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FREE SPACE OPTICAL COMMUNICATION SYSTEM FOR EXTREME ENVIRONMENT EXPLORATION ANALOGUES

Abstract

To develop a sustainable human presence in deep space, robust systems and sustainable critical capabilities must be developed. Of these systems, communication technologies are essential for planetary exploration. New technologies must be created for high data rate communication.

This pioneering research explores the development, testing and analysis of a Free Space Optical Communication System (FSOC) designed for extreme and underwater environments. Using light for the communication media, high data rate and robust communications links are possible. We have designed and built an LED-based communications system to test the operational considerations for using light-based communications systems in human extreme environment exploration scenarios.

This system was deployed to the Aquarius Reef Base, located in the ocean near Key Largo Florida as part of the NASA Extreme Environment Mission Operations (NEEMO) Mission 21 in July of 2016. Results will not only support NASA's efforts to utilize FSOC for missions, but could potentially lead to new beneficial applications for earth-based underwater operations and other extreme environments.

The FSOC system was designed in phases which were tested throughout the design process. Additionally, full system integration for the operational environment and human factors were critical focal points throughout the system development and were evaluated during the mission. Traditional communications systems were assessed along with their limitations, specifically pertaining to reliability and data transfer rates. In conjunction with the hardware and software development, crew procedures were developed and assessed as well as the mission which included communications delays which will be present on human deep space exploration missions.

Our FSOC system demonstrates the potential to provide more reliable and faster data/voice communication links between EVA crewmembers and their habitat while using less power, and having a smaller footprint for EVA suits. The FSOC system offers benefits beyond the space environment. It has the potential to improve communications for underwater operations on Earth, particularly between vehicles and diver-to-diver links without major multi-path aversion events, high power requirements and attenuation concerns; issues in which divers face currently in this environment. Future development will expand the capability to transmit real scientific and engineering data between EVA astronauts as well as robotic vehicles.

This paper summarizes work completed so far such as the system design and test in the NEEMO exploration analog. Lessons learned from this testing will be presented as well as plans to improve the technology and carry it further to additional exploration analog and eventually in-space testing.