Technology Introduction

In-house application of XR (cross-reality) technology for realizing digital twins

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1 Introduction

The Internet of Things (IoT) technology has made remarkable progress in recent years. We are now able to collect, link, and display data, including numerical data and images, from a wide variety of things, further increasing the speed of information exchange. In addition, the use of wearable devices has transformed not only things or objects, but even people's life rhythms and biometric information into data. This has led to the creation of new products and services. As one of these new ways of using this type of data, Cross Reality (XR) technology, which represents (visualizes) data collected in the real world, has gained attention. This technology allows us to create new experiences by merging information from the real world with that from a virtual world.

As IoT and XR technologies have advanced in this way, the spotlight has also turned to digital twins [1], which duplicate the environment equivalent to the real world in a virtual world. The digital twin enables real-time monitoring and simulation, allowing us to verify in a virtual world the possibility of anything happening in the real world. The verification results are fed back to the real world using the XR technology, leading to efficient development and maintenance.

In response to these changes in the industrial structure, KYB is promoting digital transformation (DX) to change the way work is done using digital technology, to create new ideas and businesses in the fields of technology, quality, and manufacturing, and ultimately to improve quality and productivity. This paper mainly introduces current initiatives for using digital twins.

2 Digital Twins

Digital twins can be realized by combining many different technologies. Typical technologies include the above-mentioned IoT and XR technologies, the 5th Generation (5G) mobile communication technology that can reflect data collected with these technologies in real time without delay, Artificial Intelligence (AI) technology that can efficiently analyze large amounts of collected data, and Computer Aided Engineering (CAE) technology that can implement real-time simulation in a quasi-real environment in a virtual world.

The use of digital twins has already begun. One example is PLATEAU [2], a Japan-wide urban digital twin realization project led by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). These PLATEAU 3-dimensional urban models are open to the public. This open data is available to everyone and is used for a variety of initiatives.

The realization of digital twins makes it possible to safely replicate in a virtual world harsh conditions or destructive tests that are difficult to implement in the real world. We consider digital twins to be an important technology for the transformation of work using digital technology in KYB. Recently, KYB has focused on the use of AI and IoT technologies but has not yet started to work on XR technology. Then, we have carried out research and implementation of XR technology this time.

3 XR Technology

XR technology is a general term for a group of technologies that can create spaces for people to vicariously experience augmented reality (AR), virtual reality (VR), and mixed reality (MR).

AR technology is used to read the real world and display the results overlaid with virtual information, allowing people to experience an augmented real world. VR technology allows people to experience a virtual world created entirely with computer graphics (CG) as if it were a real world. MR technology, which is positioned as an intermediate between AR and VR, can allow people to experience a virtual world that is highly integrated with the real world through interactions between the real world and virtual information. For example, MR enables direct manipulation of objects reflected in a virtual world, including expansion, contraction, and overwriting of information. However, recent advances in image processing technology have led to an increasing number of contents that use a combination of AR, MR, and VR technologies. It has become difficult to draw a clear line between these technologies.

XR technology promises to be applied to many fields including remote work support, technology transfer/training, and layout study. It is expected to be used by utilizing the characteristics of MR, AR, and VR technologies. Table 1 shows examples of XR technology applications.

Table 1 XR technology applications

Type	Example of application
AR	Customer satisfaction improvement through product experience
MR	Work support with a combination of reality and CG
VR	Training program based on virtual experience with full CG

These XR technologies, which were originally developed for and used in the entertainment and sales promotion fields, have recently begun to find more applications in industry. One reason for this penetration is that compatible equipment has advanced to a level that meets market needs. Another reason is the established communication environment, which enables high-speed mass data transmission and improves real-time quality. In addition, the improvement of the remote working environment can encourage people to use XR technology as a remote communication tool.

With the above background in mind, we first selected AR/MR from the XR technologies. For testing purposes, we applied the technology to remote support tools, which are increasingly in demand due to the proliferation of remote work. Furthermore, we have been working on the development of content using highly flexible AR/MR for its future application to various settings in the company.

4 Compatible Devices

The use of XR technology requires compatible devices. For remote support and AR/MR content delivery, we used smartphones, tablets, and smart glasses. Smart glasses are wearable glasses that provide hands-free operation with good visibility. Fig. 1 shows an example of smart glasses.

Recently, smart glasses have evolved in several ways, including significant performance improvement, miniaturization and weight reduction, and adaptation to MR. Despite the high price, the performance improvement has led to an increase in their application in industry. As XR devices have become more powerful, the development of their software has become more active. Many software programs are being developed to provide remote support, operator support, and other various functions.

Fig. 1 Smart glasses

5 Use Case: Remote Support

Remote support is the real-time support of site operations from a remote location by sharing voice and image data over a network. We used a remote support tool to communicate between KYB sites. In addition to videophone conversations, the tool allowed us to give visual instructions to site workers by using AR technology. In this way, we achieved a smooth exchange of information even between remote locations.

Of course, this type of information exchange is certainly inferior in terms of the amounts of information that can be obtained by actually traveling to the site, as implied by the concept of "the actual place, the actual parts". Nevertheless, for remote places to which frequent travel is difficult, the use of this type of tool allows convenient communication. In fact, we have confirmed the high effectiveness of the tool, including the ease of obtaining the latest information about the site. It is better to use the tool and on-site communication on a case-by-case basis, instead of depending on only one way.

6 Use Case: Application of AR/MR Content

6.1 Creation of AR/MR content

This time we developed AR/MR content using an AR content creation tool and tested the content by displaying it with smart glasses. Fig. 2 shows the process of using AR/MR content. To provide valuable information using AR/MR displays, you need to develop an idea of what you want to realize. You should also draw pictures and graphics to embody and communicate the idea. Next, you prepare the necessary data based on the idea. The data can be a 3D CAD model, a scanned model, document files, or image data. You can then place the prepared data in a virtual world and explore how the content should appear from different perspectives including layout. Fig. 3 shows a conceptual image of content creation in a virtual world. Finally, you reflect the created data in the real world. After verification, you can move on to the delivery phase. After that, it is desirable to collect the knowledge gained from the delivery phase from time to time and update it regularly.

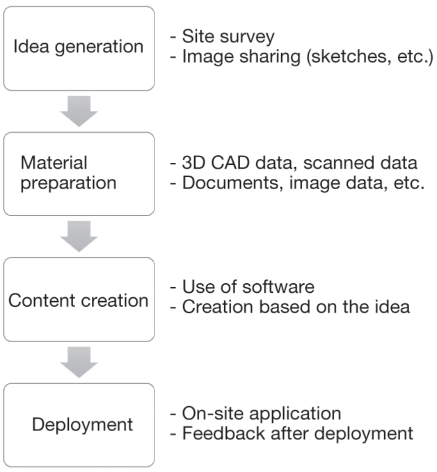

Fig. 2 Content creation process

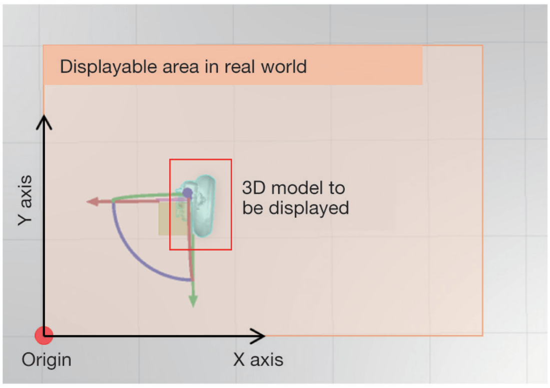

Fig. 3 Content image in virtual world

6.2 Product Display on KYB Virtual Plant Tour

In KYB's virtual plant tour, which was held as one of its recruiting events for students, the company implemented the visualization of 3D models using AR/MR displays, instead of the conventional exhibition using actual products. The 3D model exhibition covered hydraulic damper (oleo struts), which are KYB's basic product. Fig. 4 shows the model created by 3D scanning.

In fact, the display of 3D data can hardly provide feelings of weight and quality. However, unlike the exhibition of real products, this data representation does not require us to worry about the weight of the product to be exhibited or the traffic line when transporting in the exhibition hall. Virtual products can be positioned at any angle in a given space, even in the air. In addition, the same virtual product can be viewed anywhere, not only in a specific physical place such as an exhibition hall, thereby enabling people to share information smoothly. Moreover, the virtual product displayed from the data can be easily rotated so that people can view the product from different angles without moving themselves. This means that if you use the technology effectively, you could deepen your understanding of the structure of the product more than through an actual exhibition. Those who experienced the AR/MR content gave positive comments, including that they could easily visualize the actual size of the product and easily understand the structure.

This application demonstrated that the AR content creation tool can provide an adequate level of 3D model visualization for smooth information sharing and deeper understanding of product structure.

Fig. 4 AR/MR display of the product (oleo strut)

6. 3 Virtual Product Display at KYB Museum

As a substitute for exhibiting the actual large hydraulic cylinder manufactured at Gifu South Plant, its 3D model visualization was made using the AR/MR display in the KYB Museum. Fig. 5 shows the 3D model of the hydraulic cylinder.

In fact, it was difficult to find a place to exhibit the cylinder in the KYB Archives building, as its installation space is limited due to its large size (5 m long) and weight (about 10 tons). This problem was solved by the AR/MR technology, which allowed the display in any given space, which led to the product display using this technology. To make the display more appealing, the 3D model was overlaid with animation to visually express how the hydraulic cylinder works. Fig. 6 shows an example of the animation. Those who viewed the content commented favorably on the life-size display of the model, which was enhanced by the animation.

This application proved that AR/MR display of large products that are difficult to display in a showroom can provide an effective presentation, and the addition of animation can make the display more appealing.

While this 3D data projection was basically a substitute for an actual display, it will be necessary to consider combining actual product displays with data projection to achieve an even better display that incorporates the best of both, as a measure to make it more appealing in a limited space. We believe that information display connected to the real world will help people understand better and find problems earlier.

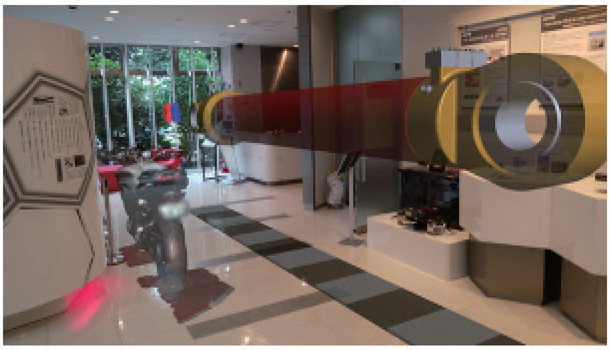

Fig. 5 AR/MR display of the product (hydraulic cylinder)

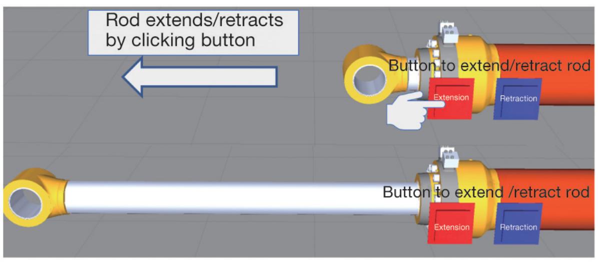

Fig. 6 Example of animation

7 Prospects

We have conducted a trial use for research and implementation of the XR technology and verified that it can be used in various settings and applications. The following describes what we are trying to use the technology for internally.

7. 1 Equipment Layout Planning

XR technology will be applied to equipment layout planning. We will use the technology to pre-design equipment layout in a virtual world and use the result in the real working environment to verify the layout.

7. 2 Operation/Training Manual Development

XR technology will be used to promote the electronification of paper-based documents. By using expressions that utilize the characteristics of XR technology, we will create digital versions not only of instruction manuals but also training materials.

8 In Closing

As part of the digital twin activity, we conducted research and testing of the XR technology and realized that the technology can provide various improvements.

Based on the results of this trial use, we will actualize this initiative and promote technology dissemination for a full-scale use.

Finally, we would like to take this opportunity to express our sincere gratitude to all those who have provided substantial support and cooperation in promoting this activity.

References

1) Website of the Ministry of Internal Affairs and Communications, JAPAN
https://www.soumu.go.jp/hakusho-kids/use/economy/economy_11.html

2) Release by the Ministry of Land, Infrastructure, Transport and Tourism: "Will open a teaser site on Map the New World. -Project “PLATEAU”", December 22, 2020.

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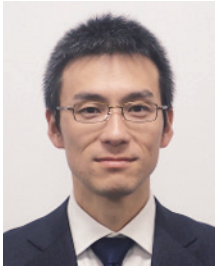

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