Service Robot Solution "AI Edge Robot" for Solving Labor Shortages

Kurato Maeno **Kei Kato** **Tetsuya Ogawa**
Noriyuki Matsuda **Yasuo Yamamoto**

Various industries are discussing the utilization of service robots to solve the serious problem of labor shortages. Service robots operate autonomously to support businesses in various scenes such as cleaning, security, welfare, and receptionist support, and many demonstration projects are being conducted in Japan. However, in many cases, fully autonomous operation is difficult, and many issues need to be solved before the robots play an active role in the social infrastructure.

OKI announced the concept of a service robot solution "AI Edge Robot" that focuses on these operational issues, aiming for a society in which robots coexist with people and are operated properly.

The concept was awarded the grand prize at the new business idea contest "Yume Pro Challenge 2018" held within the OKI group in April 2019. A project was organized in response to this award, and in just five short months, a prototype was developed and exhibited at CEATEC (Combined Exhibition of Advanced Technologies) 2019 Exhibition. This prompt action is in line with OKI's "Innovation Management System" Yume Pro, and the project is currently in the co-creation phase with multiple companies.

This article introduces the background, aim, and activity status of the project.

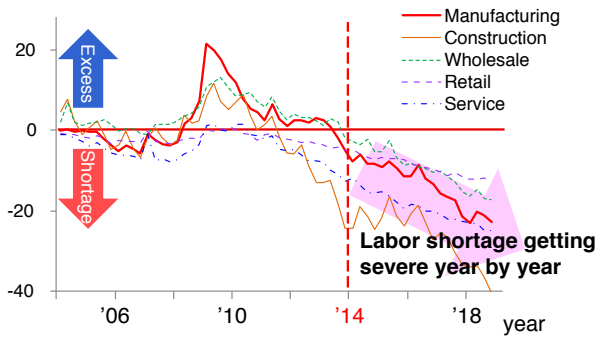
Background

OKI introduced the "Innovation Management System" called Yume Pro in 2018 to solve social issues stated in the SDGs (Sustainable Development Goals) established by the United Nations. Yume Pro is a mechanism for launching innovations based on the international standard ISO56002. In order to centrally maintain the mechanism and foster further culture across the entire OKI group, the Innovation Promotion Center was established.

The new business idea contest "Yume Pro Challenge" is an initiative sponsored by the Innovation Promotion Center and serves an important part in the mechanism for starting innovation activities. "AI Edge Robot" concept became the first grand prize winner of the contest and pushed forward the launch of an innovation project.

The growing labor shortages and global technological innovations in recent years have created a service robot boom. **Figure 1** is statistics compiled from a survey conducted by The Small and Medium Enterprise Agency in Japan and shows the surplus and shortage of corporate employees. From around 2014, the severity of labor shortages has spread across all industries. Although the labor force population has risen due to the increasing willingness of women and the elderly to participate in the labor force, the decline in the working-age population resulting from declining birthrate and aging population has led to a shortage of labor for field-type occupations.

Based on Japan's current situation, the need to rely on robots just to maintain national strength will expand yearly. Formerly, robots were considered to deprive people of their work opportunities. However, people are now becoming more receptive and the signs of a society that coexists with robots are beginning to appear. Under such circumstances, robot utilization is expected to improve the efficiency of field operations and promote the participation of women and the elderly in the labor force.



Employee Surplus/Shortage DI: Ratio of companies with employee "surplus" (%) minus the ratio of companies with employee "shortage" (%)
(Source) Created based on The Small and Medium Enterprise Agency's "2019 White Paper on Small and Medium Enterprises in Japan"[1)]

Figure 1. Changes in the Number of Employees in Japan's Small and Medium Enterprises

The world is currently in midst of a third robot boom. After the first boom of industrial robots in the 1970s, excitement centered on biped walking robots around the year 2000,

and the current boom became certain in circa 2010. The evolution of autonomous control technology accelerated by the development of AI technology and expectations for autonomous driving together with increased investment through global open innovations are the underlying factors for the current boom. The characteristic of the third boom is the expanded movement to utilize various robots to solve problems in various industries, and this diversity is likened to the Cambrian Explosion[2].

OKI is preparing future business scenarios while keeping an eye on these world changes. The Innovation Promotion Center's mission is to function as a compass. Comprehending the world's technological trends and OKI's own technologies, the Center derives a technological strategy to close the gap between the two. The robotics technology is one of OKI's core themes. Taking the concepts derived from the Center's activities, OKI's current business advantages of information communication and mechatronics technologies are integrated to embody value that is indispensable for solving social issues.

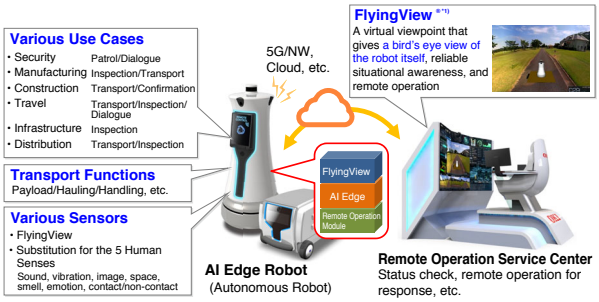


Figure 2. AI Edge Robot Concept

Advanced Remote Work Support through Collaborative Autonomy

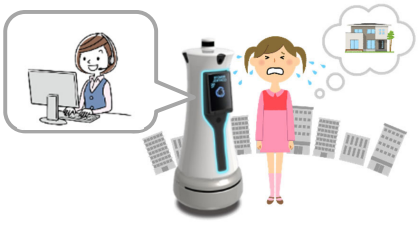
Service robots that autonomously perform complex tasks are beginning to appear globally, and collaborative and power assist robots are reaching a practical use phase. Now, expectations are growing for autonomous mobile robots. These robots benefit from the development of autonomous driving technology and move about in a coexisting environment with humans. There is increasing number of cases in which sensing, communication and other ICT technologies are combined to provide these robots with limited functionalities such as seeing, talking and hauling. It is important to limit tasks in such a way and increase the practicality of applications as solutions to business problems are built up.

However, it is difficult to grow business with that approach alone. Issues often heard from companies considering robot implementation include "It ran out of battery and won't come back," "Two times out of ten it stops somewhere," and "It won't move as planned." In reality, it is still difficult to keep a robot moving 100% automatically in various mixed environment with people, and unless the robot seeks decisions from humans at key points, it will stop. OKI proposes the concept of "collaborative autonomy" as an efficient solution to the issue.

The collaborative autonomy concept dramatically increases the operation rate of autonomously operated robots through remote human intervention and overall contributes to solving the labor shortage issue. If AIs installed in the robots illustrated in **Figure 3** are unable to deal with their respective situations, remote human support can remedy the problems and enable the robots to continue operation.

In example (a), the robot is surrounded by people. For safety reasons, robot cannot force people to move away, but if a remote operator provides audio warning to the people and remotely operates the robot, it is possible to overcome the predicament. Example (b) involves an encounter with a lost child. AI dialogue technology has not matured enough to handle this situation, thus remote operator interaction is more appropriate. The robot in example (c) is faced with a mismatch between the map it possesses and the surrounding environment obtained by its sensor due to construction. A remote operator can reconfigure the route to maintain operation.

(a) Operate among crowds while maintaining safety



(b) Careful and thoughtful response

(c) Tolerant response to surrounding changes

Figure 3. Utilization of Collaborative Autonomy

*1) FlyingView is a registered trademark of Oki Electric Industry Co., Ltd.

Since the occurrence rates of such situations are relatively low, the operation side can handle multiple robots with a just small number of operators. If the operation is carried out by a center or at-home operators, a variety of working environments can be provided. With OKI's proposed concept, such comprehensive measures for labor shortages are possible.

Concept Model Development by Team OKI

In order to put the concept into practice, OKI launched a group-wide project consisting of the head office, marketing & sales group and business groups, and proceeded from planning to prototype development in just five short months. Since time was limited, the project team was divided into five sub-groups, business scenario planning, marketing, design, development and promotion. Each sub-group assigned a group leader for prompt decision making. In order to express the concept in an easy-to-understand manner, a system was to be developed in which one operation center cockpit manages multiple autonomous mobile robots.

The robot was equipped with four wide-angle cameras on the upper portion, and assuming communication with people, its height was 130 cm tall. The shape and design will be flexibly changed according to the application.

The FlyingView system was used on the images from the four top-mounted cameras to facilitate situational awareness from the center. As shown in **Figure 4**, FlyingView is an image composition function that combines the four camera images into a single image to provide visual confirmation of situations surrounding the robot. In addition to being able to check the situation from a virtual viewpoint overlooking the robot itself, it is possible to change the viewpoint in real time and record images of the entire surroundings.

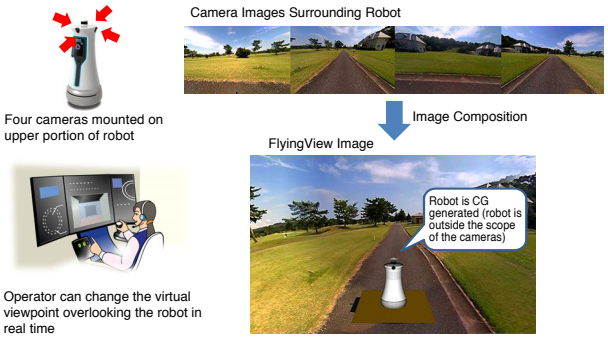


Figure 4. Image Monitoring with FlyingView

As the name "AI Edge Robot" implies, the autonomous mobile robot has a built-in AI function. In addition to such function, it is equipped with an AI edge computer that can be customized with various anomaly detection and image recognition functions at the application level. The various situations captured by the camera can be recognized in real time regardless of the network status, and the results can be recorded and the corresponding actions can be autonomously performed.

Front Display

Side Touch Panel Display Robot Switching

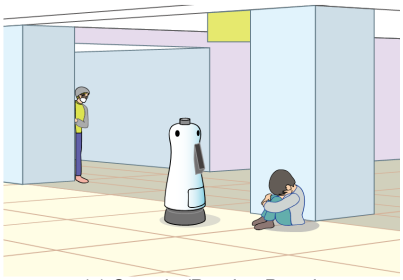
Figure 5. Example of Cockpit Display

The cockpit is capable of monitoring eight robots in parallel. Due to collaborative autonomy, an operator does not need to constantly monitor each robot and only respond to situations that the robot's AI cannot handle. In order to present these functions and the previously mentioned FlyingView in an easy-to-understand visual system, the Unity*2) 3D rendering engine was used. To achieve a futuristic and exciting design, the system was developed at OKI IDS*3) with the cooperation of game creators.

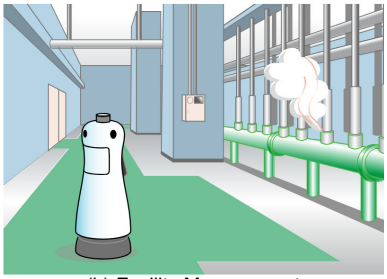
The organization of all functional blocks and the interfaces were precisely defined to smoothly carry out the various developments in a short period of time. As a result, the development time was shortened through efficient division of roles and enabled functions to be easily expanded.

In the development, an agile development style was adopted, and software and hardware were created through many short cycles of creating, testing and fixing. With a tight schedule that called for all parts to be ready just two weeks before the exhibition, even this style of development could not ensure success. At the end, it was the highly motivated efforts of the engineers struggling late into the

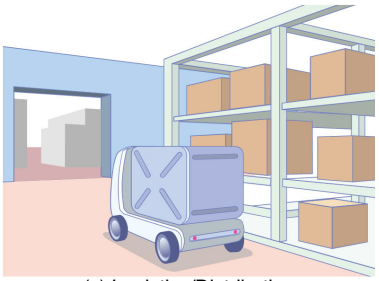
*2) Unity is a trademark or registered trademark of Unity Technologies and its affiliated companies in the U.S. and other countries.
*3) OKI IDS Co., Ltd.



(a) Security/Routine Patrol



(b) Facility Management



(c) Logistics/Distribution

Figure 6. Expected Use for AI Edge Robots

night and on weekends to weed out frequently occurring problems that completed the system development.

The development of the system may have been hectic, but a great deal of knowledge was gained and also led to the growth of the development members. The knowledge that the team obtained will be applied to future projects.

Concept Evaluation and Challenges

Expected fields for the use of AI edge robots include security, facility management, logistics and distribution (**Figure 6**). Extensive market research through hearing surveys, exhibit at CEATEC (**Photo 1**) and several POCs (Proof of Concept) have resulted in favorable feedback from over 100 leading companies, and co-creation activities are also underway.

For example, a company that manages a large-scale facility suffering serious labor shortage and rising labor costs praised the concept as “A truly efficient and realistic solution for facility management.” In addition, companies having issues with remote control of robots evaluated the concept highly for the dramatic improvement in the operational feel provided by FlyingView.

Furthermore, there were many requests for various sensing functions that replace or transcend the five human senses. Examples include detecting minute changes to a facility due deterioration that is overlooked by people, detecting odors that is difficult to quantify, and detecting equipment abnormalities that is normally detected with sight, sound and touch. As such, the needs were great for a more reliable method of preventing deterioration and detecting failure signs through quantitative analysis of state changes.

Various other usages were suggested by customers including security/crime prevention applications, such as detection of suspicious people, and careful/thoughtful responses that only humans can provide.

Additionally, the customers also expressed a need for a way to derive optimal solutions through the integration of fixed cameras and sensors installed in the facility, as well as equipment logs, instead of the robot alone, which suggests that a study for such a system is necessary.

Photo 1. Robot and Cockpit exhibited at CEATEC

Future Outlook

Based on the “Innovation Management System” Yume Pro, OKI introduced the concept of a service robot as a solution to the labor shortage problem, and in five months, developed a robot, which was exhibited at CEATEC. Currently, OKI is preparing business scenarios in various areas such as facility management, security, logistics and distribution, and have started co-creation activities.

As the use of service robots expands in the future, the need for highly reliable remote operation will grow. In such areas where humans and robots coexist, OKI will make wide use of this project’s results and aim to bring advanced IoT society to reality.

References

1) The Small and Medium Enterprise Agency: 2019 White Paper on Small and Medium Enterprises in Japan, October 2019, p6 https://www.chusho.meti.go.jp/pamflet/hakusyo/2019/PDF/2019hakusyosummary_eng.pdf
2) Gill A. Pratt: Is a Cambrian Explosion Coming for Robotics?, Journal of Economic Perspectives, Vol.29, No.3, Summer, 2015. https://www.aeaweb.org/articles?id=10.1257/jep.29.3.51
3) Hiroyuki Itami, Hiroshi Miyanaga: Management with technology as a weapon What is the MOT required for Japanese companies Three barriers to innovation management, Nikkei BizGate, 2014 (in Japanese) https://bizgate.nikkei.co.jp/article/DGXMZO31154140300520180000000

Authors

Kurato Maeno, Planning & Management Division, Innovation Promotion Center

Kei Kato, Innovation Promotion Department, Innovation Promotion Center

Tetsuya Ogawa, IoT Application Development & Business Promotion Center, Solution Systems Business Group

Noriyuki Matsuda, Automation Systems Division, Components & Platforms Business Group

Yasuo Yamamoto, Business Division, OKI IDS Co., Ltd.

TIPS【Glossary】

3D rendering engine
A module that draws 3D images from 3D objects and light source information.