Technical Lead: Brian J. Schwartz –Technology Manager Manufacturing

P&W Space Grant Project Coordinator: Dr. William T. Cousins, 860-565-8589

Description

Manufacturing of gas turbine engine components is a challenging and changing environment. Aircraft engine components often are composed of high temperature alloys in complex configurations that often challenge the state of the art manufacturing processes. The goal of this program is to compare and contract best practices in the areas of machining, drilling, welding, broaching, rapid prototyping, coatings and other manufacturing methods against other competitors and the supplier base. This information would be summarized to better understand trends in the industry.

The student would interact with manufacturing development engineers in the areas above to better understand these processes and the manufacturing challenges in producing them.

The student working on this effort will work under the tutelage of the Technical Lead for this project; yet perform the work at their University location. Possible methods to approach the problem include web searches, publications and other information available in the public domain.

Skills Required

- The ideal candidate will have an interest in advanced manufacturing methods and have excellent research skills