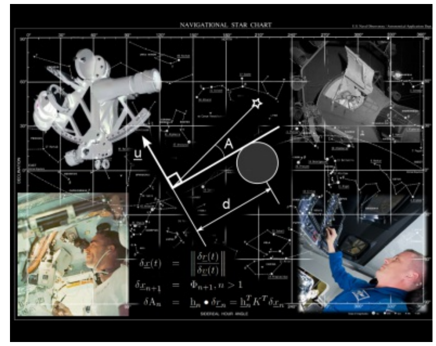
Crew-Aided Autonomous Navigation Project

Center Independent Research & Developments: JSC IRAD Program | Mission Support Directorate (MSD)

ABSTRACT

Manual capability to perform star/planet-limb sightings provides a cheap, simple, and robust backup navigation source for exploration missions independent from the ground. Sextant sightings from spacecraft were first exercised in Gemini and flew as the loss-of-communications backup for all Apollo missions. This study seeks to procure and characterize error sources of navigation-grade sextants for feasibility of taking star and planetary limb sightings from inside a spacecraft. A series of similar studies was performed in the early/mid-1960s in preparation for Apollo missions, and one goal of this study is to modernize and update those findings. This technique has the potential to deliver significant risk mitigation, validation, and backup to more complex low-TRL automated systems under development involving cameras.



Manual spacecraft navigation concept (Walter Cunningham, Apollo 7; Edwin Aldrin, Gemini 12)

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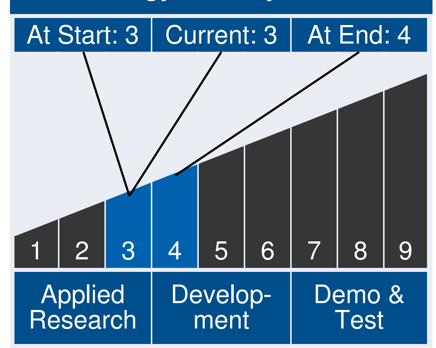
Technology Maturity



ANTICIPATED BENEFITS

To NASA funded missions:

The Orion Multi-Purpose Crew Vehicle requires a backup source of navigation in the event communication with the ground is lost. This technique can provide confidence and verification of low-TRL automated onboard systems.

To NASA unfunded & planned missions:

All future crewed exploration missions in the Evolvable Mars Campaign will need a backup source of navigation in the event communication with the ground is lost. Such a backup/emergency capability needs to be simple, robust, and reliable. The human eye/brain combination is a remarkable piece of optical equipment and provides many advantages over camera-based systems, including dynamic range and detail resolution.This technique has the potential to deliver significant risk mitigation, validation, and backup to more complex low-TRL systems under development involving cameras. It provides important autonomy to the crew in the event of loss of communication with the ground, and can provide confidence and verification of low-TRL automated onboard systems. This approach is low-cost and implementable in the near-term with the buying power of the current budget. It can be used in Deep-Space Proving Ground missions, and has extensibility to Earth-Independent missions. The technique is extremely flexible and is not dependent on any particular vehicle type.

To the commercial space industry:

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DETAILED DESCRIPTION

All future crewed exploration missions will need a backup source of navigation in the event communication with the ground is lost. Such a backup/emergency capability needs to be simple, robust, and reliable. The human eyeball is a remarkable piece of optical equipment and provides many advantages over camera-based systems, including dynamic range and detail

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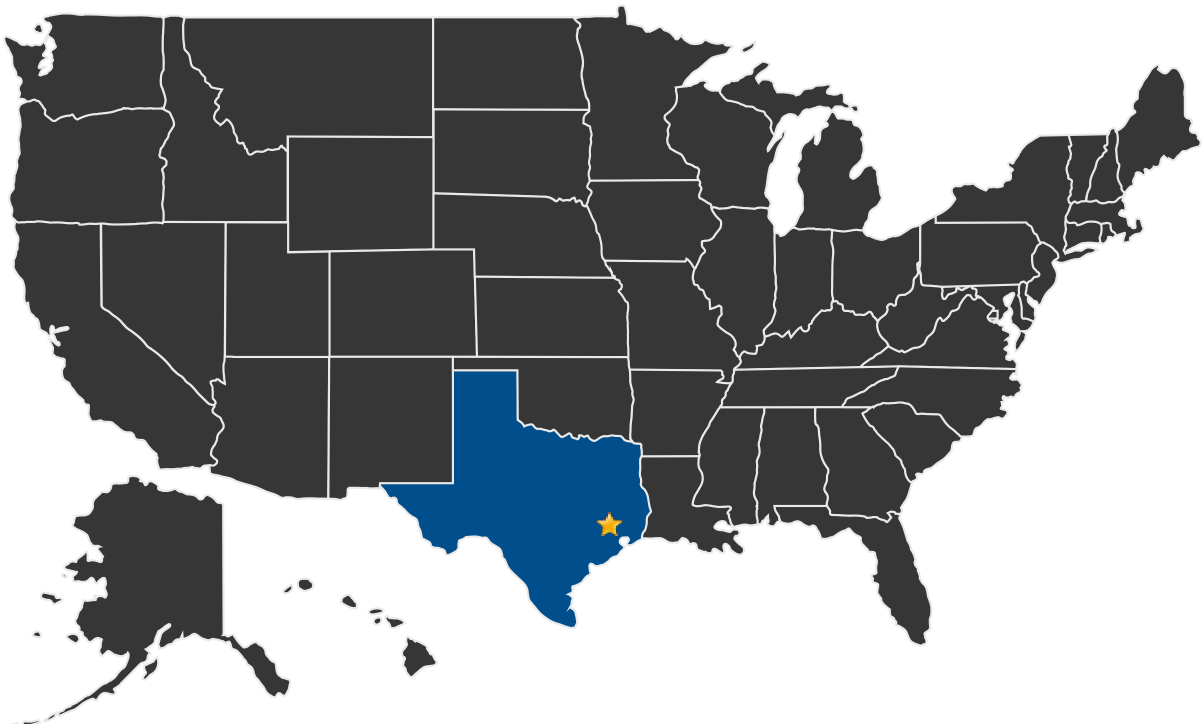
U.S. LOCATIONS WORKING ON THIS PROJECT



U.S. States With Work

Lead Center:
Johnson Space Center

DETAILS FOR TECHNOLOGY 1

Technology Title

Astrometric Angular Measurement Instrument for Crew-Aided Autonomous Navigation

Technology Description

This technology is categorized as a hardware component or part for manned spaceflight

An angular measurement instrument for crew-aided autonomous navigation is a sextant-like device for use in human spaceflight missions. It is generally handheld, but can be mounted to a base to aid in taking measurments. Like traditional sextants, it consists of a horizon and index mirror which superimposes two images when aligned by the crew member.

Capabilities Provided

This technology provides the capability to take precise astrometric angular measurements from inside a crewed space vehicle. It may be used to measure the apparent angular separations between stars, planets, landmarks, or other spacecraft. These measurements can then be reduced or incorporated into processing software for autonomous navigation.

Potential Applications

This technology is applicable as an autonomous backup or confirming navigation source for human spaceflight missions.