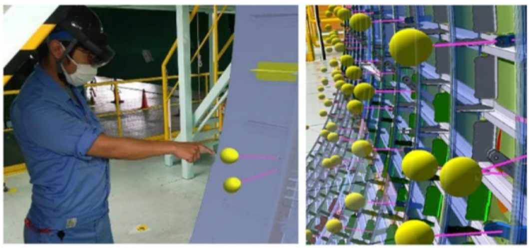
Efficiency of on-site Work Using MR Glasses



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Head mounted display (HMD) glasses applying augmented reality (AR) and mixed reality (MR), which are technologies for superimposing and displaying virtual information over real space, have been put into practical use in various fields in recent years.

Mitsubishi Heavy Industries Ltd. (MHI) is also working to improve the efficiency and quality of field work by developing technologies to superimpose and display 3D models of large components or structures of aircraft, ships, plants, etc. with high accuracy, and user interface technologies that can be used for on-site work by using Microsoft Corporation's MR glasses "HoloLens 2". This report introduces examples of our efforts in aircraft fuselage panel assembly work and marking work for boiler installation.

1. Introduction

Microsoft Corporation released its MR glasses, HoloLens (first generation) in 2017 and HoloLens 2 in 2019. MHI is working to develop a technology using these MR glasses that allows a 3D model of large components or structures of aircraft, ships, plants, etc. that can not be handled by commercial applications to be superimposed and displayed over the real components or structures with high accuracy and display and user interface technologies that can be used for efficient on-site assembly and inspection work.

For Example, concerning work for products comprised of large-scale components or structures, there has been a problem that when drawings are used for work instructions in parts installation, wiring, marking and inspection for the components or structures that have three-dimensional shapes and whose positions are difficult to identify, so it takes time to identify or check the installation positions, wiring route, marking positions, etc.

To solve this problem, we developed a technology using HoloLens 2 that allowed a virtual 3D model and work information and object indicating inspection point to be superimposed and displayed over a real work object through its translucent glasses. As a result, we could easily obtain information about the installation positions, orientations and shapes of parts, wiring route and marking positions, as well as work information and inspection point, and the efficiency of assembly and inspection work and the work quality were substantially increased.

The following chapters introduce the application examples of MR glasses in aircraft fuselage panel assembly work and the marking work for boiler installation.

2. Aircraft fuselage panel assembly work

2.1 Operational issues

The assembly work of aircraft fuselage panels (**Figure 1**) involves fastening of a large number of varied rivets and parts installation work. Therefore, the work instruction drawings are difficult to understand and this takes time and may result in mistakes to identify and check parts positions, kinds, working (processing and finishing) methods, etc.

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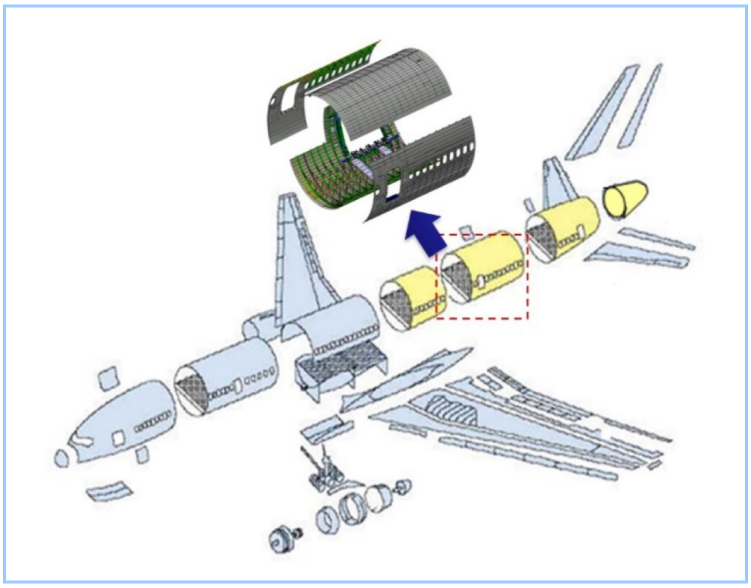

Figure 1 Aircraft fuselage panels

2.2 Work instruction and inspection record utilization of MR glasses

Through the head-mounted MR glasses that the worker wears, a 3D model containing installed parts and information of kinds of rivets/positions, work method, etc., are superimposed and displayed over a real object and work points. This makes it possible for the worker to instantaneously identify the positions, shapes and orientations of the rivets without seeing drawings or templates, resulting in improvement of the work efficiency and quality.

The features of this function are as follows.

(a) Application to large objects

Multiple alignment markers, which are used to superimpose a virtual 3D model over a real object, are placed so that a 3D model can be accurately superimposed and displayed over a fuselage panel with a width of about 10m.

(b) Automatic addition of symbols for work points and work information

In addition to a 3D model automatically, the coordinates of work points that can be obtained from the database and work information are displayed. (**Figure 2**)

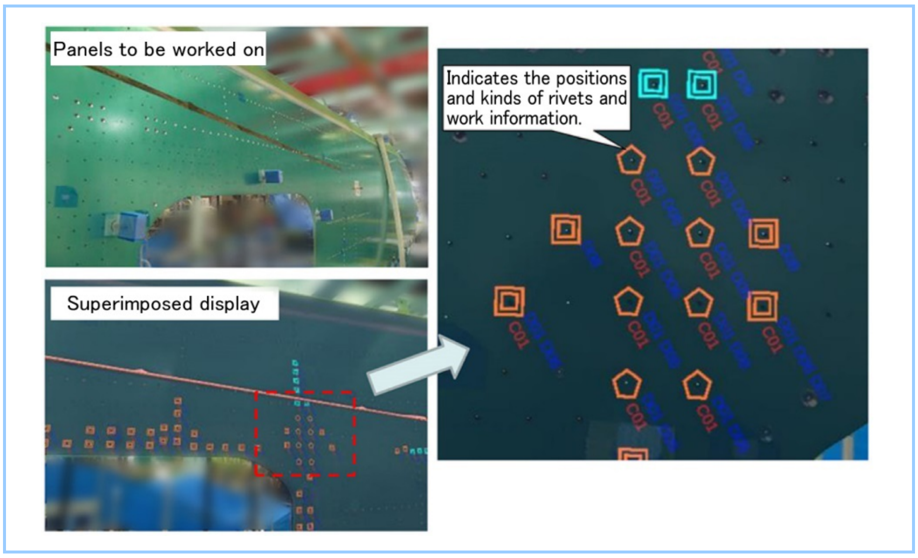

Figure 2 Superimposed display of work order information

(c) Recording of inspection results

Automatic placement of balloons on the inspection part obtained from the database makes it easy to identify inspection points and the presence or absence of mounting parts, part errors, and wrong directions.

Inspection results such as OK/NG can be recorded quickly by touching the balloon (**Figure 3**)

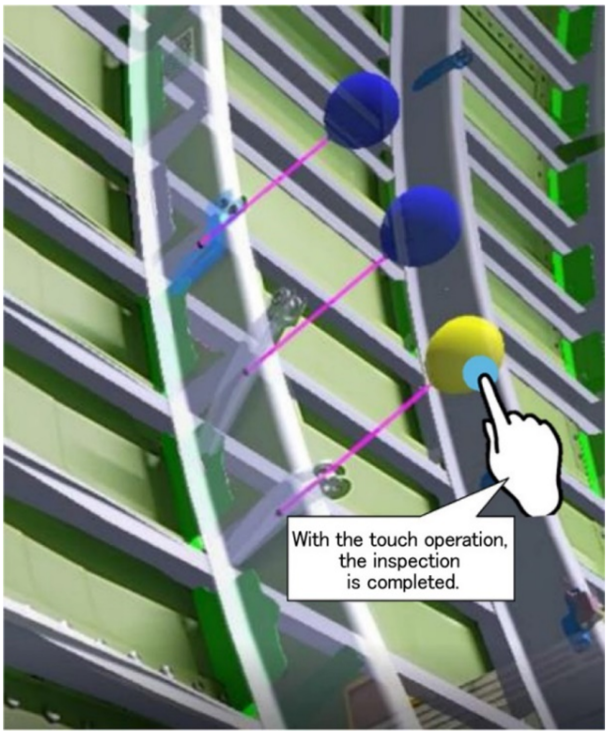

Figure 3 Record of inspection results (touch operation)

2.3 Results

The use of this function requires the time for preparing a model and work instruction information to be superimposed and displayed. We applied this function to the assembly work and the inspection work on-site. As a result, we confirmed that the working hours could be reduced by half compared to the conventional working hours.

3. Marking work for boiler installation

3.1 Operational issues

In the boiler installation work at thermal power plants, when a girder installed on the upper part of a boiler is hoisted, a girder and multiple related products are lifted together after the related products are placed on the ground.

At this time, markings are sprayed on the floor to indicate the positions where the products should be placed. The marking work requires performing a survey with reference to multiple drawings, which takes a lot of time. In addition, it significantly affects other work and adds constraints to the process, because, for example, heavy equipment in the work area must be temporarily carried out or work that is conducted near the marking area must be restricted (**Figure 4**).

Figure 4 Markings for installation of equipment

3.2 Marking work utilizing MR glasses

We developed a function of capturing drawing data into the MR device and directly projecting the positions where products are placed in a real space. This function allows the workers to identify the positions without performing a survey and conduct marking work free from errors.

The features of this function are as follows. (**Figure 5**)

(a) Application to large space

In the same way as previously described, multiple alignment markers are placed, so that marking positions can be accurately superimposed and displayed on a large floor that can not be covered by projection mapping technology.

(b) Manual adjustment to superimposed positions

If there is a slight deviation in the superimposed positions after the work is suspended and restarted, they can be manually adjusted.

(c) Display of drawing information

In addition to the marking positions, the drawing information of products to be installed can be displayed.

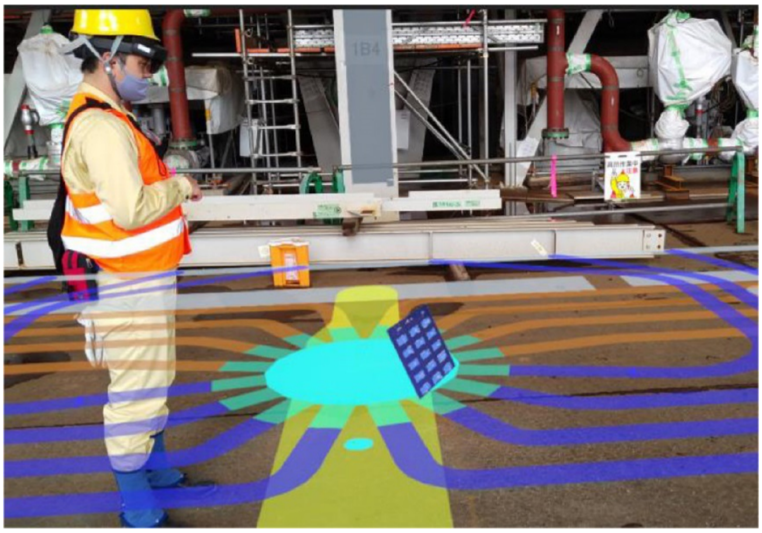

Figure 5 Superimposed display of marking positions

3.3 Results

The labor, etc., for performing a survey is greatly reduced and the man-hours for the entire marking work can be reduced by about 97%. In addition, the stoppage time of other work near the marking area that had to be restricted can be reduced by 85%.

4. Conclusion

In this report, we introduced our developed technologies to superimpose and display 3D models of large components or structures of aircraft, ships, plants, etc. with high accuracy, and user interface technologies that can be used for on-site work by using MR glasses and the application examples in which a virtual 3D model and work information are superimposed and displayed over a real work object, so that we could easily obtain information about the installation positions of parts, work information, etc., thereby achieving the significant efficiency improvement of assembly and inspection work and the improvement of work quality.

Moving forward, we aim to improve the more efficiency and quality of field work by utilizing tablets and smartphones having MR functions other than MR glasses as well as projection mapping technologies that allow markings and work information to be directly projected with high accuracy, applying devices suitable for the application and requirements to our various products.