Selection Abstract
FY20 NASA Research Announcement (NRA) NNH20ZHA001N for the NASA OSE Fellowship Activity

The National Aeronautics and Space Administration (NASA) journeys have propelled technological breakthroughs, pushed the frontiers of scientific research, and expanded our understanding of the universe. These accomplishments, and those to come, share a common genesis: education in science, technology, engineering, and mathematics (STEM). NASA’s Office of STEM Engagement (OSTEM) seeks to leverage NASA’s unique mission activities to enhance and increase the capabilities, diversity, and size of the nation’s next generation STEM workforce needed to enable future NASA discoveries, including NASA’s Artemis Program that begins the next era of exploration.

The NASA Fellowship Activity is designed to provide academic institutions the ability to enhance graduate-level learning and development. Institutions are provided funds that support graduate students at a level that allows the students to fully concentrate on academic and research proficiency without the need to seek employment.

NASA STEM Engagement delivers tools for American students and educators to learn and succeed. The objectives are:

- Create unique opportunities for students and the public to contribute to NASA’s work in exploration and discovery;
- Build a diverse future STEM workforce by engaging students in authentic learning experiences with NASA people, content, and facilities; and
- Strengthen public understanding by enabling powerful connections to NASA’s mission and work.

To achieve fellowship goals, NASA STEM Engagement strives to enhance higher education, support underrepresented communities, and strengthen online education. The intended outcome is a generation prepared to code, calculate, design, and discover its way to a new era of American innovation.

The most recent NASA Fellowship Program NRA was released on December 23, 2019. Proposals were due by February 21, 2020. NASA received a total of 279 proposals in response to this NRA. All compliant proposals were evaluated against the following factors for award:

- Scientific Merit of the proposed research: 1) proposal addresses in the scientific research and literature 2) proposal clearly describes a collaborative approach with a NASA installation 3) research is in alignment with academic goals;
- Academic Merit: 1) ability to synthesize and evaluate original thoughts into a clear and concise document 2) previous experiences conducting research and/or desire/potential to conduct research in an authentic lab setting 3) intrinsic motivation; and determination to complete an advanced degree, broader impact of research,
- Broader Impact: the proposed research’s potential to benefit society or advance desired societal outcomes. These include activities that are directly related to the specific research projects or activities that are supported by, however complimentary to, the project. For instance, participation by an under-represented and underserved community, enhancement of STEM education and educator development, improved well-being of individuals, increased partnership between the academia and industry, and improved national security; and
- Funding Criteria (e.g. Minority University Research and Education Project (MUREP) requirement to execute activities to enhance the involvement of all MSIs in NASA’s mission).
NASA Awards Over $3 Million in Fellowships to U.S. Institutions

NASA has awarded 22 fellowships to U.S. institutions, which will begin in the 2020 Academic Year. Through its Minority University Research and Education Project (MUREP), 17 minority-serving institutions have been selected. Through its Centers, using project funds associated with the Aeronautics Research Mission Directorate (ARMD), Science Mission Directorate (SMD), Science and Technology Mission Directorates (STMD), and the Human Exploration and Operations Mission Directorate (HEOMD), five majority institutions have been selected. These awards total over $3 million to support graduate student research.

The recipient institutions of MUREP fellowships are:

**Submitting Institution: New Mexico State University**  
State: NM  
Name of Student: Ali Hyder  
Abstract

This proposal presents a methodology to constrain the 3D atmospheric energy cycle of Jupiter, using data from the Jovian Infrared Auroral Mapper (JIRAM) imaging spectrometer on board the Juno spacecraft. The approach is outlined to use the JIRAM spectral data to inform the vertical velocity flows in the atmosphere via the vertical mixing strength using observations of trace gas species germane, phosphine, and arsine in the 5-micron window. The use of JIRAM’s imaging data is further outlined in cross-correlation schemes to determine horizontal velocity flows of latitudes poleward of ±60˚. The atmospheric energy cycle will be constrained via numerical simulations of the breakdown of horizontal banded structure at low latitudes to vortex morphologies at high latitudes, using the Explicit Planetary Isentropic Coordinate (EPIC) code and study how the 3D dynamics relate to the underlying disequilibrium chemistry of Jupiter’s troposphere."

**Submitting Institution: University of New Mexico**  
State: NM  
Name of Student: Megan Hoffman  
Abstract

This study will review images from the Curiosity, Opportunity, and Spirit rovers to identify and measure the diameters of small craters. Once a comprehensive survey has been collected, our crater distributions will be compared with model predictions. The models are based on either a constant atmospheric pressure or a fluctuating atmospheric pressure. The pressure fluctuates because the tilt of Mars varies, which results in melting or freezing of the carbon dioxide ice at the poles. Comparing the observed craters with model estimates will provide insight into the dynamics of the recent atmosphere. Understanding how the tilt of Mars affects the modern atmosphere could help refine our understanding for how much carbon dioxide is available at the poles to interact with the atmosphere. In addition, erosion rates are controlled by the properties of the atmosphere, so exploring the dynamics of the atmosphere will assist in refining known rates.

**Submitting Institution: University of California, Davis**  
State: CA  
Name of Student: Samantha Sharp  
Abstract

The frequency and magnitude of harmful algal blooms of cyanobacteria in fresh, brackish, and marine waters are increasing around the world. Additionally, the high spatial and temporal variability of bloom
organization complicates our understanding of bloom dynamics. For my doctorate research, I propose to quantify the variability of cyanobacteria in freshwater lakes using a combination of autonomous underwater and aerial robotics. This applied research study will validate remote sensing tools across aquatic systems in California. Ground-truthing data will be collected and used to calibrate and validate remote sensing algorithms aimed at detecting cyanobacteria. Validated remote sensing data coupled with the coincident in situ data will offer a holistic view of cyanobacteria blooms across varying blooms and resolutions, which will be used to understand the dynamics of cyanobacteria blooms. The results of this work will support decision-makers with the management of our water resources that are currently plagued by harmful algal blooms, which will allow for improvement in ecological health and water quality, and ultimately benefit humanity.

**Submitting Institution:** Texas Tech University, Lubbock  
**State:** TX  
**Name of Student:** Nathan Wilson  
**Abstract**

This project aims to develop biomass-based polymer electrolytes for the electrochemical reduction of CO2 into chemicals. In-situ resources will be used in all facets of the design, from plants grown on Mars, to ions extracted from Martian regolith, to the CO2 that comprises the Martian atmosphere. The methodology includes synthesis, optimization and characterization of pectin-based gel electrolytes, integration into an electrochemical cell, followed by cell testing for CO2 reduction and durability. We will publish at least three peer reviewed publications on tentative subjects from biopolymers synthesis, their use in CO2 reduction, and cell optimization. Successful completion of this project will lead to the development of methods that integrate in-situ resources into components to maintain and sustain deep-space operations. The proposed technology will move from TRL 1 to TRL 3, providing CO2 conversion devices that can operate in harsher Martian conditions.

**Submitting Institution:** University of Central Florida  
**State:** FL  
**Name of Student:** Yuen Yee Li Sip  
**Abstract**

Biofilms are formed by the attachment of microorganisms onto substrates via self-synthesized extracellular polymeric substances. Biofilms can jeopardize the performance of key equipment in space crafts and can pose health threats to the astronauts. This project aims at building conformal nanoporous surfaces that are infused with lubricant and decorated with antimicrobial nanoparticles and evaluating their efficacy in preventing biofilm formation. Lubricant-impregnated surfaces (LIS) are fabricated by using a layer-by-layer assembly to generate conformal nanoporous coatings on various substrates and filling the films with fluorinated fluids. Silver or copper nanoparticles will be deposited on the coatings prior to lubricant infusion in order to provide antimicrobial characteristics to the coating. Surface morphology and biofilm growth will be studied to understand how the coating morphology affects the LIS stability and anti-biofouling behaviors (stationary and in a flow). The success of this project will illustrate the impact of LIS structures on biofouling performance and will provide improved biofilm resistant coatings.
**Submitting Institution: Florida International University**  
State: FL  
Name of Student: Roberto Prado-Rivera  
Abstract

This project will investigate a new class of solar photovoltaic absorber materials—sulvanites— theoretically predicted to overcome the Shockley-Queisser limit for single-junction cells achieving power conversion efficiencies larger than 60%. The work will be conducted at the interface of theory and experiment, investigating nanostructured sulvanites Cu3MX4 (M=V, Nb, Ta; X=S, Se, Te). The rationale for nanoscale relates to the capability to build thin film solar cells in space, through simple processes and on lightweight, flexible substrates. Materials will be prepared by solid-state synthesis. Extensive materials characterization will verify their structural as well as optoelectronic properties. Calculations using density functional theory of the surface energies, optoelectronic properties, and the effects of size will complement and validate the experimental work. The long-term goal of this proposal is to demonstrate promising nanomaterials for the inexpensive implementation in space made devices, including solar cells, detectors, and sensors for future NASA missions such as the Artemis program and the deep space voyage to Mars.

**Submitting Institution: Florida International University**  
State: FL  
Name of Student: Marisol Roman  
Abstract

This project proposes a novel simultaneous transmit and receive (STAR) transceiver architecture to enhance spectrum utilization within the NASA spacecraft communication bands from UHF to Ka-band. The essence of STAR is to cancel self-interference (SI) due to the coupling of the high power transmit signal into a nearby receiver chain. Some key novelties of this proposal are 1) Improved antenna isolation to 50dB by introducing decoupling techniques across multiple bands, 2) Reconfigurable multi-input SI cancellation (SIC) filters to suppress coupled signals (direct, noise, and harmonics) from nearby transmit elements by 40dB and account for phase and amplitude mismatches, and 3) Adaptive multi-path interference cancellation (MPIC) filters to suppress reflections from nearby objects. Overall, the proposed architecture implies unprecedented spectral efficiency across various NASA satellite bands by providing highly coveted isolation of 70 to 120dB.

**Submitting Institution: Florida International University**  
State: FL  
Name of Student: Ricardo Rivadeneira  
Abstract

Future satellite radios are expected to be spectrally agile to ensure optimal resources allocation and reliable communication links across large frequency bands. In this effort, we propose a novel reconfigurable radio frequency (RF) transceiver architecture with fully adaptive and autonomous operation across satellite bands (viz. 300 MHz to 18GHz). The proposed architecture is composed of a reconfigurable antenna array and a tunable transceiver architecture that can adaptively switch among different satellite bands, using smart-decision schemes and customized artificial intelligence (AI) and machine learning (ML) algorithms strategies based on cognitive radio concept. These smart capabilities aim to attain certain figures of merit to achieve dynamic band selection and link optimization using RF hardware reconfiguration and digital signal processing. Altogether, incorporating ML/AI algorithms to RF hardware and software design will lead to game-changing technologies for future Satellite radios.
Abstract

The origin of organics on carbonaceous chondrites still remains a mystery to scientists. Unraveling this mystery could lead to a deeper understanding of how organics arrived on Earth, and subsequently lead to the origins of life as we know it. In recent years a lot of attention has been given to the formation of complex organics from irradiation of astrophysical ice analogs. These irradiation experiments typically leave a less volatile residue on the substrate that the ice was irradiated on, within these residues many scientists have found organics similar to those found on carbonaceous chondrites. It has been suggested that this could be the origin of these organics on parent asteroids of carbonaceous chondrites. Similarly, recent comet coma analysis has puzzled scientist by the presence of hypervolatile species in large abundances. Some have suggested that radiation induced processes could have formed progenitors of these hypervolatiles. During the sublimation process they are subsequently broken down into smaller more volatile species, which are being detected in large abundances. This project proposes to investigate the radiation induced formation of complex molecules, with emphasis on elucidating the origins of organics on carbonaceous chondrites and hypervolatiles in comet comas.

Abstract

"Silicon photomultipliers (SiPMs) offer a broad range of applications from nuclear particle detections, biophotonics, to LiDAR applications. For NASA applications, SiPMs are fundamental building blocks for scintillation-based space particle detection and imaging tools and instruments. High performance, durable, and/or performance restorable SiPMs are essential for space missions in either satellite or gateway base platforms. In the space environment, radiation damage gradually changes device characteristics. IV curve changes and breakdown voltage shift can be mitigated with predesigned bias control scheme to the device gain. The radiation damage produced dark current and increasing of dark count rate (DCR) will not be possible to compensate. Annealing of device may provide a solution to this problem and enable the creation of radiation resistant/hardened SiPMs.

Abstract

One of the biggest unanswered questions of modern cosmology is whether dark matter consists of heavy, collision-less cold dark matter particles. The gravitational effects of dark matter on visible matter currently provide the only direct probe of its nature. In particular, strong gravitational lensing studies will be sensitive to the presence or absence of very low-mass dark matter halos that are so small that they do not contain stars. The detection of such starless dark matter halos would provide strong evidence in favor of the standard model. Their absence would motivate significant rethinking within the field. The observed signals from these halos will depend sensitively on their overall count and internal mass distribution. This drives the need for precise predictions. This project proposes to use cosmological simulations, with unprecedented resolution to provide rigorous calculations and predictions for these critical starless dark matter halos. These predictions will be essential for interpreting strong gravitational lensing observations, including observations performed with current and future NASA observatories including HST and JWST. This will characterize the abundance and density structure of low-mass dark
matter halos and sub halos based on the current benchmark lambda cold-dark matter model and provide predictions that are easily folded into interpretive studies.

**Submitting Institution**: San Diego State University  
**State**: CA  
**Name of Student**: Jessica Torres  
**Abstract**

This proposal aims to directly address Goal #1, as set by the NASA 2018 Strategic Guide, “to improve the knowledge of environmental requirements for habitability, NASA will develop tools for detecting life, develop tools for determining the relative habitability of present or ancient environments, and explore analog environments on Earth”. One location where evidence of past life might be found, but has yet to be explored, are the insides of porous rocks. Such pores could harbor trace chemical evidence of past microorganisms that sought refuge in a changing and challenging environment. The rock pores may have served to protect and preserve these chemical signatures from degradation and may offer an alternative niche to explore beyond liquid and soil samples.

This project proposes to develop an extraction and quantification method applicable to porous rocks for the detection of biomarker evidence of past life on other planetary bodies. The biomarkers of interest are chiral amino acids that are frequently found within biotic and abiotic processes. Their detection will be accomplished by utilizing capillary electrophoresis coupled to laser induced fluorescence. This proposal will develop and optimize a fluorescent labelling method for chiral amino acids to allow for low nanomolar detection levels. Spiked rock standards will be prepared to determine optimal extractions from amino acids. This will be done by creating a well inside the rock with a diamond or rock drill. Known amounts of amino acid standards will be allowed to dry inside of the wells for future extractions. The extraction process will involve using subcritical water, and a series of solvents to determine the optimal recovery conditions. The capillary electrophoretic separation will be refined to allow for the differentiation of the chiral species, as enantiomeric excesses are a proven means of identifying biotic from abiotic processes.”

**Submitting Institution**: University of California, Santa Cruz  
**State**: CA  
**Name of Student**: Alissa Lance-Byrne  
**Abstract**

The modern-day surface of Mars is a cold, hyperarid desert. Yet geologic and spectroscopic evidence suggest that billions of years ago, abundant liquid water existed there, raising the possibility that the planet was once a habitable world. The discovery of molecular biosignatures would serve as compelling evidence that Mars was once capable of harboring microbial life, but key questions remain concerning the feasibility of their detection. It is unknown both how recently the planet was theoretically habitable, as well as whether biomarkers associated with ancient life could have been preserved over geologic timescales under the extreme conditions that characterize the Red Planet. Terrestrial analogue environments are valuable for addressing these questions, with the most tractable Mars analogue found in the hyperarid core of Chile’s Atacama Desert. A well-characterized Atacama rainfall gradient may serve as a suitable proxy for the incremental changes that occurred over the course of Mars’ trajectory from a world with abundant aqueous environments to an inhospitable hyperarid desert. Characterizing shifts in microbial functional DNA recovered from soils along this gradient may aid in the elucidation of adaptive strategies employed under conditions of increasing desiccation and may help to define the dry limit of life. This in turn may help to constrain the temporal window of habitability on Mars. Furthermore, microbial ancient DNA recovered from dated sites in the Atacama’s hyperarid core may contribute to our understanding of the biosignature preservation potential of the Red Planet.
Submitting Institution: University of Nevada, Las Vegas
State: NV
Name of Student: Alexandrea Washington
Abstract

With the advent of soft robotics, robots and robotic systems can operate in capacities where flexibility is a necessity. For ventures such as exploration and inspection, a system that is flexible yet robust is incredibly important. The Hybrid Robotic Mobile Platform aims to fulfill this need. This platform is designed to traverse unique terrains and explore places humans cannot yet reach. The platform will also aim to increase understanding of how dynamic systems and different materials function in extraplanetary or extraterrestrial environments. This platform is designed as a hybrid system utilizing liquid-based soft actuation and a rigid chassis. To fulfill the purpose of this project will study the actuation method in depth, through the use of physics-based modelling in COMSOL, as well as material characterization and dynamic modelling of the platform. This project aims to produce a functioning platform, determine a control scheme for a complex actuator array and produce accurate models for the actuation components and the dynamic motion of the platform.

Submitting Institution: University of California, Irvine
State: CA
Name of Student: Branden Butler
Abstract

Integrating Boundary Layer Ingestion (BLI) in aircraft design increases the efficiency of propulsor and reduces the total drag acting on an aircraft. BLI induces complications in the realms of propulsion as nonuniform velocity profiles and unsteadiness are inevitable when considering boundary layer flow. The integration of BLI in turbo machinery requires a trade-off between the size of an engine and the thickness of the boundary layer at intake. If the boundary layer is too thick at the entrance of an engine, therefore augmenting the unsteady characteristics of the flow, engine components (e.g., fan blades) are at risk of failure. The simulation of BLI is crucial as NASA strives towards developing the Aurora D8 and STARC-ABL aircrafts. The former consists of an embedded engine configuration that results in an asymmetric BLI, whereas the latter consists of a tail cone propulsor with a full annular BLI. In this project, the asymmetric case will be studied. Further, the effects of an asymmetric BLI will be modeled via CFD to quantify the enhanced propulsion efficiency and drag reduction for various airframe geometries. In using CFD, an optimal engine design can be determined for a given velocity profile as a result of BLI.

Submitting Institution: University of California, Irvine
State: CA
Name of Student: Cody Gonzalez
Abstract

Application of current linear, steady-state theories has led to stagnation in aerodynamic designs. If a leap is to be made towards next generation aircraft, we must be capable of exploiting unsteady aerodynamic phenomena at high angles of attack, achieving performance that cannot be accessible under steady, small-alpha analysis. Additionally, reducing time and computational costs of fluid dynamics analysis, while expanding the scope beyond traditional aerospace applications, would impact a broad selection of designers, including those that do not currently employ fluid flow analysis methods. The benefits of expanding amenable flow regimes for preliminary analysis and increasing diversity of design cannot be overstated. However, the complexity of the flow field in such regimes stipulate too high a computational burden to be analyzed in a preliminary design phase where millions of design alternatives are investigated. Therefore, reduced-order modeling of fluid dynamics in these expanded regimes will be
indispensable for the development of next generation flying vehicles, automobiles, and wind turbines. The main goal of the proposed research is to provide a novel reduced-order modeling framework by extending traditional potential-flow methods via physics-reinforced and data-driven models for constraints on acceleration coupled with the fundamental principle of constraint minimization. The developed models will be (i) rich enough to capture the main physics of the flow dynamics and (ii) efficient and compact enough to be suitable for preliminary design phases.

Submiting Institution: University of California, Santa Barbara
State: CA
Name of Student: Brian Lee
Abstract

Forest degradation is an understudied field that often leads to deforestation and continued land degradation. Artisanal mining and selective harvesting are the major drivers of forest degradation, and scientists have had difficulties quantifying degradation and its effects on the ecosystem. This project proposes to leverage various remote sensors and techniques, including differential interferometric synthetic aperture radar, LiDAR, and optical sensors to create a novel geospatial data product that will allow us to detect land-surface changes that single sensor studies have difficulty doing. Working with in-country partners, we will first quantify total area degraded within our study area, and then study the environmental impacts, including effects on biodiversity and other ecosystem services. The techniques and products developed by this project will use NASA and partner organization products in novel ways, which will contribute to our knowledge of how and where humans are interacting with the natural world.

The recipient institutions of Center funded fellowships are:

Submiting Institution: University of Michigan, Ann Arbor
State: MI
Name of Student: Ariana Bueno
Funding Center – Marshall Space Flight Center
Abstract

Plume-surface interactions (PSI) lift large amounts of regolith particles that limit visibility and reduce flight safety. Particles are ejected at high velocities and can damage the spacecraft and its instruments. Understanding PSI processes is paramount to the safety of any exploration mission in which landers play a vital role. The objectives of the proposed work are to analyze data from ground testing at MSFC, develop an instrument for in flight PSI characterization and support ground testing. Pulse data from the Saltation Sensor (SALT) will be collected to determine the flux, kinetic energy and relative direction of particles impacting the sensor. SALT will be modified to function as the PSI flight instrument. We also propose to add temperature and pressure sensors to SALT. We will visit MSFC to help integrate the SALT sensor into the ground tests. The results of these tasks will help us better understand PSI effects and mitigate the risks for future missions to the Moon and Mars.

Submiting Institution: University of Miami, Coral Gables
State: FL
Name of Student: Edward Blocker
Funding Center – Goddard Space Flight Center
Abstract

The water leaving radiance in ocean water is known to be partially polarized. However, at this time, there are a very limited number of data sets of the spectral upwelling polarized radiance distribution in seawater. With two polarimeters being planned for the upcoming NASA PACE satellite platform, there
needs to be more data, both for exploring the possible applications of polarization and for validating the polarimeter products. During this work, we will continue to develop (using internal university funding) an instrument to measure the upwelling polarized radiance distribution at several wavelengths common to those in the PACE Harp-2 polarimeter. The instrument is being developed to be easily deployed and suitable for use on cruises of opportunities when other optical and bio-optical properties are being measured. This new instrumentation will be used in a large variety of water types and provide a good database to explore the possibilities of additional information in the polarized light field. There is the potential that this information could lead to the establishment of reliable optical methods for quantifying the PSD and related sinking of organic particles to the deep using the polarization radiance data from satellites. These methods would provide the scientific community with a unique tool to improve understanding of particle dynamics and biological carbon pump over unprecedented temporal and spatial scales.

**Submitting Institution:** Rensselaer Polytechnic Institute  
**State:** NY  
**Name of Student:** Tucker Babcock  
**Funding Center –** Glenn Research Center  
**Abstract**

Electric and hybrid-electric aircraft have the potential to significantly reduce the aerospace sector's environmental impact. In order to analyze and design these vehicles effectively, engineers need new software tools to model and optimize electric engines, because existing tools do not account for the unique requirements of aircraft design. To address this research gap, this project proposes to develop a novel, electro-thermal topology optimization framework for electric motors. The proposed approach is distinguished by its use of adaptive, unstructured, curved meshes to efficiently resolve complex boundaries. Furthermore, the framework will use a high-fidelity multi-disciplinary analysis based on the finite-element method that will accurately model the coupled electro-thermal physics present in electric motors. The team will work closely with the NASA Technical Adviser to conduct optimization studies that can inform the design of the high-lift engines on the X-57 aircraft. This framework will be implemented as an open-source software library, allowing the aerospace industry to leverage this work for their own studies of electric-propulsion aircraft. If successful, this project will facilitate a faster and more accurate design process for the next generation electric and hybrid-electric aircraft.

**Submitting Institution:** University of Michigan, Ann Arbor  
**State:** MI  
**Name of Student:** Shayan Jalili  
**Funding Center –** Langley Research Center  
**Abstract**

This project proposes to build techniques and tools to reason about parallel programs in cyber-physical systems in a compositional way. There already exist semantic formalisms that are inherently parallel, such as Zelus, a hybrid systems modeler based on the synchronous language Lustre (the underlying language of SCADE). The big advantage of Lustre and Zelus is that they incorporate composition and parallelism from the beginning. They also have strong ties to a highly successful industrial project in the form of SCADE. However, they do not handle verification. The idea of this project is to add a verification formalism on Zelus, either in the form of dependent types, or in the form of dynamic logic, to prove properties about Zelus programs. These techniques would be applicable to a large body of NASA-relevant applications.
Automated reasoning in the presence of uncertainty is a fundamental task performed during space mission operations. Reasoning tasks include choosing science observations to perform, path and motion planning in the presence of hazards, and contingency planning in the presence of faults. Constraints on computational resources such as processor speed, utilization time, and memory allocation substantially increase the complexity of choosing the appropriate reasoning algorithm at design time. Currently, mission designers and their teams spend thousands of hours manually evaluating different algorithms for a given space mission, which are error prone and not guaranteed. “Designers of autonomous systems do not have the right information at their disposal to evaluate the tradeoffs between different approaches to autonomous systems.” Complex decision-making algorithms typically do not end up deployed on-board due to software complexity, resource consumption, or lack of solution quality guarantee given the resource limitations of the on-board processors. On NASA’s recently chartered High-Performance Space Computing, A researcher at Airforce Research Laboratory was quoted as saying “since we do not yet have an actual HPSC for tests, we can make some educated guesses as to what its performance may be like,” (Krywko, 2019), meaning space-based computing will remain resource-limited for some time to come.

Under the proposed research, a framework for evaluating different approaches will be developed, and the results of evaluating a select number of algorithms will be presented as hardware/software trade metrics to space mission designers. The trades may be performed for a number of automated reasoning tasks; the results of the research will also provide a template for evaluating other automated reasoning algorithms needed by future space missions. The results of this research will provide the information mission managers need to evaluate the tradeoffs between solution quality, software complexity, and resource utilization, allowing them to deploy better decision-making algorithms, and increase autonomy for more complex missions. The problem space we consider in this work is contingency planning under faulty conditions, whereby the system develops a fault that is detected, isolated, and now must recover or continue operating autonomously.