IRIS - Integrated Robotic Integrity Surveyor

PI: Joshua Kraus, Team #43

Goal / Objective

Project Title: IRIS [Integrated Robotic Integrity Surveyor]: An automated gantry-based robotic array for multi-modal surface inspection and ultrasonic mapping of reusable rockets.

IRIS addresses NASA and the commercial space industry's need for rapid, accurate, and autonomous pre- and post-flight surface inspection of the heat shield and rocket fuselage. The team will develop a modular gantry-based system that uses an array of wire-suspended umbilical robots fitted with integrated imaging, ultrasound, LiDAR and AI grid-based damage grading tools. The system generates an automated survey which provides a rich digital twin. A 3D image-stitched model of the rocket, with geotagged inspection data (surface features, damage grade, thermal and ultrasound characteristics) can be stored and examined by engineers. IRIS leverages existing technology in a novel and inexpensive way. It will decrease inspection time, increase examination rigor, and allow for finer trend analysis and timely reflight decisions in reusable spacecraft.

The final deliverable of the $10k seed funding will consist of one of the IRIS robots, a scaled down gantry suspension system, as well as a series of scans and 3D mockups to demonstrate the effectiveness of the full-scale IRIS system.

IRIS qualifies for an NTR.

Team Overview

El Garner - Sophomore, Aerospace Engineering, WPI
Joshua Kraus - Junior, Aerospace Engineering and Psychology, Lehigh University
Hannah Speranza - Junior, Aerospace Engineering and Leadership Studies Minor, UIUC
Ethan Maher - Junior, Mechanical Engineering & Physics, Lehigh University
Leanne Pham - Sophomore, Mechanical Engineering, UB
Bryan An - Junior, Electrical Engineering, OSU
Jonathan Durkin - Graduate Student, Space Systems Engineering, ASU
Ibrahim Arnous - Junior, Engineering Physics & Mathematics Minor, ERAU

Mark A. Nurge - SME: NASA Kennedy Space Center, APL

The aggregate team has skills in systems engineering philosophies and technical writing/engineering documentation. The team has thorough knowledge of Python, LaTeX, and MatLab, and has access to makerspace facilities to create the first IRIS robot and scaled gantry sTeam 43 has specialists in government policy, human psychology, biology, satellite design, physics, computational simulation, ROS2, and tooling/fabrication. Mark Nurge has experience completing surface evaluations for the windows on the Orion capsule for Artemis 1. The IRIS team is aptly suited to address shortfalls **1602 (3D Imaging and Tomography), 1535 (Autonomous Health Monitoring), 1538 (General-Purpose Robotic Manipulation), 1494 (Digital Transformation Technologies).**

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Metrics and Key Performance Parameters

	SOA Human-Led Surface Inspection of Reusable Spacecraft	***Next Generation Integrated Robotic Integrity Surveyor (IRIS)***
Timeline	*10+ days*	*24-48 hours*
Digital Twin	*Partial, Just pictures*	*Full body twin with integrated data and grading*
Crew	*20-30 Technicians*	*3-5 Technicians*
Man-Hours	*300-600*	*20-50*
Scalable to Extraterrestrial Bases	*No, requires skilled onsite crews*	*Yes, relies on remote engineers*
Automated Surface History	*No, history is logged but general trends may be missed*	*Every part of the scanned surface lives in a accessible history grid*
Cost (USD)	*$130,000 - $280,000* ***per mission***	*$160,000 - $200,000* ***once***

Note: All SOA values are estimated averages, as the values would change per mission. The ranges above are accurate and up to date as of Team 43's knowledge.