AUGMENTED TELEWORK

TECHNOLOGIES FOR A NEW WORKSTYLE

IN A POST-CORONA SOCIETY

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INTRODUCTION

The novel coronavirus disease, COVID-19, which began its spread at the end of 2019, has now become a worldwide pandemic. As of April 2020, several countries around the world have imposed severe restrictions on citizens' movement [i], and some countries and cities have imposed a requirement to suspend most business activities [ii]. The infection continues to spread around the world, and it is unclear when it will be contained. Currently, it is of utmost importance to take action to bring the infection under control. On the other hand, it is also necessary to consider the effects on life, work, industry, and society during the period toward complete control ("with Corona") and after control ("post Corona").

At this stage, one of the most important preventive measures against COVID-19 is social distancing, in addition to regular hand washing [iii]. Specifically, people have been requested to limit their movements and avoid crowds, owing to which various business activities have had to stop. Clearly, most industries cannot continue their businesses without gathering people (employees, consumers, etc.) together.

Meanwhile, as COVID-19 brings economic activity to a standstill, major unexpected social and environmental changes are taking place. For the many businesses that are adopting telecommuting models, work management has to change. In addition, the limitation of human movement and economic activity has considerably reduced global carbon dioxide emissions [iv]. The fact that COVID-19 has forced a change in our

socially and environmentally harmful behaviors has caused mixed reactions. Nonetheless, the damage caused by this pandemic in terms of health, social restrictions, and economic stagnation is enormous, and it is disproportionately affecting vulnerable populations.

Here, it is considered that the post-corona society does not imply returning to a pre-corona society with the adaptive capacity to prepare for the next infectious disease, but rather, a society that (1) raises awareness on labor issues, (2) employs environmentally sustainable measures as far as possible, (3) reduces the burden on vulnerable people, and (4) prepares for the next infectious disease to come.

It has been estimated that the COVID-19 epidemic may continue over the next year or longer[v]. Increasing productivity by gathering people together has been a basic strategy of industrialization and urbanization since the modern times, but this pandemic has exposed the industrial and social vulnerabilities that this policy brings in an unprecedented way. Therefore, first, the continuation of businesses without gathering people needs to be considered. In the process of getting through the with-corona period, working in a mutually remote environment will be an important issue. We believe that the technology to support people to continue businesses without gathering people during the with-corona period could enhance the sustainability of the new post-corona society.

The Human Augmentation Research Center (HARC), AIST is engaged in research and development to measure human activities and physiological and psychological changes, and to enhance human

capabilities with the support of digital technologies. One of the key themes in HARC research is smart work technology[vi]. In this research on smart work, we aim to create a working and social environment in which people can expand their various working abilities with the support of technology, thus gaining a greater sense of fulfillment through social achievement and personal growth.

Telework is one of the technological fields of smart work. It is a major area of business continuity, but it is primarily applied for office desk work. In this report, we indicate the directions in which the applications of telework can be extended, particularly in interpersonal service fields such as hospitality, entertainment, education, and tourism services, which have been significantly impacted by COVID-19. This type of telework is referred to as "augmented telework" in this report.

Some of the technologies necessary for augmented teleworking are already in the demonstration and practical stages. By utilizing and developing these technologies for society, this work aims to support the continuation of business operations without gathering people together during the with-corona period. Importantly, another objective is to set a foundation for a post-corona society that balances the dispersion and concentration of people in various life and work situations. This approach could lead to an active life/work style and fundamental changes in organizational, urban, and industrial structures.

We assume that some readers may currently be facing difficult situations. From our experiences of the Great East Japan Earthquake, we are aware that in times of suffering, the immediate availability of effective solutions to key problems is of utmost importance. While this report may not be able to provide a direct solution, it can serve as a guideline when considering new approaches to work, sustain businesses, and realize a more sustainable society in the coming months and years. It is hoped that business owners, entrepreneurs, middle management, and employees from various industries will read this report, and together, we can consider how to persevere through these unprecedentedly difficult times.

EXPANSION OF TELEWORK

In response to the COVID-19 pandemic, a large number of companies have started or extended the use of teleworking for business continuity. Specific challenges concerning teleworking are being discussed from various perspectives (such as social isolation[vii]). This report specifically focuses on the fact that the current teleworking system only supports limited types of work.

At present, teleworking is primarily used for office workers handling digital information, such as creating documents, in front of personal computers. Software developers and system operators are also major beneficiaries of it. Telecommunication is another principal element of teleworking. At the moment, the video conference system is the most widely used telecommunication tool. While its use cases are expanding, its main use is for business meetings. These technologies enable companies to continue business as usual.

Meanwhile, one of the industries majorly influenced by COVID-19 is the interpersonal service business. Because people are required to avoid crowded places, hospitality (restaurants, retail outlets, accommodation, etc.), fitness, entertainment (theaters, concert halls, etc.), and tourism businesses are required or even forced to shrink or terminate their services. In addition, education services such as public and private schools have begun remote services. However, remotely conducting education services that involve practical skills is extremely difficult. These services consist of human-to-human physical interactions such as dialogues,

gestures, and space sharing with others, and they cannot be substituted by the existing video conference system.

The proposed augmented telework concept embodies human-to-human physical interactions in the telework environment by using technology to enhance human physical and cognitive capabilities. Such technologies can support interpersonal service providers to continue or even innovate their businesses and provide employees with opportunities to utilize their skills and capabilities to sustain their lives. Augmented telework has additional potential to create novel customer experiences and to increase employees' work engagement and well-being. These points will be discussed in detail further on.

One thing to be noted is that augmented teleworking does not depreciate direct contact and relationships among humans. Augmented teleworking is not intended to replace all human-to-human contacts with technology-mediated ones. Rather, by providing different approaches to working that creatively utilize employees' skills and capabilities, it is intended to sustain businesses during periods of restriction on direct human interaction.

Table 1 shows the principles of the proposed telework expansion process. The next step in augmented teleworking is to cover tasks that require direct human touch and/or close and frequent collaboration among multiple people. We temporarily refer to this augmented telework 2.0. However, detailed discussion of this work is beyond the scope of this report.

Table 1. Telework expansion process

|	Current	Augmented telework	Augmented telework 2.0
Major tasks	Desk work (documentation etc.), business meetings	Tasks involving dialogues, gestures, and sharing space with others	Tasks requiring direct human touch / close, frequent collaboration with others
Characteristics	- External access to intranet systems - Verbal/video communication	- Estimation of physical and mental status by multiple sources - Utilization of remote devices - Shared experience in virtual environments	- Fast, highly accurate contact and manipulation to human/object - Real world-level perception and recognition
Major technologies	- Video conference system - E-mail - Online storage - Business management system	- Multi-modal interface - Virtual reality - Avatar technology	- Fast, highly accurate sensing and remote operation
Major industries	Headquarter function, software development, information service	+ Hospitality, fitness, education (requires skill practices), entertainment, tourism	+ Care, architecture, disaster relief

FEATURES OF AUGMENTED TELEWORK

The key technologies for augmented teleworking are introduced as follows.

- Multi-modal interface: communicating multiple information sources and means including video, sound, etc.
- Virtual reality (VR): Developing a virtual space and presenting information
- Avatar technology: operating a physical (robotic) or virtual double

In augmented telework, employees interact with customers and other employees through a combination of these technologies. These technologies, which do not automatize human tasks but technologically augment human capabilities, are classified as "human augmentation technology." It can realize the followings.

SENSING PHYSICAL AND PSYCHOLOGICAL CHANGES

Compared to face-to-face dialogues, it is more difficult to understand an individual's thoughts and feelings when communicating with them through a video screen. Thus, by analyzing their gaze, smile, and tone of voice, the person's emotional changes and intentions can be estimated. This could realize attentive interactions, choosing adequate topics, and improved communication. There have been several application cases of the assessment of smiles and emotion estimation from tone of voice. Interaction support can be arranged for different types of businesses by combining these methods,
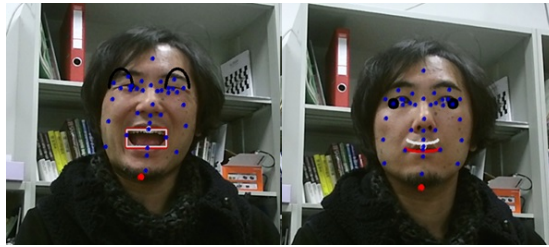
In addition, it is possible to sense body movement at a remote site by using video analysis and various sensing devices such as gyro sensors and touch sensors. These technologies can useful in many cases, such as remote coaching based on the movement data of several body parts.
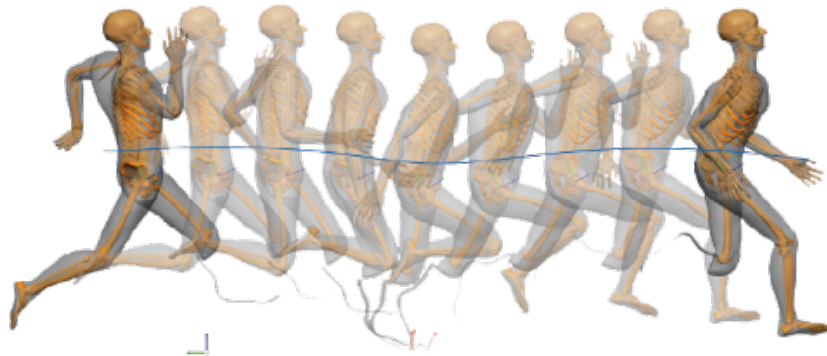

Working anywhere using an avatar

A virtual avatar that can freely operate from a remote site can appear in any environment with a screen. Virtual YouTuber (VTuber), an application which provides a variety of information using a virtual avatar, is popular in Japan, and there have already been several attempts to utilize this technology in real service environments[viii]. The unique feature of this is that the avatar can appear at any remote location while the physical body remains in one place. Avatar technology has the potential to dramatically increase the productivity of hospitality services.

In addition, physical, robotic avatars that can be controlled remotely are also becoming increasingly common. For example, Ory Lab's public experiment, the DAWN Avatar Robot Café is operated by people with physical disabilities controlling avatar robots[ix]. Avatars have already demonstrated their potential not only for business continuity during epidemics, but also for social participation and job opportunities for those who cannot work for physical and social reasons. This is highly effective in increasing their self-efficacy and well-being as well as improving the overall productivity in our society.
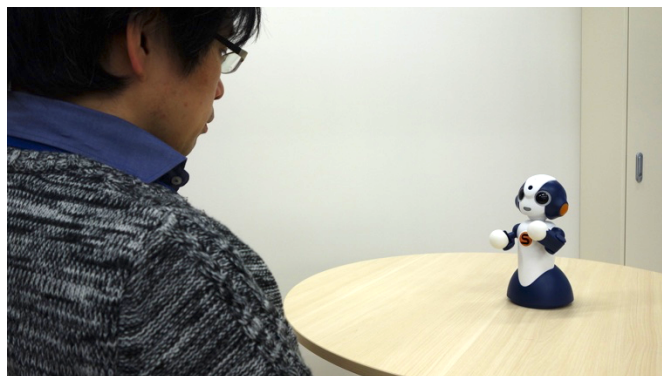

SHARING EXPERIENCES IN VIRTUAL SPACE

It is becoming possible for people to remotely share experiences through virtual spaces. For example, online game users who are physically located far away from each other can enjoy collaboratively performing tasks and sharing experiences. It is also becoming possible to virtually share experiences of live music, theater, and other events. The evolution of VR technology has been so rapid that it can now realize an event which

participants can enjoy without gathering at one place[x]. Other features of VR include the provision of a variety of communication opportunities during an event and virtual stages that are impossible in the real world. All of these features are effective in realizing novel customer experiences.

In addition, VR-based employee training is also under development[xi]. In this training system, employees train by interacting with an avatar customer in a virtual space, demonstrating an actual service floor. When onsite training is not possible, VR-based training can be a promising approach to improve service quality.
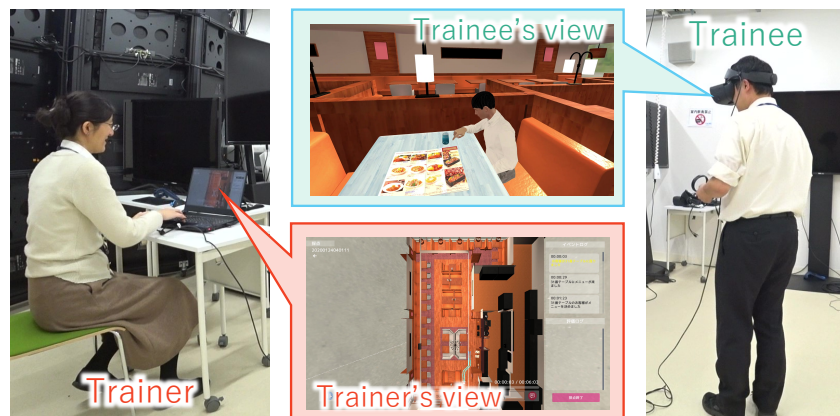
Working in an augmented telework

In this section, hypothetical cases of novel work and business approaches realized by augmented teleworking are presented.

Tele-hospitality service

In Japan, banks and other financial services have applied telecommunication systems for certain accounting services. Recently, some restaurants and bars have started their businesses using virtual avatars[xii].

 Tele-hospitality services have the following features:

- Staff can serve customers from anywhere (e.g., even from home)
- Tele-hospitality services can be provided at multiple points (shops) and channels (onsite and online) using the same human resources.
- Less-experienced staff can be technologically supported, for example, by analyzing customers interests.
- Staff can change their facial expressions or gestures and provide adequate information interactively.

This approach will be effective, particularly for counter services such as a hotel reception or an insurance consulting desk, which require professional knowledge and skills.
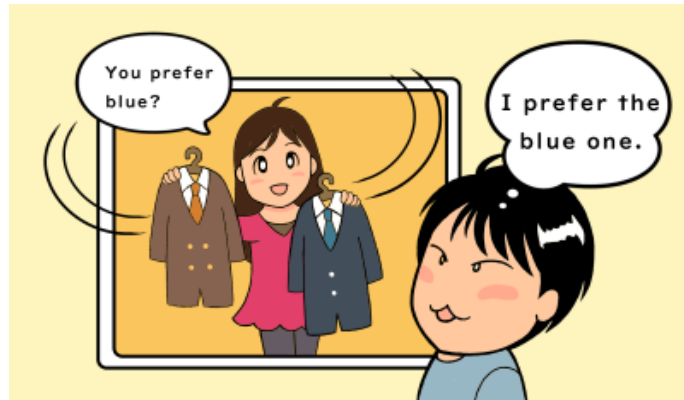
Group exercise at home

In a group exercise program, it is difficult for instructors to assess the status of all the participants. In an existing research project, an instructor can change the program content based on an estimate of emotional change and resistance via video analysis. This approach will be useful in increasing participant satisfaction and the effectiveness of the exercise.

In addition, VR may realize an effective exercise service at home, without gathering people together. While exercise at home is known to be challenging in terms of maintaining motivation, it could be made possible through group sessions with others in a virtual environment. Self-contracted instructors may also be able to provide group exercise services without a studio.
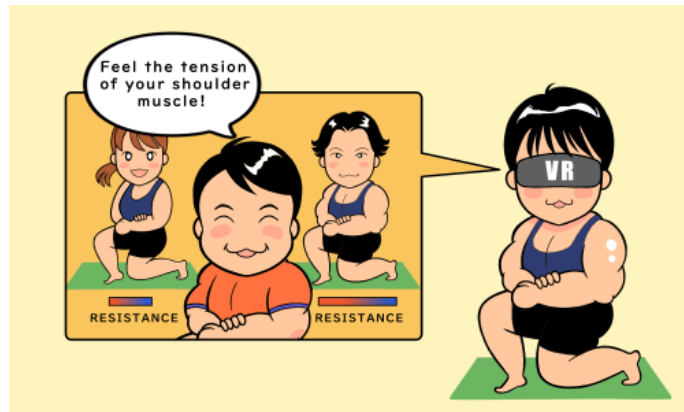
Virtual exhibition and live-event operation

Video streaming of webinars and live performances is becoming more popular. While this is an effective approach, it tends to be unidirectional. By developing a virtual space in which performers and participants can coexist and feel the presence of others through multi-modal interfaces, a shared experience can be realized. In addition, event producers can aim to plan new types of events by developing a virtual event platform in which different views and angles are set for participants to enjoy, which is generally not possible real-world events.
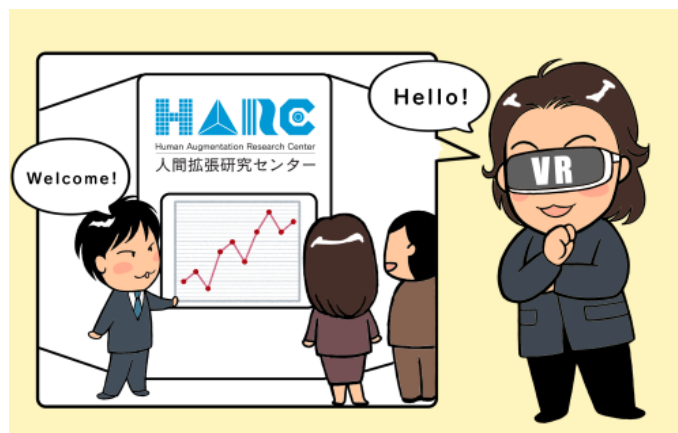
Toward implementing augmented telework

In this section, some fundamental approaches to implementing augmented teleworking in industry and society are introduced.

Analysis and redesign of the current work

First, it is necessary to analyze present work and business styles and to specify which tasks are suitable for augmented teleworking. In addition, the partial replacement of work could even decrease the total efficiency and productivity. In the process of shifting to telework-based models, it may become necessary to completely change the existing business and service models. Implementing augmented teleworking may require overall business redesign or new business development. This also corresponds to (1) raising awareness on labor issues, as discussed in the Introduction section.

Cooperation among stakeholders

The implementation of augmented telework needs to be performed by multiple stakeholders, including business managers, employees, and customers, with the support of external professionals such as technology developers and researchers. Firstly, as the primary users, the active participation of employees and customers is essential; they need to acquire relevant literacy to utilize such novel technologies. The

acquisition of literacy requires a considerable amount of use experience. Iterative trials should be conducted for better utilization, even if users face temporary inconvenience. Naturally, technology developers should listen to users' comments and opinions and improve their technologies during the trial period. In addition, it is essential that the management shows a strong commitment toward workplace innovation through augmented teleworking. Another prominent issue is that the information infrastructure, such as network capacity and information security, must be enhanced. Policy-level support is also expected to promote the development of new industries.

Human-centered approach and diversity

It is most important that augmented teleworking realizes better experiences and life/work styles of employees and customers. Augmented telework has the potential to make work environments more flexible and acceptable for diverse workers, overcoming differences in gender, age, ability, knowledge, and skill, and even derive latent capabilities by adopting a technology-mediated approach. It is essential to explore the possibility of considering wider diversity based on the principles of human-centered and inclusive design approaches. This contributes to (3) reducing the burden on vulnerable people and further realizing a more inclusive society.

Long-term impact and assessment

As mentioned above, augmented teleworking does not depreciate direct contact and relationships among humans. However, unexpected adverse

effects may occur in teleworking through new types of technologies. For example, technological support may cause changes or even delays in skill acquisition processes. Changes in social relationships in an organization and social isolation, which have already been exposed in existing teleworking systems, also need to considered. In addition, self-management of work–life balance will become more important. It is necessary to assess the impact of augmented telework during and after its introduction and take the required actions to ensure meaningful work. Moreover, the change in workstyle, including commuting, may bring another change in urban functions and the relationship between cities and suburbs, and even demands for energy and other resources. It is important to monitor such long-term changes in a comparable manner. This continuous research would contribute to (2) employing environmentally sustainable measures.

It is important to explore new workstyles and businesses through the aforementioned approaches.

CONCLUSION

This report proposes a new work concept called augmented telework which realizes human-to-human interactions in a remote work environment using human augmentation technologies including multi-modal interfaces, VR, and avatar technology. The readiness of technologies and applications for augmented telework is still varied, but they have enormous potential to sustain business continuity, create new customer experiences, realize diverse work environments, and improve work engagement and well-being.

Implementing augmented telework could mean the overall redesign of work and business, which requires active participation by stakeholders. A human-centered view that emphasizes human-to-human relationships and stakeholder satisfaction is essential in this process, and its long-term impact should be assessed continuously. This will be a challenging task, but it seems to be a promising approach to make our industries and societies more resilient and sustainable during both the with-corona and post-corona periods.

This report only describes a small part of the actions required to overcome a number of challenges related to the COVID-19 pandemic. Our research results related to augmented telework (and augmented telework 2.0) will be continuously reported, and this crisis will be handled through collaborative action with partners from different sectors.

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Illustration: Noriko Arai (p. 13-14)

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