

THE SPACE FRONTIER STUDIO KIBG and the utilization of the system to produce broadcast programs

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Content of the first series of programs

With technologies and designs, we will make space open to everyone. From the remote place called space where only astronauts were able to make statements, every individual will have the opportunity to send messages and express himself or herself, while watching the blue Earth. The laptop terminal installed by the round window facing Earth of the Japanese Experiment Module (JEM) "Kibo" on the International Space Station (ISS) is the main equipment of the newly constructed Space Frontier Studio KIBO. Messages uplinked by the TV studio (ground studio) located in Tokyo are displayed on the onboard terminal. Videos showing the interior of the JEM Kibo are transmitted to the ground studio. This is the world's first face-to-face participatory two-way live communication system linking space with Earth. This system is utilized to produce and deliver TV broadcast programs.

The Space Frontier Studio KIBO (ISS)



A real-time video of the ground is displayed together with the surface of Earth as seen through the window of the JEM Kibo module.

The ground studio (Tokyo)



The real-time video of the JEM Kibo is downlinked to the ground studio. It takes about 7 sec to transmit video data from the ground studio to the ISS and then return it to the ground.

[PROGRAM]

The program content was arranged and progressed with the 90-minute ISS orbit around Earth. As the ISS travels in Earth's daytime zone, various communication experiments linking the JEM Kibo with the ground studio are conducted. During the Earth's nighttime zone, The Perseid meteor shower was also filmed and broadcast live by the ground studio.



(OPERATION)

The Tsukuba Space Center houses the Mission Control Room (MCR) and the User Operation Area (UOA). In collaboration with the ground studio in Tokyo, these facilities transmit video and other data to the ISS and direct specified intra-vehicular activities. The MCR/UOA check live videos sent from the ISS for broadcasting and also conduct camera switching and other operations.



Ground studio (Tokyo)

Control Room (Tokyo)

UOA/MCR

(Tsukuba Space Center)

Space Frontier Studio

Development of face-to-face two-way live communication system with stations other than the ISS/NASA/JAXA intranet

Network

The ISS was connected on an intranet with the Tsukuba Space Center and it is not possible to import external data into the intranet.

Our system is based on the mechanism of converting external data into two-dimensional codes, capturing two-dimensional code images, and then re-converting those codes into data to transfer real-time external data. This mechanism enables external data to be imported on a real-time basis, while maintaining a secure state of the intranetwork.

Application

The following types of data are imported into the intra-network of the Tsukuba Space Center and ISS: Videos filmed in the ground studio

·Display switching commands of the application running on the laptop terminal installed in the JEM Kibo · Messages uploaded through SNS by program viewers (e.g., text data, icon images).

Such data emitted by the ground studio in Tokyo are received through the system booth in the Tsukuba Space Center by the application running on the laptop terminal in the JEM Kibo.

The terminal displays operation commands with a one-second delay (each way) and video from the ground studio with a two-second delay (each way). It can be operated on a real-time basis from the ground studio in Tokyo in harmony with the progress of the TV program.

The ground studio also operates the onboard terminal to display video of the ground studio and SNS messages of the viewers, which are then captured by the intra-vehicular camera to downlink the video data. This is the world's first configuration of a two-way live communication system.

Video filmed in the JEM Kibo Tsukuba NASA

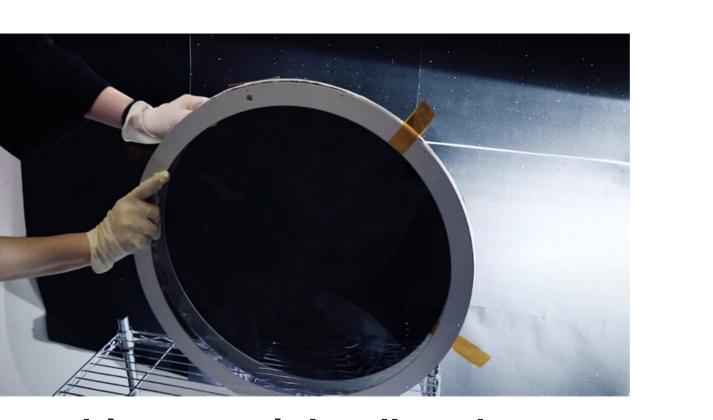
Technical Challenge 2

Fabrication and operation of a variable ND filter for optimal filming of intra- and extra-vehicular objects with different illumination levels

Due to the ever-changing intensity of sunlight, filming intra - and extra - vehicular objects with different illumination levels (e.g., screen of the onboard laptop terminal, Earth as viewed through the round window of the JEM Kibo) with an optimal exposure previously required real-time regulation (dimming). We therefore fabricated a variable ND filter with double polarizing film dedicated to filming the view through the round window of the JEM Kibo, and transported it to the ISS. It has a simple dimming mechanism. The user need only "roll" the closer filter to one side in order to smoothly reduce the light.







Rolling the closer filter to one side to smoothly control the dimming.

Verification with a simulation system for filming Earth and the terminal at optimal angles

The positions and filming angles of the camera and laptop terminal for filming videos sent from the ground studio and the images of Earth at optimal angles were examined and verified with a 3D simulator. Thus, the camera was precisely installed in a short time.



angles in the ISS

Actual camera image

Technical Challenge 3

Broadcast programs in arranged with ISS's orbit, daytime/night time zone, and AOS/LOS

The ISS's time zones, sunrise and sunset times, and AOS/LOS (acquisition of signal/loss of signal) zones are visualized on a single world map. These visualized data are used for producing broadcast programs. The intra- and extra-vehicular camera angles and the sun's relative orientation, which could not be tested beforehand, were simulated using an original 3D simulator. Both the onboard crew and viewers on the ground could thus observe the rising sun together during the broadcast.

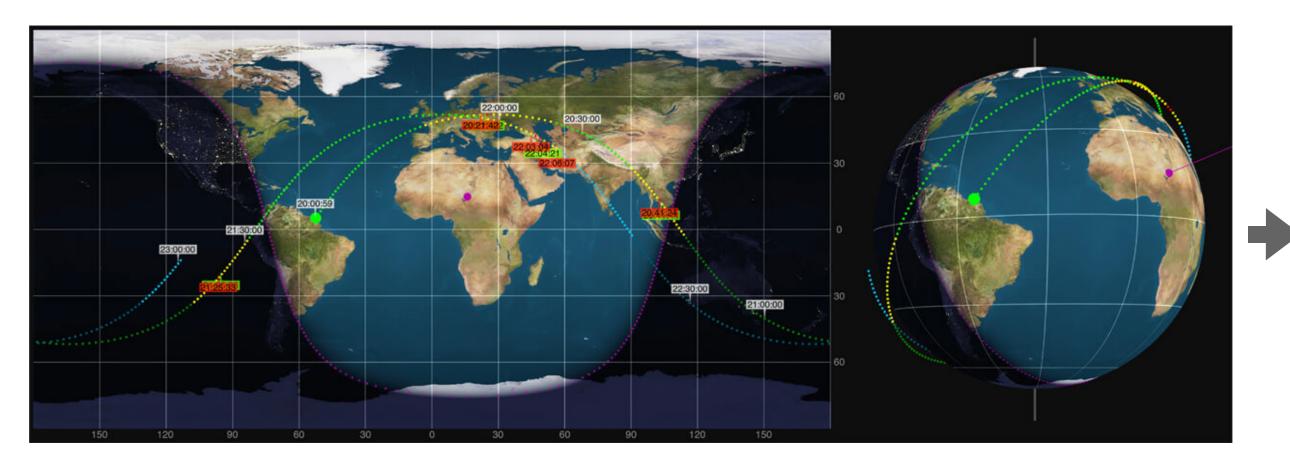


Chart of the predicted orbit and AOS/LOS zones on the date of broadcast



Configuration of broadcast programs

3D simulation of the rising sun



Actual filmed video of the rising sun

Result

Making maximum use of the available on-orbit equipment, we have configured a new studio system based on a unique idea: establishing technical bases for using the ISS as a means of entertainment business.

[World-first achievement] The ISS/Earth face-to face two-way live program delivery system was technically demonstrated for broadcast.

A general-purpose data communication protocol that considers limited communication lines between the ISS and Earth, and an application dedicated to two-way communications enabled in a short time were originally developed. Using relays provided by JAXA, NASA, and other stations, two-way live video delivery was successfully demonstrated between the ground and ISS.

Remote control of the application installed on the terminal in the JEM Kibo was successfully demonstrated with commands sent by a private studio in Tokyo (outside the JAXA Tsukuba Space Center). This marked Japan's first achievement of such a command operation.

The private studio in Tokyo sent commands via JAXA and NASA for the following three operations:

- 1. Broadcasting live video of the ground studio in Tokyo
- 2. Displaying in-application video and still image assets
- 3. Displaying comments and tweets by international viewers

The on-orbit equipment received data sent by the ground studio during the broadcast. Operations that included the display of data by commands sent from the ground were successfully demonstrated.

The usefulness of a variable ND filter was successfully demonstrated for the simultaneous filming of Earth and the terminal screen--objects with vastly different illumination levels.

The variable ND filter for views through the round window of the JEM Kibo successfully helped control the reduction of Earth's illumination level.

The TV program broadcast taking the ISS's orbit, time zones, and AOS/LOS into consideration proceeded as planned.

Future Vision

- Production of the next series of broadcast programs at the end of 2020 and early 2021
- Two-way video communication with reduced delay that uses UDP protocol
- Production of two-way broadcast programs linking videos of astronauts in the JEM Kibo and those of the ground
- Production of global content linked with the ISS's horizontal passing position over Earth
- Development of advertisement products in view of commercialization
- Utilization of the broadcast system for stations other than the Space Frontier Studio KIBO
- Introduction of AR/VR content
- Teleradiography based on remote camera control

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