Efficient Field Communication with Augmented Reality

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A shortage of skilled operators has been a major problem in plant operation for many years, hindering stable operation and raising the risk of serious accidents. Although there is an urgent need to train young workers and hand on skills, there is also a shortage of skilled operators who can lead such work, making it difficult to secure work-ready operators. This is a vicious circle for customers. To overcome this problem, Yokogawa has been developing a real-time visual sharing system using augmented reality (AR) technology. This solution is expected to facilitate handing on skills while overcoming the shortage of skilled operators. Yokogawa has been conducting and evaluating a series of proof of concepts (PoC). This paper reports the concept and development of this solution, and describes our survey of customers' needs and challenges by using a prototype.

INTRODUCTION

Declining field skills resulting from retirement of skilled engineers is a major problem at home and abroad. The biggest issue in plant facility management is the cultivation and recruitment of human resources and the relevance rate is on the rise, according to a survey by the Japan Institute of Plant Maintenance (Figure 1). It is not an exaggeration to say that cultivation and recruitment of human resources is the two biggest issues, along with measures against aging facilities, to be solved to ensure stable operation of existing plants.

This problem is not just a problem for maintaining and managing existing plants, but it is a problem that brings about a shortage of instructors and maintenance operators for plants that are constructed. Therefore, this is also a management issue to be solved for customers to ensure sustainable growth.

We define this problem as a problem for passing on the knowledge and skills of plant operators. To solve this problem, we have repeatedly proposed solutions and discussed them with customers.

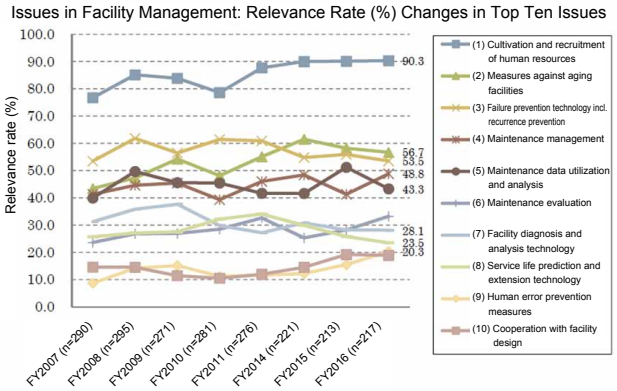

Figure 1 Fact-finding survey on maintenance[(1)]

This paper first describes the hypothesis of the problem for passing on the knowledge and skills of production operators that we try to solve, secondly describes a real-time audio-visual information sharing solution that we are proposing, thirdly presents examples of proof of concept (PoC) activities that we carried out so far and the development status of the solution aimed at commercialization, and finally describes the future outlook for the development.

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PROBLEM FOR PASSING ON THE KNOWLEDGE AND SKILLS OF PRODUCTION OPERATORS

The definition of the problem for passing on the knowledge and skills is broad and ambiguous. In particular, in Japan, where the birthrate is declining and the population is aging rapidly, this is a common issue in all industries. There are different definitions and views depending on the industry and expert [(2) (3)].

We focused on "who" passes on the knowledge and skills "to whom" and classified the plant engineers and their skill levels into the following three categories and created a hierarchical structure through discussions with customers.

1. Highly experienced operator: Has skills to perform a variety of routine and non-routine field operations and is qualified to supervise, evaluate, and approve the operations of other operators. The operator sometimes works as an instructor in new plants.
2. Moderately experienced operator: Has skills to mainly perform routine operations for which the procedure is specified on one's own and has skills to perform some easy non-routine operations on one's own. The operator performs difficult operations by consulting and receiving instructions from a highly experienced operator.
3. Inexperienced operator: Performs some easy high-frequency routine operations such as daily inspection on one's own. The operator receives training and acquires skills for performing low-frequency difficult routine operations on one's own under the guidance of a supervising operator.

Passing on the skills takes place in this hierarchical structure mainly at two points: (A) from a moderately experienced operator to an inexperienced operator and (B) from a highly experienced operator to a moderately experience operator. We interviewed customers to get feedback about this hypothesis. From analysis of the results we concluded that there may be more and big issues for passing-on pattern (B). The reason is that passing-on pattern B requires a wealth of knowledge and practical experience that cannot be acquired by mere education and on-the-job training (OJT) compared to passing-on pattern (A) in which the inexperienced operator is able to acquire a lot of skills through education and OJT. In particular, many customers said that acquiring judgmental skills is most difficult and acquiring those skills requires a lot of experience in the field. We are convinced that the key to solving the issue for passing on the knowledge and skills for customers is how to provide more engineers with more opportunities to experience operations in the field under circumstances in which the number of highly experienced operators is decreasing.

Therefore, we believe that an effective approach is to provide more opportunities to pass on skills through a virtual experience in the field that lets operators feel as if they are standing in the field, in addition to doing so through a practical experience in the field.

REAL-TIME AUDIOVISUAL INFORMATION SHARING SOLUTION USING AN AR TECHNOLOGY

To solve this issue for customers, we have developed a real-time audio-visual information sharing solution using an augmented reality (AR) technology. This solution was implemented by refining one of the concepts that we have presented before in Yokogawa Technical Report [(4)]. This solution is currently at the prototyping phase aimed at commercialization. In this paper, we use code name iBuddy for this solution and describe the aim of deploying iBuddy, and its functions and features.

Aim of Deployment: Providing More Opportunities to Gain Field Experience

The AR technology provides an experience of intuitive reality of the kind not experienced before by significantly extending the potential of the most reliable visual information of the five senses of humans. iBuddy provides an experience of real communication that lets you feel as if you are standing at the site while in a remote location, which is accomplished by combining the AR technology with merely video and audio communication such as a video call. This solution enables a highly experienced operator in a remote location to give more accurate advice and instructions to a moderately experienced or inexperienced operator in the field, compared to conventional support by phone. As a result, we think that this solution can reduce the frequency of precious and rare highly experienced operators to physically travel to the site and thus relatively increase the manpower of highly experienced operators. The following shows two expected specific benefits.

(1) Increase in the number of moderately experienced and inexperienced operators whom one highly experienced operator can support.
(2) Increase in the number of visits (per day) to the site that require the presence of a highly experienced operator.

We believe that these benefits will provide moderately experienced and inexperienced operators with more opportunities to gain field experience.

Major Functions

The following shows three major functions of iBuddy (Figure 2).

(A) Sharing the field situation via a video call
(B) Visual work support and sharing instructions using AR
(C) Sharing operational information by transmitting images

The following describes the details of each of the functions above.

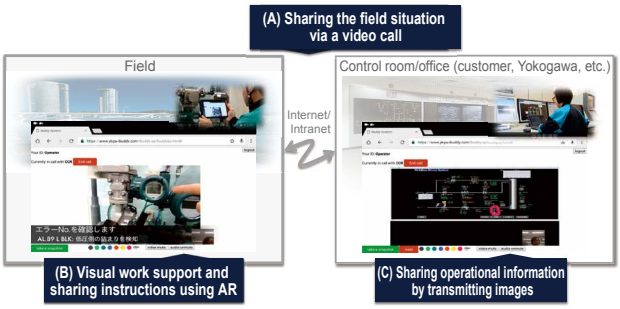

Figure 2 Major functions of iBuddy

Sharing the Field Situation via a Video Call

The mainstream of conventional communication between the field and control room was voice-only communication using transceivers and phones. However, it is said that 80% of perception of the five senses of humans is visual [(5)]. It is difficult to communicate and understand the field situation accurately with an only-voice communication. Many of our customers say that there are many cases in which you can understand the field situation by just sharing photos and videos and you do not need to visit the site.

iBuddy is able to transmit field information more accurately and quickly by sharing the visual information on video images.

Visual Work Support and Sharing Instructions Using AR

This function enables operators to draw and share graphical instructions on video and still images (Figure 3).

Although a video call enables operators to understand the field situation accurately and quickly, it does not sufficiently enable them to give specific work instructions and point to the keys to press, for example. Meanwhile, this function maximizes the visual effect of AR by enabling operators to draw instructions directly on the video images from the field. This enables operators to give more accurate information in an easier to understand manner than only-video-and-voice instructions.

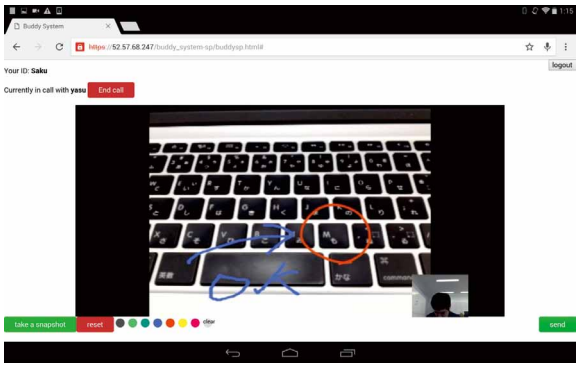

Figure 3 Information communication by AR

Sharing Operational Information by Transmitting Images

You may want to refer to the operational information or instrument manual in the field depending on the details of field work in which you engage. You can expect to increase the efficiency of field work by transmitting images of human interface station (HIS) screens of a distributed control system (DCS) or an instrument manual and sharing them with field operators. You can also draw instructions on the shared images so you can give more accurate instructions as described above (Figure 4).

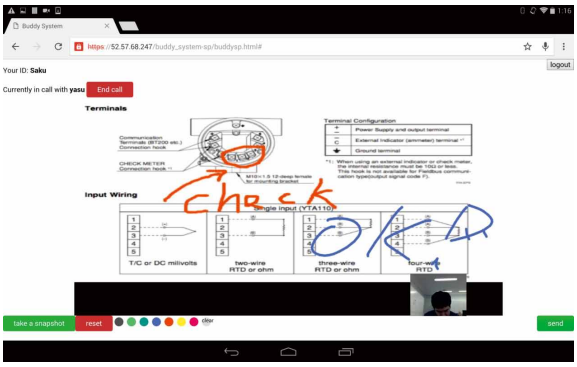

Figure 4 Sharing operational information

Solutions that Pursue Convenience

We have developed and implemented the iBuddy solution keeping in mind the convenience for customers. “Convenience” as used herein means providing customers with a system that can operate in an environment currently owned by customers without need of special applications and complicated settings and thus lowers the barrier of initial deployment for customers.

iBuddy uses the following three technologies to realize this convenience.

(1) Development using the WebRTC open standard technology
(2) Web browser application-based development
(3) Cloud system using a cloud server

The following describes the details of each of the technologies.

WebRTC Open Standard Technology

WebRTC is an abbreviation of Web Real-Time Communication. It is standards for transmitting video, audio, and other data on IP networks. A major feature of Web RTC is an open standard technology [(6)]. Many of the similar video call services are implemented using a proprietary technology. Meanwhile, WebRTC enables convenient implementation of a real-time communication application.

Web Browser Application-based Development

An application using WebRTC can be implemented using a Web browser application or an Android/iOS native application. We have selected a Web browser application that runs on a browser to implement iBuddy.

iBuddy is expected to be used by field operators with mobile devices such as smartphones and tablets and by remote operators with desktop PCs and notebook PCs. A Web browser application runs on any platform so customers can conveniently use the service.

This eliminates complicated application setup and thus enables customers to more conveniently use this service.

Cloud System Using a Cloud Server

A server to run an application is required to implement iBuddy using a browser application. There are two server options. One is an on-premises server that is installed and operated on the premises of a company and the other is a cloud server on the Internet. We have selected a cloud server to install the iBuddy application by considering the convenience of customers.

Unlike an on-premises server, the cloud server option does not require to install an additional server. Customers can use the service conveniently in terms of both cost and deployment speed.

PROOF OF CONCEPT (PoC) ACTIVITIES

We have carried out PoC activities inside and outside the company aimed at commercialization of iBuddy. As mentioned above, one of the features of iBuddy is convenience. This is a result of successful data collection and analysis to identify the customer needs, which were achieved by a repeated short cycle of demonstration to customers, incorporating the feedback from customers into the prototype, and another demonstration of the results to customers. This paper presents one example of the results obtained by an internal trial.

Internal Trial

Effectiveness of iBuddy in solving the issue for passing on the skills is highly regarded by customers. There are many customers who say, for example, "we want to use it immediately" or "when will it be commercialized?" There are also operators in Yokogawa who say they want to use it immediately. So, we have conducted an internal trial in part to evaluate the prototype.

We have carried out the trial for four months from December 2016 to March 2017. We were able to get a lot of honest feedback from internal users. It greatly helped to increase the perfection of iBuddy. Table 1 and Table 2 show some use examples and operational evaluation.

Table 1 Use examples of internal trial
(use between field and control room)

No.	Use Example
1	Loop check between field control panel and HIS.
2	Used for a loop test and failure test in a periodic inspection in a water treatment plant.
3	DCS periodic inspection and field control station (FCS) functional inspection. An FCS operator carried out the tests while watching the live images showing the FCS status and alarm summary information using AR on the HIS panel in the monitoring room.
4	Used to replace 37 fans for a running system while watching the live images of field work on the operator control panel in the central control room and checking alarms and system status and giving instructions to the field operators.
5	Used for a loop test between field and central control room by giving voice instructions to inexperienced operators while watching video images.

Table 2 Feedback of operational evaluation

Feedback
• We easily understood the field situation and gave appropriate instructions. • Increased a sense of confidence at work. • Helped improve the safety management. • Eliminated the need for expert engineers and solved a problem with a shortage of engineer resources. • Allowed us to maintain the quality by preventing operational errors. • Others (improved operational efficiency, allowed us to appeal to customers, and so on)

Since feedback shows that there are many needs for iBuddy in Yokogawa, we are aiming to commercialize iBuddy in an effort to roll out the service both inside and outside the company.

CONCLUSION

The AR market is predicted to grow at an annual rate of approximately 180% to become an 83 billion dollars market by 2021 [7]. The mobile AR segment is driving the growth. The spread of mobile devices is expected to lead to ubiquitous AR reality in plant operation in the near future. To move ahead of competitors toward such a future, we must work together with customers to identify issues and create value as early as possible. We must also cooperate with relevant departments in Yokogawa to deliver services for customers as early as possible. We will continue research and develop in cooperation with customers to create and provide greater value for them.

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