# Angles-Only Navigation System for Nanosatellites

Completed Technology Project (2015 - 2019)

## Project Introduction

The objective of the proposed work is to develop and implement an angles-only relative navigation system on hardware suitable for deployment on nanosatellites or CubeSats. The key components of this work will include: (1) development of an efficient formulation of the angles-only navigation problem consistent with the performance constraints of current commercially available, space-capable hardware, (2) development of a software implementation of this formulation, and (3) integration of the software with a commercially available camera and processor. The navigation formulation selection will be conducted by developing a set of candidate formulations with different relative state formulations, methods of resolving the along-track separation ambiguity, and models of secular disturbances. The requirements of these formulations will be compared with the performance limitations of CubeSat-compatible hardware. The optimal navigation formulation will be selected by conducting a trade study using the formulation candidates consistent with CubeSat hardware constraints. The software will be developed using Space Rendezvous Laboratory (SLAB) experience with the ARGON experiment as a baseline. The software modules will be optimized for speed in order to satisfy the CubeSat processing power constraint. Once integrated with representative hardware, the system will be validated extensively in two high-fidelity simulation environments currently in development at SLAB. The proposed work will result in a relative navigation and control system sufficiently miniaturized to be compatible with CubeSats and capable of handling relative navigation with a non- cooperative target at separation distances ranging from meters to tens of kilometers. This technology would be a critical enabler for on-orbit servicing and debris removal missions.

## Anticipated Benefits

The work will result in a relative navigation and control system sufficiently miniaturized to be compatible with CubeSats and capable of handling relative navigation with a non- cooperative target at separation distances ranging from meters to tens of kilometers. This technology would be a critical enabler for on-orbit servicing and debris removal missions.

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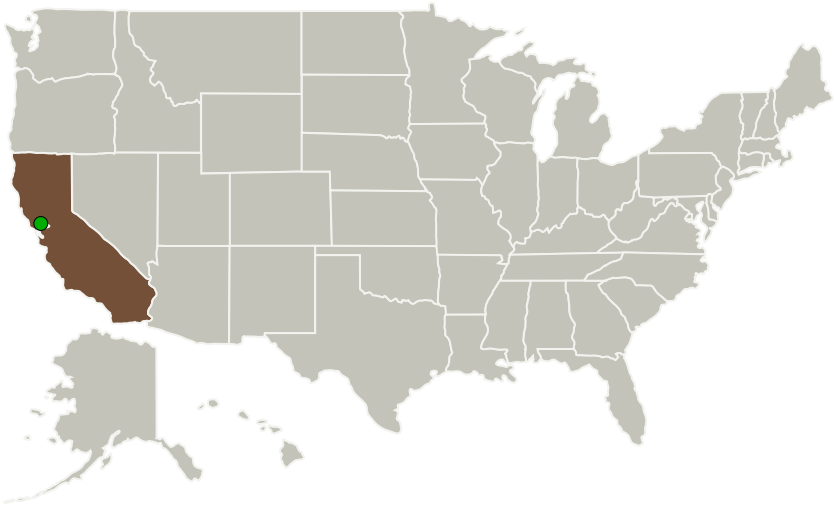
## Primary U.S. Work Locations and Key Partners



| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| Stanford University(Stanford) | Lead Organization | Academia | Stanford, California |
| Ames Research Center(ARC) | Supporting Organization | NASA Center | Moffett Field, California |

| Primary U.S. Work Locations |
|---|
| California |

### Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

Stanford University (Stanford)

**Responsible Program:**

Space Technology Research Grants

## Project Management

**Program Director:**

Claudia M Meyer

**Program Manager:**

Hung D Nguyen

**Principal Investigator:**

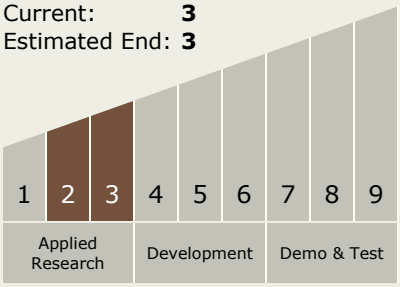
Simone D'amico

**Co-Investigator:**

Adam W Koenig

## Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**




## Technology Areas

**Primary:**

- TX17 Guidance, Navigation, and Control (GN&C)
  └ TX17.2 Navigation Technologies
    └ TX17.2.1 Onboard Navigation Algorithms

## Target Destination

Earth