COE CST Eleventh Annual Technical Meeting

TASK 311. Robust and Low-Cost LED Absorption Sensor for Spacecraft Early Warning Fire Systems

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Agenda

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Team Members

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2022 Defense and Commercial Sensing Presenters

Sponsoring Organizations

Students 2021-2022 who got internships
- Giovanni Wancelotti
- Farid Abuid (Veteran)
Task Description

• Develop a device which quantifies the presence of gases which indicate a fire or malfunction on spacecraft

• LEDs are used as sources for absorption spectroscopy

\[ T_\lambda = \left( \frac{I_\lambda}{I_{\lambda,0}} \right) = \exp\left(-\alpha_{\lambda,i} \cdot \chi_i \cdot L\right) \]

- \( T_\lambda \) - Spectral Transmittance

- \( \alpha_{\lambda,i} \) - absorption coefficient of \( i^{th} \) species

- \( \chi_i \) - molar fraction of \( i^{th} \) species

- \( L \) - Path variable

\( I_{\lambda,0} \) - Source Intensity

\( I_\lambda \) - Transmitted spectral intensity of electromagnetic radiation
Schedule

• 2016 – Laboratory proof of concept
• 2017-2020 – Demonstration of functionality in a high-altitude balloon flight, system downsizing
• 2021 –now, Downsizing
  • 3d Printing of optomechanical components/enclosure
  • Task built electronics (analog, power, & data processing)
  • Power & computational need reduction
  • Optics validation
• 2022 Forward, testing (ground and sounding rocket), commercial adoption
Goals

- Spacecraft cabin air is confined aboard spacecraft and toxic gases may accumulate.
- Toxic gas sources include:
  - Human activity
  - Astroculture
    - (plant hormones, pollen, etc.)
  - System malfunctions
- Rapid detection and localization is necessary to ensure safety of crew & experiments.
- Commercial space needs “standard solutions”
Results

1. “Gaseous Absorption Detection for Space Applications (GADSA): An LED-Based Early Fire Warning System”

2. “Rapid Indexable Positioning System (RIPS) for 3D printed aerospace electro-optics”

3. “High efficiency thermoelectric optoelectronic component temperature regulation”

4. “Embedded systems development for spacecraft MIR hazardous gas detector”

5. “3D Printed Optomechanical Positioners for Aerospace Metrological Instruments”
Publications, Presentations, Awards, & Recognitions

PRESENTATIONS 2021-2022


Conclusions and Future Work

- Several students (traditional, veteran, & underrepresented in STEM) have contributed to developing aerospace hardware
- CSWaP of sensor was reduced, <4.5W, ~3kg, ~2.1 L

- Future tests include lab ground testing
  - Shake Table, environmental chamber with fill gas mixtures, temperature & pressure
- Subsequent sounding rocket testing