

Phase 2 Project Summary

Firm: Luminit, LLC

Contract Number: NNX-09-C-A46C

Project Title: Holographic Waveguided See-through Display

Identification and Significance of Innovation: (Limit 200 words or 2,000 characters whichever is less)

For successful extravehicular activities (EVA), astronauts need a low-volume, rugged, reliable, low-power consuming display that provides critical information regarding their life support systems, warnings, and checklists. The importance of such a display is increasing with the development of a new type of the space suit. For a display technology to support astronauts on EVA, several environmental and human factors must be addressed. The display must be rugged, immune to vibration, and readable in any light, all while consuming little power. The displayed information will include oxygen level and battery power updates from the Primary Life Support System (PLSS), warnings, and checklists. Current displays tend to interfere with the work envelope, are too bulky, or are not truly see through.

To address the NASA need to display information efficiently during EVA, Luminit, LLC proposed to develop a new Holographic Waveguided See-through Display (HoWSD) based on wave-guiding holograms and a bright micro-display source. HoWSD offers a compact, low-profile display with high resolution, high adjustable brightness, high contrast, a wide field-of-view, and a convenient non-pupil forming tube-shaped eye-box, creating a communication tool that will not interfere with the work envelope. It provides a see-through holographic visor that conforms to the Mark III Helmet.

Technical Objectives and Work Plan: (Limit 200 words or 2,000 characters whichever is less)

The overall goal of this Phase project was to further develop the see-through display technology proven feasible in Phase I, and to develop a full-scale HoWSD prototype. To reach this goal, Luminit established the following objectives.

- Objective 1. Optimization and refinement of the HoWSD system design.
- Objective 2. Optimization of the hologram design, and development of a two-hologram recording system.
- Objective 3. Development of a high-resolution, high-brightness microdisplay image projection subsystem.
- Objective 4. Integration of a prototype HoWSD system.
- Objective 5. Exploration of the commercial potential.

To achieve the five objectives Luminit, LLC defined the following work plan:

- Task 1. Optimize HoWSD Design
- Task 2. Select and Procure Display Image Source
- Task 3. Procure Curved Substrates for Holo-Visor Fabrication
- Task 4. Design an Optical Set-up for Recording Holographic Elements on Curved Substrate
- Task 5. Select and Procure Opto-Mechanical Components for the Optical Set-up
- Task 6. Record Holograms for a Curved Holo-Visor
- Task 7. Improve and Optimize the Diffraction Efficiency of Holographic Elements
- Task 8. Protect a Holo-Visor on a Curved Substrate
- Task 9. Test the Holo-Visor
- Task 10. Integrate and Assemble HoWSD
- Task 11. Prepare and Conduct Performance Test
- Task 12. Commercialize HoWSD
- Task 13. Prepare and Submit Reports

Technical Accomplishments: (Limit 200 words or 2,000 characters whichever is less)

During Phase II, Luminit, LLC, has accomplished the following:

- Task 1. Optimize HoWSD Design
- Task 2. Select and Procure Display Image Source
- Task 3. Procure Curved Substrates for Holo-Visor Fabrication
- Task 4. Design an Optical Set-up for Recording Holographic Elements on Curved Substrate
- Task 5. Select and Procure Opto-Mechanical Components for the Optical Set-up
- Task 6. Record Holograms for a Curved Holo-Visor
- Task 7. Improve and Optimize the Diffraction Efficiency of Holographic Elements
- Task 8. Protect a Holo-Visor on a Curved Substrate
- Task 9. Test the Holo-Visor
- Task 10. Integrate and Assemble HoWSD
- Task 11. Prepare and Conduct Performance Test
- Task 12. Commercialize HoWSD
- Task 13. Prepare and Submit Reports

As a result, Luminit:

- Fabricated and assembled prototype as per the design
- Improved image/backlighting uniformity.
- Demonstrated for a flat visor:
 - Resolution: 1024 × 768 pixels
 - Grayscale: 32 gray levels
 - Image quality: ~ 12.5 lp/deg
 - Adjustable brightness: 400 nit - 2000 nit with green display source
 - Contrast (on/off): ~75:1
 - Field of view: ~15.5° dia.
 - Eye relief: ~70 mm
 - Transparency to the eye: at least, ~81%

Luminit also achieved target mechanical parameters for weight, profile, and size.

NASA Application(s): (Limit 100 words or 1,000 characters whichever is less)

HoWSD improved image quality and ergonomics will provide a display tool that enhances astronaut capabilities and improves safety during EVAs.

Non-NASA Commercial Application(s): (Limit 200 words or 2,000 characters whichever is less)

Commercial applications for HoWSD include helmet and head-mounted displays for Government, military, and commercial sectors ranging from medicine and security to gaming.

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