S.P.I.D.E.R.

Surveying Platform and Inspection Device for Enclosed Regions

$100,000 lost per day for each grounded airplane
$8,000,000 lost per year for a fleet of 800 with inspections at a minimum of 10 years
$2,000,000 saved per year using S.P.I.D.E.R.
The goal of S.P.I.D.E.R. is to sell a contracted service of fuel tank inspections to airlines

S.P.I.D.E.R. is a hexapod robot that is designed to carry out aircraft fuel tank inspections

- **Six legs** provide **stability** and **maneuverability**
- An **eddy current** probe attached to the end of the arm will provide NDI to detect subsurface defects
- S.P.I.D.E.R. will be fully **ATEX Zone 0 rated**, meaning it is safe to enter the fuel tank when fuel vapors are present
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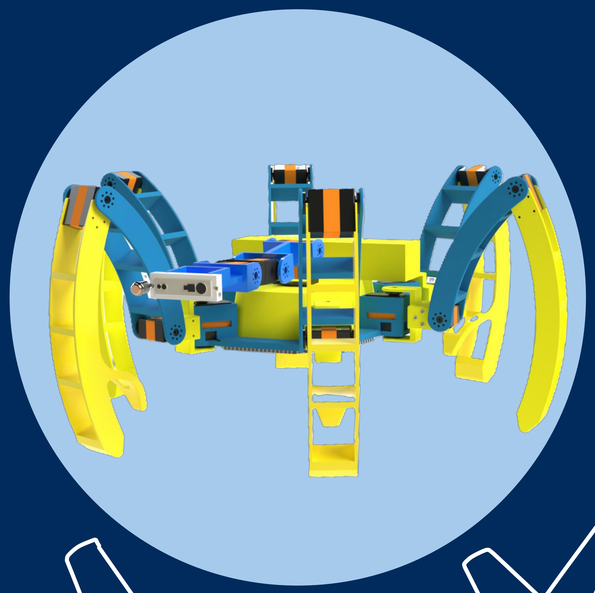

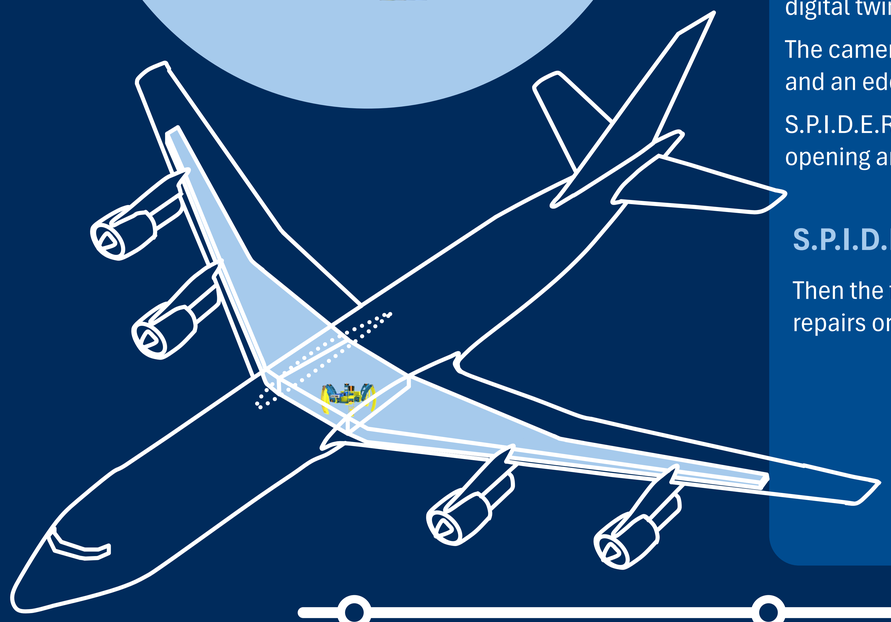

Fuel Tank is Drained

S.P.I.D.E.R. Inspection

S.P.I.D.E.R. Enters Fuel Tank

After the fuel tank is drained, S.P.I.D.E.R. can immediately enter the fuel tank and not wait 24 hours for the fuel tank to vent

S.P.I.D.E.R. is placed into the fuel tank by a trained technician

The technician can then navigate the fuel tank through the camera and a digital twin

The camera is used for visual inspection, and an eddy current probe for NDI

S.P.I.D.E.R. is maneuvered to the opening and removed by the technician

S.P.I.D.E.R. Finishes Inspection

Then the fuel tank will undergo repairs or be sent off

Human Inspection

Fuel Tank Is Vented

The fuel tank is vented for 6 to 24 hours to ensure safe oxygen levels

Time aircraft is grounded and waiting for the fuel tank to be vented

Safe for Human Inspection

After the fuel tank is vented for up to 24 hours it is finally safe for humans to enter 8 man hours for inspection

IMPLEMENTING ISACC SIM/LAB

CREATE VIRTUAL ENVIRONMENT WITH NVIDIA OMNIVERSE

- Collaborate with airlines to model fuel tank geometry
- Add internal structures, obstacles, materials, and operating conditions

DEFINE REINFORCEMENT LEARNING OBJECTIVE

- Robot is rewarded for successfully making it through the hole
- Robot base is rewarded for not touching ground during traversal

TRAIN HEXAPOD IN SIMULATION USING REINFORCEMENT LEARNING (RL)

- Define state space, action space, and reward function
- Train in Isaac Lab (RL framework)
- Optimize for climbing, stability, and traversal success

IMPLEMENT CODE WITH NVIDIA + ROS ARCHITECTURE

- Export trained policy/model
- Integrate with ROS (control, perception, logging)
- Deploy on NVIDIA Jetson platform

TEST IN REAL ENVIRONMENT

- Deploy on a physical robot
- Test in a controlled environment and fuel tank mock-up
- Evaluate performance, safety, and robustness

EVALUATE & ITERATE

- Compare simulation vs. real-world performance
- Identify gaps and failure cases
- Refine environment, reward, or model
- Retrain and redeploy as needed

ITERATE
Refine, retrain and improve

END RESULTS

- Robust, RL-enabled hexapod ready for fuel tank inspection

2026
Preliminary Design and Initial Prototyping
- Develop initial mechanical, electrical, and software prototypes
- Begin laboratory mobility and sensing validation
- Integrate full hexapod platform with imaging, NDI sensing and onboard computing
- Conduct controlled confined-space mobility testing and inspection accuracy studies

2028
Relevant Environment Testing
- Testing in representative fuel-tank mockups and metallic confined spaces
- Validate communication reliability and operator workflows
- Refine electrostatic-safe materials
- Engage with certification and regulatory stakeholders

2030
Pre-Certification and Operational Demos
- Mature safe power, sensing, and actuation subsystems
- Extended duration inspection trials and reliability testing
- Demonstrate integration with maintenance documentation and NDI processes
- Prepare safety case documentation and certification test plans

2032
Certification Testing and Field Evaluation
- Formal Hazardous-environment testing
- Supervised demos in operational environments
- Validate reduction in human tank entry time, inspection duration, and downtime

2035
Initial Operational Implementation
- Achieve operational approval for restricted commercial use
- Deploy early production systems within partner maintenance organizations
- Collect operational data to support broader adoption
- Transition to sustained manufacturing, training, and lifecycle support

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