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CONTRACTOR PERFORMANCE ASSESSMENT REPORT (CPAR)
INCOMPLETE-RATED**Nonsystems****Name/Address of Contractor:**

Company Name: HONEYWELL INTERNATIONAL INC.
 Division Name: AEROSPACE GOLDEN VALLEY (ADVANCED TECHNOLOGY)
 Street Address: 1985 DOUGLAS DR N
 City: GOLDEN VALLEY
 State/Province: MN Zip Code: 554223935
 Country: USA
 CAGE Code: 27327
 DUNS Number: 039380407
 PSC: AR11 NAICS Code: 541712

Evaluation Type: Final**Contract Percent Complete:** 100**Period of Performance Being Assessed:** 09/22/2016 - 11/21/2017**Contract Number:** NNL14AA05C **Business Sector & Sub-Sector:** Nonsystems - Science and Technology**Contracting Office:** NASA LANGLEY RESEARCH CENTER **Contracting Officer:** DAVID O. GARNER **Phone Number:** 757-864-2784**Location of Work:****Award Date:** 09/23/2014 **Effective Date:** 09/23/2014**Completion Date:** 11/21/2017 **Estimated/Actual Completion Date:** 11/21/2017**Total Dollar Value:** \$900,229 **Current Contract Dollar Value:** \$900,229**Complexity:** Medium **Termination Type:** None**Competition Type:** Full and Open Competition **Contract Type:** Cost Plus Fixed Fee**Key Subcontractors and Effort Performed:****DUNS:****Effort:****DUNS:****Effort:****DUNS:****Effort:****Project Number:****Project Title:**

Category-Theoretic Approaches for the Analysis of Distributed Systems

Contract Effort Description:

The scope of this task is to develop and evaluate innovative techniques from the mathematical field of Category Theory (CT) as a framework to evaluate the overall performance of a System-of-Systems (SoS) as applied to distributed systems in the airspace. The Contractor shall develop a category-theoretic framework to analyze and assess safety of NextGen capabilities from a distributed systems perspective. The Contractor shall address automated aircraft separation using the existing communication channels defined for NextGen and supporting all planned meetings, reviews, and presentations.

Small Business Subcontracting:

Does this contract include a subcontracting plan? Yes

Date of last Individual Subcontracting Report (ISR) / Summary Subcontracting Report (SSR): 09/30/2016

Evaluation Areas	Past Rating	Rating
Quality:	Exceptional	Exceptional
Schedule:	Very Good	Very Good
Cost Control:	Satisfactory	Satisfactory
Management:	Very Good	Exceptional
Small Business Subcontracting:	Satisfactory	Satisfactory

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Regulatory Compliance: Satisfactory Very Good

Other Areas:

(1): N/A

(2): N/A

(3): N/A

Variance (Contract to Date):

Current Cost Variance (%): Variance at Completion (%):

Current Schedule Variance (%):

Assessing Official Comments:

QUALITY: The quality of the research produced under this contract was very innovative and really changes the way one thinks about systems of systems. Existing techniques for modeling systems of systems do not scale arguably because they do not employ powerful enough abstraction mechanisms. Deep abstraction is the *raison d'être* of pure mathematics. The research conducted under this award applies powerful abstractions originated in algebraic topology and algebraic geometry to the problem of modeling systems of systems. The initial results obtained under this award illustrate that the proposed techniques are far more flexible and scalable than existing modeling approaches.

The work has been presented at a number of workshops and conferences and has been very well received. The formalism and associated modeling techniques developed in this award will be featured in a special workshop on applied category theory to be held in March 2018 and organized by NIST. Many of the results obtained during the course of this award have been incorporated in the book "Temporal Type Theory" by Schultz and Spivak and will be published by Springer-Verlag in 2018. Having a graduate level textbook on the topic is the best way to spread the modeling technique to a wider audience.

Although the bulk of the research was carried out at a foundational level, the research has yielded a graphical representation that could be the basis for a computer based graphical tool.

The formalization of NextGen airspace models identified in Sections 3.3.1 and 3.3.2 of the statement of work develops category theoretic techniques that while more abstract are more flexible and powerful than existing formalisms for modeling hybrid dynamical systems.

Applying the algebraic theory of monoid actions to aircraft actions, positions, and orientations (SOW requirement 3.3.3) was reported in the journal article "Abstraction, Composition, and Contracts".

The categorical techniques developed in this work was applied to model a simple aircraft collision avoidance system satisfying SOW requirement 3.3.4.

A conference paper and journal article were published (requirement 3.3.5 in the SOW).

The final report (requirement 3.3.6 of the SOW) was delivered along with a draft of the aforementioned textbook.

SCHEDULE: The contractor has met all objectives and milestones and produced all required reports.

COST CONTROL: Contractor kept cost within budget.

MANAGEMENT: This award was to conduct very low TRL research in computer science, but guided by problems from the aerospace domain. Such awards are a particular challenge for the industry in general and the aerospace industry as it goes against a culture that rewards quick returns. My experience is that in an attempt to "mitigates risk" management usually winds up mitigating away the high-reward that comes with it.

The goal of the research to apply category theory to model aerospace systems-of-systems is truly thinking outside the box. These sorts of efforts often flounder due the fact that the mathematicians just want to do pure math and are not that interested in delving into the application domain while the aerospace folks lack the background in pure math and wind up using the tried and true methods they always use. This project was a success primarily due to the fact that the contractor did a superb job in constructing the right team. David Spivak at MIT may be the leading mathematician in the world at applying category theory modeling to engineering applications such as aerospace and controls. I do not think the project would have succeeded with anyone else. Honeywell put together a team comprised of people possessing both a significant background in working aerospace problems as well as a pure math background that is woefully lacking in the aerospace industry. The PI for Honeywell passed away during the course of the project. This could have resulted in a considerable disruption in the work, but the contractor managed this tragedy with great finesse. The prime contractor replaced the PI with someone with the appropriate background, was excited by the project, and worked to ensure success.

The contract management was very focused on the desires of the NASA customer to ensure the research is applicable to the aerospace. The interaction with the customer has been excellent throughout the course of the contract.

SMALL BUSINESS SUBCONTRACTING: Contractor was in compliance with the approved small business plan.

REGULATORY COMPLIANCE: The contractor has complied with all regulatory requirements.

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ADDITIONAL/OTHER: Honeywell is easy to work with, contract management is very responsive to inquiries and responds quickly. Honeywell was very proactive in finding the right individual to fill the vacancy created by the passing of the PI. Overall, NASA is very pleased with Honeywell's technical, management and contract performance under this effort.

RECOMMENDATION:

Given what I know today about the contractor's ability to perform in accordance with this contract or order's most significant requirements, I would recommend them for similar requirements in the future.

Name and Title of Assessing Official:

Name: David O. Garner

Title: Contracting Officer

Organization: NASA LaRC Office of Procurement

Phone Number: 757-864-2784 Email Address: david.o.garner@nasa.gov

Date: 11/29/2017

Contractor Comments:

Name and Title of Contractor Representative:

Name:

Title:

Phone Number: Email Address:

Date:

Review by Reviewing Official:

Name and Title of Reviewing Official:

Name:

Title:

Organization:

Phone Number: Email Address:

Date:

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