

## Phase I Project Summary

**Firm: Luminit, LLC**

**Contract Number: NNX-11-C-I41P**

**Project Title: Luminit Optical Tank-level Sensing System:**

### **Identification and Significance of Innovation**

Luminit Optical Tank-level Sensing System (LOTS) combines a broadband light source (LED) and a silicone photodetector for phase-sensitive light detection to measure the liquid level in LH<sub>2</sub> tanks with an accuracy of ~0.5-1.0%. In Phase I, we designed and assembled a LOTS proof-of-concept system that can measure liquid levels in tanks up to 60 ft high. The LOTS prototype consists of a light source module, a light collection module, support electronics, and a computer algorithm/interface for rendering modulation of the light source emission at a certain frequency and providing detection at the same frequency. The demonstrated results indicate that LOTS will offer NASA the ability to incorporate a compact, rugged, reliable sensor into maintenance equipment for LH<sub>2</sub> tanks.

### **Technical Objectives and Work Plan:**

The following specific objectives were established to reach the Phase I goal:

- Objective 1. Analysis and design of the optical liquid level sensor
- Objective 2. Optimization and homogenization of the light spot shape on the surface of the liquid
- Objective 3. Development of software for calibration and display
- Objective 4. Fabrication, assembly, and testing of LOTS components
- Objective 5. Exploration of the commercial potential of LOTS.

We accomplished the objectives of the proposed project through the performance of the following tasks.

- Task 1. Design LOTS Optics to Meet Sensitivity and Accuracy Requirements
- Task 2. Design Camera Module
- Task 3. Design Illumination Module
- Task 4. Design and Make Mechanical Package for the System
- Task 5. Develop Algorithms for Calibration and Data Display
- Task 6. Assemble and Test LOTS
- Task 7. Demonstrate Feasibility of LOTS
- Task 8. Explore Commercial Potential and Product Viability
- Task 9. Prepare and Submit Reports

### **Technical Accomplishments:**

In Phase I, Luminit investigated and evaluated various light sources, analyzed the optimal parameters of the components, identified technologies for implementing LOTS, designed, assembled, and integrated a proof-of-concept LOTS experimental setup comprising a light source with light conditioning optics, light detector with light collection optics, and control

electronics. The Phase I evaluation results showed that the high-power LED-based LOTS, provides liquid level detection in tanks up to 60 ft high with an accuracy of ~0.5-1.0%, and can potentially demonstrate high accuracy measurements for LH<sub>2</sub> tanks. The proof-of-concept demonstration met all the Phase I objectives and proved the feasibility of the proposed LOTS.

**NASA Application(s):**

The proposed LOTS will enable NASA to improve the accuracy of measurements of liquid level in LH<sub>2</sub> tanks. The LOTS system integrated into LH<sub>2</sub>-tank maintenance equipment will enable NASA personnel to monitor the liquid levels. LOTS not only directly meets NASA requirements for a highly-sensitive and safe sensor system, it is adaptable to measuring liquid levels of other cryogenic liquids and non-cryogenic fluids. The compactness, lightweight, low power consumption, robustness, and high reliability will make the sensor suitable for deployment in LH<sub>2</sub> maintenance equipment.

**Non-NASA Commercial Application(s):**

LOTS can be adapted to measure liquid levels in oil, chemical, and other industries where rugged sensors are needed. Liquid level sensor technology advances made possible by the successful development of LOTS will lead to cost-effective commercialization. In particular, LOTS will find cryogenic liquid level applications (e.g., for liquid nitrogen). Industrial/laboratory tanks, avionics, and semiconductor material processing industries represent markets for compact, low-cost LOTS in the private sector.

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