Video from the International Space Station

Technology Development and Demonstration

Short Abstract

The video capabilities of International Space Station have continued to develop over time, with a maturing core capability ready to support both the operation and the payload users of the flying laboratory. Beyond that core capability, there are opportunities for more unique and developmental uses of video imagery. This paper looks at the existing and near-term roadmap of capabilities for ISS video downlink and distribution, and an overview of some of the innovative uses of imagery that have been recently demonstrated, including Ultra High Definition/UHD video, 360º degree video capture, and augmented reality applications.

Long Abstract

The first element of the International Space Station launched in 1998, the same year as the launch of high-definition (HD) video. The original camera system for ISS was derived from the Space Shuttle, which was designed in the 1970's. But the video capabilities of International Space Station have continued to develop since inception, with a maturing core capability ready to support both the operation of the flying laboratory and the scientific and commercial payload users of the facility. Beyond that core capability, there are opportunities for more unique and developmental uses of video imagery. This paper looks at the existing and near-term roadmap of upcoming capabilities, and an overview of some of the innovative uses of imagery that have been recently demonstrated, including Ultra High Definition/UHD video, 360º degree video capture, and augmented reality applications.

The core ISS video capability provides six simultaneous video channels of live video through most of the orbit, with occasional dropouts during Loss of Signal (LOS) periods while Ku-band satellite connectivity is not available. If needed, the "missing" segments from LOS can be downloaded later for an uninterrupted recording. Each of the six channels can be either Standard Definition (SD, 480p/30) or HD (720p/60 or 1080p/30). Two additional HD channels are planned for 2021. The core video resources are used for maintaining and running the spacecraft, for the science and commercial work that's taking place on board, and for communications and outreach purposes.

A common source for the core downlink channels is the handheld video camcorders. For several years, the Canon XF-305 camcorder has been the multiprogram device available for astronauts to capture video in SD or HD formats live or recorded on the device. In 2021,

transition to a Canon XF-705 will support Ultra-High Definition (UHD) and HD formats. The process for live HD video will be the same as it was with the XF-305, while support for downlink of live UHD video is still in development. Initially, support for UHD (2,160p60) will only be for a single live channel, for pre-planned outreach content.

Besides the core capabilities, individual payloads can fly their own imagery resources and download video, potentially using one of the provided video downlink channels, or by using Internet Protocol (IP) resources to stream video or download files. There is even the option of recording the video to media and returning the media to the ground, though cargo return capacity is even more precious than delivery to ISS.

Examples of payloads that include their own imagery:

- Several generations of RED cinema cameras capable of capturing high resolution video in RAW format that can be graded to 4K or higher High Dynamic Range (HDR) footage. One of the cameras was also used to demonstrate a live UHD broadcast from orbit.
- Free flyer robots, such as the NASA's SPHERES and Astrobee, JAXA's Int-ball, and DLR's Cimon have cameras that allow them to see where they are flying, as well as for documentation
- Numerous payloads have cameras internal to an equipment rack enclosure, such as animal habitats and materials science experiments
- There have been a couple of cameras/camera rigs capable of shooting 360º video to provide an immersive experience when viewed.
- The High-Definition Earth-Viewing (HDEV) payload was mounted external to the ISS and used the same video encoder used for most HD content inside the ISS. Video was downloaded live using the HOSC Payload Ethernet Gateway (**HPEG**) and delivered to the internet for public viewing. After the payload failed, the stream was replaced by content from an ISS External High-Definition Camera, due to the popularity of having a live Earth view.

For someone contemplating creating a payload to fly on ISS, there are several things to consider in planning to meet any video requirements. The space environment comes with some constraints compared to most common Earth environments. There is an advantage to using equipment that's already on board, of course, and there is also advantage to using hardware that's the same as has been previously used and proven to work. New equipment has to be qualified for flight, which may impact cost and schedule, though requirements aren't too onerous for flying in the pressurized area. Another consideration is the content of the video. For a camera sealed in a proprietary experiment rack, the video could go directly to the owner with no need for anyone else to view it or have a copy. On the other hand, video that may have a view of astronauts, of someone else's intellectual property, or that has been paid for by the government will likely need to be reviewed before any public release and may need to be archived.

Links and references to detailed documentation about video use on ISS will be included for further research.