Utilization of Projection Mapping in the Tokyo 2020 Games

OOMARU Yoshihisa MIZUSHIMA Tetsuro ICHIKAWA Masaki
MATSUKI Daizaburo SAKANISHI Yasuaki

Abstract

The Olympic and Paralympic Games Tokyo 2020 utilized projection mapping to stage the opening and closing ceremonies and competitions. This article introduces the technology and efforts focused on Japan National Stadium, where the opening and closing ceremonies and athletic competitions were staged.

Keywords : Projector, Projection mapping, Tokyo 2020

1. Introduction

Panasonic has supported the Olympic and Paralympic Games for 30 years, which started by delivering broadcasting equipment for the Barcelona 1992 Games using the latest video and audio technologies. Panasonic provided projection mapping for the opening and closing ceremonies, starting with the London 2012 Games, then Rio 2016 Games and Pyeongchang 2018 Games. Taking advantage of its high staging potential and the possibility of direct visual effects on the competition field, we have provided projection mapping for the opening and closing ceremonies and the competition venues.

In the Tokyo 2020 Olympic and Paralympic Games (hereinafter referred to as "Tokyo 2020"), projection mapping was provided to multiple competition venues, expanding the range of its use. This article introduces the technology and efforts of the Tokyo 2020 Games, focusing on the projection mapping at Japan National Stadium (Olympic Stadium), where the opening and closing ceremonies and athletic competitions were staged. Figure 1 shows the projection mapping of the opening ceremony of the Paralympic Games at Japan National Stadium.

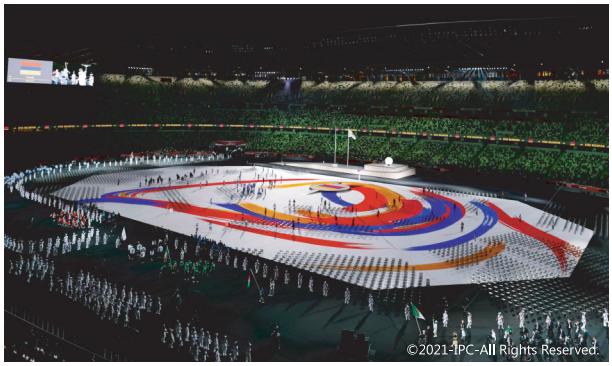

Figure 1 Projection Mapping at Japan National Stadium

2. Projection Mapping Technology and Efforts

The Tokyo 2020 Games aimed "the most innovative Games in history, bringing positive reform to the world",

OOMARU Yoshihisa
Media Entertainment Business Division, Panasonic Connect Co., Ltd
MIZUSHIMA Tetsuro
Media Entertainment Business Division, Panasonic Connect Co., Ltd
E-mail mizushima.tetsuro@jp.panasonic.com
ICHIKAWA Masaki
Media Entertainment Business Division, Panasonic Connect Co., Ltd
MATSUKI Daizaburo
Media Entertainment Business Division, Panasonic Connect Co., Ltd
SAKANISHI Yasuaki
Media Entertainment Business Division, Panasonic Connect Co., Ltd
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as stated in the Games Vision. Communication from eitire Venuse at Opening and Closing Ceremonies and Innovation for Athletics were requested. Also, it was necessary to reduce the total cost and respond to the long period, including rehearsals, and to deal with Covid-19 issues.

The following technologies and approaches were applied to meet these requirements.

2.1 Development of an Ultra-bright Projector

For the opening and closing ceremonies of the Tokyo 2020 Olympic and Paralympic Games, projection mapping was required for an area of approximately 10,000 m^2 inside the competition track to enable communication and staging from the entire venue. The area for projection mapping for the Tokyo 2020 Games was approximately 1.7 times larger than the Rio 2016 Games, making it the largest-scale projection mapping compared to previous sporting events.

Large-scale projection mapping requires high-power light and the use of multiple projectors. In Rio 2016 Games, approximately 110 projectors with a luminance of 20,000 lm were used. However, using a large number of projectors requires man-hours for installation and adjustment, as well as space for installation. To solve this problem, we developed the PT-RQ50K ultra-brightness projector. Figure 2 shows a photograph of the projector and its main specifications. This projector has a high luminance output of 50,000 lm and a compact chassis with a footprint (width × depth) of less than 0.8 m^2, equivalent to a conventional model with half the light output, thanks to a more efficient cooling mechanism. The use of this projector has realized a 1.7-fold increase in image projection area and a 1.2-fold increase in illumination intensity while reducing the number of projectors to approximately 60, nearly half the number used at the Rio 2016 Games.

The projectors can express 4K resolution and a wide color gamut by newly adopting red lasers, which have higher color purity than lamps and phosphors, as the light source. This projector enables realistic presentation for 4K international broadcasting, which has been adopted from the Games of this year.

2.2 Overall System Design

The overall system design for the projection mapping of the opening and closing ceremonies was based on the following two points, in addition to the projection area and support for international broadcasting.

① Reduction of shadows of casts and structures
② Redundancy of the system against the risk of loss of images

Many casts and structures are used in the opening and closing ceremonies. In normal projection mapping of buildings, light is projected from one direction, resulting in shadows on the opposite side. To avoid this problem, we adopted a design in which images are projected from four directions by installing four projection towers. Figure 3 shows the projection layout of the projectors, and Figure 4 shows a photograph of the projection

■Main specifications of PT-RQ50K
- Projector type: 3-chip DLP projector
- Light output: 50,000 lm
- Resolution: Native 4K (4096 × 2160 dots)
- Dimensions: 720 × 445 × 1,070 mm
- Weight: Approx. 126 kg (excluding lens)
- Operating environment temperature: 0 ～ 45°C

Figure 2 Projector RT-RQ50K Used at Japan National Stadium

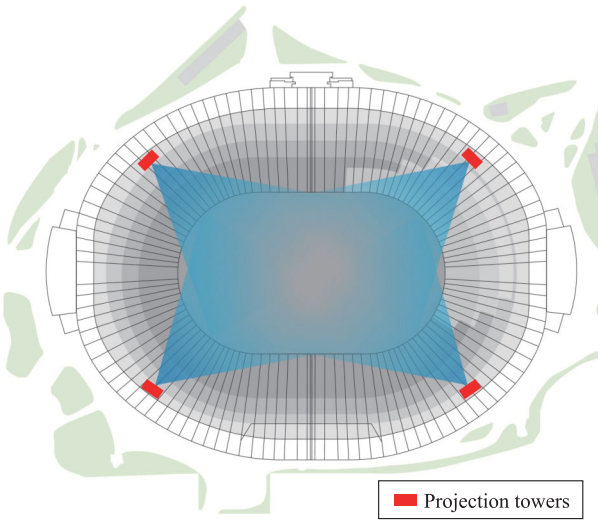

Figure 3 Layout of Projectors

Figure 4　Projection Tower

Figure 5　Athletics Projection Mapping

towers. In addition, to address the risk of loss of images, the same images were projected from four different directions and stacked to ensure redundancy.

The redundancy of the system design includes power supply backup, a redundant control system, and redundant video signal lines in a ring configuration for different paths. The projector also has a function that switches to the backup input signal in 0.3 seconds when the primary input signal is interrupted, enabling seamless restoration of images.

The total number of projection towers was reduced to approximately 60 units, reducing installation space and weight compared to past Games. The reduction in the number of projectors also made it possible to reduce the number of subsystems and cabling.

The design and initiatives enabled capturing the video presentation with sufficient brightness and color from any broadcasting camera, and the presentation could be enjoyed from any of the audience seats. The total system cost was also reduced by reducing the number of projectors.

As innovation in athletics at the Tokyo 2020 Games, projection mapping was used to introduce the finalists in the opening performance of the men's and women's 100 m finals. Figure 5 is an image of the introduction. Projection mapping can be used directly on the competition field to expand the staging area in track and field events, where competitions are held in succession. For performing a series of competitions and shows, it is necessary to adjust the lighting system to darken the field and light the field after the show. LED lighting is used at Japan National Stadium, and an unprecedented staging could be realized by coordinating the immediate darkening and brightening of the stadium. Since projection mapping on the reddish track surface was required, we conducted a projection test at Japan National Stadium more than six months before the Games and provided production support for content preparation.

The projectors used for the track and field events were also used for the opening and closing ceremonies. The same projectors were used for the different areas of the opening and closing ceremonies and the track and field events, and the installation was designed to minimize conversion adjustments. This minimized costs and ensured smooth transition and rehearsal between the athletics staging and the closing ceremony.

2.3　Operational Support

Our company provided total solutions for the video and audio systems at the Tokyo 2020 Games, including design, consulting, equipment procurement, installation, adjustment, operation, and maintenance.

For Japan National Stadium, in addition to projectors, we provided cameras for staging, video switchers, international broadcasting from video servers, large video equipment within the stadium, video distribution to the production teams, and a sound system. These video and audio systems supported a total scenography solution for the opening and closing ceremonies, not only by integrating the movement of the performers and projection mapping but also by linking the projected images and sound.

Figure 6 shows the main projection control room. We also constructed and operated the video and audio control room system.

For the opening and closing ceremonies, the installation and operation of the projector and video distribution system began more than two months before the event to

accommodate rehearsals. Because the projectors were installed in a semi-outdoor location, it was necessary to take measures against rain and wind caused by Tokyo's unique weather conditions, such as the rainy season, typhoons, and sudden downpours. A remote monitoring system was utilized to carry out manpower-saving operations in the face of the coronavirus disease 2019 (COVID-19). A wide range of work was handled, including on-site equipment maintenance. Figure 7 shows the implementation of on-site repair and maintenance support.

Heavy transport equipment such as cranes could not be used to install the projector from the perspective of protecting the stadium facility. However, the PT-RQ50K's compact one-piece body and handle made it possible for the projector to be carried by a person, thereby reducing the work time.

For video coordination and operations, the experienced members of the operation team from Japan and overseas responded quickly and flexibly to the production team's requests by utilizing the know-how gained from working on large-scale events, developing a workflow that included personnel allocation and role assignment, and conducting simulations and other

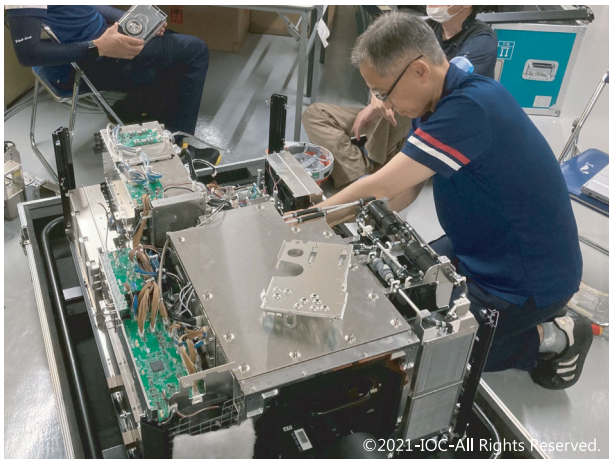

Figure 7　On-site Maintenance of Projectors

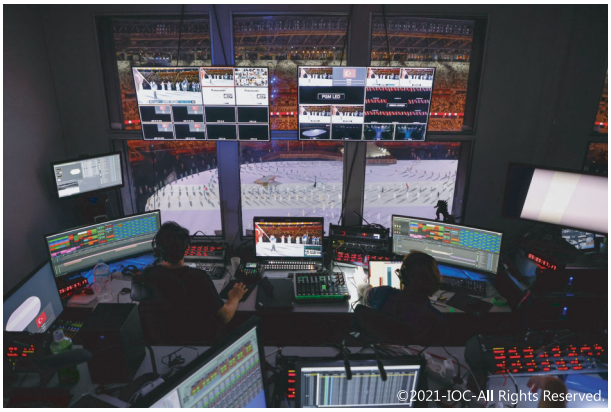

Figure 6　View of the Projection Control Room

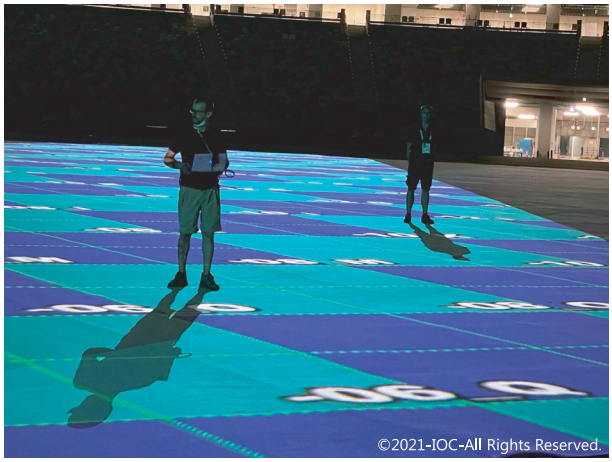

Figure 8　Projection Mapping Adjustment

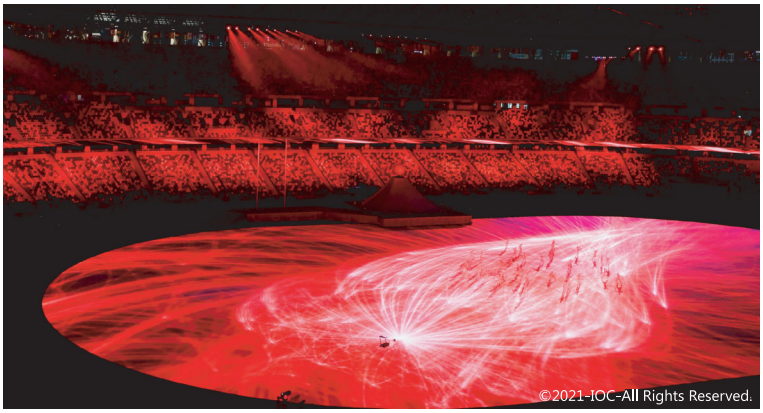

Figure 9　Opening Ceremony of Tokyo 2020 Games

preparations. Figure 8 shows the adjustment of the projection mapping. The team also adjusted the images differently from the original plan by changing the unevenness of the stage and other forms and the setting positions as needed.

Although the projection mapping was operated on-site over four months, including rehearsals, which were required to reduce the workforce due to the COVID-19, we were able to complete the production of the competition through preliminary simulations, workflow improvements, and our long experience in projection mapping.

3. Conclusion

This article describes the technologies and approaches for using projection mapping in the Tokyo 2020 Games, focusing on the example of Japan National Stadium. Based on our know-how, we developed projectors suitable for large-scale projection mapping and provided total solutions, including projection layout, system design, installation, and operation. We were thereby able to reduce the total cost and support manpower-saving operations of the Games that were required due to the COVID-19.

The opening and closing ceremonies of the Tokyo 2020 Games were delivered to people worldwide as symbolic scenes of the world's largest sporting events. We believe that using projection mapping to create a vividly colored space contributed to this success. We want to express our sincere gratitude to those involved in the Tokyo 2020 Games and the production team for their cooperation.

Figure 9 shows a scene of the Tokyo 2020 Games Opening Ceremony in which the color red was expressed very vividly. We will continue to develop our projectors and projection mapping technology to improve the image quality and the workflow, including production and operation, and to provide solutions for these improvements. We intend to make further contributions to total space production through projectors and projection mapping technology in Japan and the world.

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OOMARU Yoshihisa

He joined Panasonic Corporation in 2012, where he was in charge of subject matter and market development in the projector-related business division, and management of project managers for Expo 2015 Milano and 2017 Astana, Rio 2016 Games, Pyeongchang 2018 Games, and Tokyo 2020 Games Opening and Closing Ceremonies.

MIZUSHIMA Tetsuro

He graduated from the University of Tokyo in 1997 with a bachelor's degree in materials science and engineering. He completed his master's degree in materials science and engineering from the same university in 1999. He joined TDK Corporation in 1997 and Panasonic Corporation in 2004 and was engaged in developing laser projectors and other products. He received the Optical Design Incentive Award in 2008.

ICHIKAWA Masaki

He graduated from Waseda University in 1991 with a law degree. He joined Matsushita Electric Industrial Co. Since then, he has been engaged in product planning and marketing of professional audio equipment RAMSA. After working as a project manager for the Beijing 2008 Olympics, he served as the project leader for the Opening and Closing Ceremony Acoustics Project and as the project leader for Panasonic's public relations project at the Tokyo 2020 Games.

MATSUKI Daizaburo

He graduated from Keio University in 1997 with a bachelor's degree in electrical engineering and completed a master's degree in electrical engineering at Keio University in 1999. He joined Matsushita Electric Industrial Co., Ltd. He has been engaged in the research and development of optical systems using optical lenses and free-form mirrors. He was the primary SE in charge of the projection mapping for the opening and closing ceremonies of the Tokyo 2020 Games.

SAKANISHI Yasuaki

He graduated from Nagoya Institute of Technology in 1987 with a bachelor's degree in electronics. He joined Matsushita Electric Industrial Co., Ltd in the same year. Since then, he has been engaged in the development and design of high-definition TVs, projectors, displays, and other products. He was in charge of projection mapping SE for the opening and closing ceremonies of the Tokyo 2020 Games. Currently, he is the manager of the System Architect Section, Business Development Center, Panasonic Connect Co.