Technologies for Improving “Quality of Working”

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Keywords: human behavior sensing, service engineering, human augmentation

ABSTRACT

We are developing smart work technologies, such as human behavior sensing, modeling, simulation, and visualization, with the aim of improving productivity through improving employee satisfaction by enhancing the skills and motivation of people who are engaged in "work." In this paper, we present an overview of the technologies and some of the use cases using them.

1 Introduction

"Work" is a human activity that is done for the benefit of organizations and society to which it belongs. Productivity is an indicator of the efficiency of the activity and is important to many people involved in the activity. On the other hand, the new concept which is called “Quality of Working” is also gaining attention. The two concepts, which at first glance seem to be in conflict, have aspects that improve each other and are closely related. These concepts are also closely related to the sub-goal “8. decent work and economic growth,” of the SDGs proposed by the United Nations [1].

We have been developing "smart work technologies" for making work smart, and help users develop their skill and motivation. In other words, smart work technologies are being developed with the aim of simultaneously improving productivity and quality of working. They include technologies for redesigning work environments and business processes, and technologies for measuring human behavior. They also include virtual reality systems for training skills, augmented reality systems for information support on working sites.

2 Smart work technologies

The technologies included in the smart work technologies are classified into four categories based on their roles: “Sending,” “Visualization and Analysis,” “Modeling and Simulation,” and “Intervention.” Figure 1 shows an overview of the technologies in each category and examples of their application, as well as the flow of using the technologies in each category for improvement activities.

2.1 Sensing

The "Sensing" group of technologies acquires digital data of the environment in which services and manufacturing processes take place, as well as the activities of people in that environment.

Currently, a variety of BI tools have emerged and are being used to find out management issues and make decisions. However, the data that is the source of these analyses is the data necessary for business management, and not the data that is actively measured for analysis. For this reason, the analysis tends to be macroscopic in nature. Currently, quantitative measurement and visualization tools for on-site improvement are being commercialized, but the focus is on machine operation analysis. We believe it is important that space and process design based on the scientific analysis using human behavior measurement of the actual activities in these environments. That is why human behavior sensing technologies are included in our focus.

Pedestrian Dead Reckoning (PDR) [2] is a fundamental technology that we use in many of our use cases. This is a method of estimating walking trajectory by detecting walking motion and estimating walking velocity with acceleration, angular velocity, geomagnetism, and barometric pressure data obtained by IMU sensor modules attached to the human body. PDR can not only be used as a positioning method in indoor environments where there are many service and manufacturing sites, but also enables business analysis at a finer granularity, such as "time spent standing still," "time spent moving," and "speed of movement," by utilizing the results of walking motion detection. Since the relative positioning method such as PDR tends to accumulate errors due to its principle, an integrated positioning method that utilizes absolute positioning technologies in a complementary manner to cancel the accumulated errors is necessary for practical use [3].

In order to better understand human behavior in service and manufacturing processes, it is necessary to use sensors that are difficult to use in actual workplaces, or to measure human behavior in an environment where experimental conditions are prepared for comparison. The Service Field Simulator is designed as an environment for virtual human-sensing, especially for flow line analysis [4][5]. The Service Field Simulator is a system designed as an environment for virtual human-sensing, which is especially intended to be used for flow analysis. This system was used not only for employee flow line analysis, but also for marketing research using customer brain waves, gaze, and flow lines.

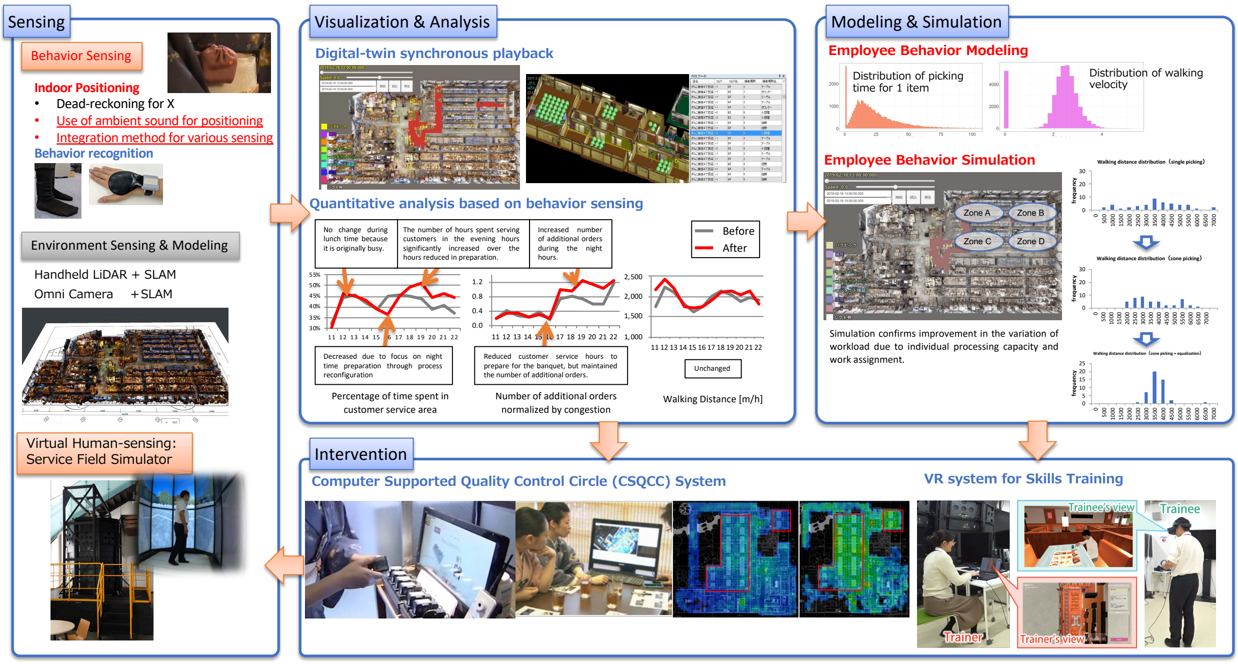

Fig.1 'Kaizen' framework with smart work technologies

2.2 Visualization and Analysis

Technologies that directly or indirectly visualize environmental or behavioral data acquired through "sensing" to find out problems in services or manufacturing processes, or to evaluate the results of improvement activities, are classified as "Visualization and Analysis."

The measured human behavior can be analyzed from various angles and used as a material for considering plans for improvement. In some of the use cases described later, recorded human movements were replayed in the environment model, and the parties involved were able to gain some insights by observing them together with the recorded business data. It was also possible to use the analysis of the combination of human movements and business data for actual improvement activities [6].

2.3 Modeling and Simulation

"Modeling and Simulation" is a category of technology that uses data obtained from "Sensing" to build human behavior models of current service/manufacturing processes and simulate improvement plans in order to predict effectiveness and reduce risk.

Based on the statistical information obtained from sensing technology, such as the distribution of stopping time and walking speed, we can construct a behavioral model of people working there. By conducting simulations using the modeled human behavior, we believe that we can obtain preliminary evaluation results that are closer to reality.

2.4 Intervention

This category includes technologies that directly or indirectly support human activities in order to improve service and manufacturing processes. This category includes the technology used for the improvement measures themselves. These include VR technology used for pre-training of business processes and AR technology used for information support in the workplace.

We believe that VR technology for skills training is the application that is closest to practical application among interventional technologies. In fact, many VR training systems have been proven and commercialized. Skills training contributes not only to increased productivity, but also to improved quality of working through a sense of growth and achievement. Our research group is building a training system for cognition and priority judgment during customer service, which is deeply related to cognitive interaction [7].

3 Use Case

The technologies described above have been researched and developed while being applied to the improvement activities of service and manufacturing processes in actual workplaces. The efforts to date are well organized in [8]. For some of the use cases, the indicators used for analysis and the results of service process improvement are shown below.

3.1 Japanese Restaurant

We have been conducting collaborative research with Japanese restaurants for several years. Through the field research, sensing technologies and analysis methods have been improved, and knowledge on service process analysis has been accumulated. We believe that restaurants are an ideal field for service research. This is because not only "customer service," the most important process in the service industry, but also "production," "transportation," "consumption," "collection," and other elements common to many service industries occur simultaneously at one site.

In 2011, we worked on service process improvement through visualization of human behavior and POS data [9]. In this year's experiment, our technology helped store managers and employees to understand their usual service processes and to make and implement improvement plans. They rearranged their processes to increase the time to serve customers during dinner time and made advance preparations for dinner time during the evening hours. As a result, the company achieved an increase in the number of additional orders per customer due to the increased customer service hours during dinner time. In this experiment, the stay ratio of waiting staff in dining areas, Number of additional orders per customer, walk distance per customer were used as indicators for analysis.

From 2018 to 2019, an AGV for food transport was introduced and improved [10]. After the development and implementation of the unmanned transport system, the transport work was shifted from staff to the AGV system. The operation and work schedule of the service staff were changed to try to reduce the working hours of the service staff. The daily working hours of the service staff after the introduction of AGVs were compared to the previous year in order to confirm whether the working hours had actually been reduced. In addition, to confirm the improvement in labor productivity, the sales per working hour after the introduction of AGVs and the previous year were compared. In addition, changes in operations and service quality were analyzed using flow line analysis techniques. The results showed that the introduction of AGVs reduced the working hours of service staff and increased sales per working hour. In addition, the time spent in relation to the work location according to the work role was analyzed, and it was confirmed that the focus was on improving the quality of service during lunch time.

3.2 Warehouse

As more and more products are purchased over the Internet, the volume of work in distribution warehouses is increasing, and there is a growing need to improve their operations and employee satisfaction. This has led to an increase in the number of joint research projects between us and logistics warehouse operators. Since many of the tasks in logistics warehouses are relatively simple, we are working on building a business process model based on the measurement results and demonstrating the preliminary evaluation of the measures using simulations.

In the 2014, we designed a picking operation model based on the location information of picker, developed a simulator using the model, and quantitatively evaluated zone picking as a kaizen plan through simulation [11]. As a result, it was confirmed that zone picking was superior to single picking in terms of both work efficiency and employee satisfaction, indicating the possibility of using the simulator to support kaizen activities. In the analysis, we used indices from the perspective of productivity, such as man-hour productivity and time required for work, and indices from the perspective of quality of work, such as leisure time and evenness of workload.

4 Conclusion

In this paper, we have introduced smart work technologies and the use cases of productivity and quality of working improvement activities using these technologies. We believe that in any case, it is human labor that creates added value, and the importance of technologies that support improvement of service and manufacturing processes based on measurement, analysis, and simulation of human behavior will continue to increase. As for intervention technologies, we believe that not only skill training VR systems, which we are currently working on, but also AR-based work information support and cooperative work between humans and robots, as was done in the Japanese restaurant research, will become increasingly important. In particular, there is a growing need for research on extending telework in line with efforts to prevent the spread of infectious diseases worldwide, and research on human-human and human-robot communication using VR space is expected to make progress in the future.

As the concept of health management is spreading, research on the design of indicators related to quality of working and their improvement will become increasingly important. A major technical issue is how to proceed with the analysis of not only behavior but also people's internal movements in actual workplaces.

Acknowledgements

This work was partially supported by JST-OPERA Program Grant Number JPMJOP1612, a project JPNP18010, commissioned by the New Energy and Industrial Technology Development Organization (NEDO). This work was also partially supported by the Council for Science, Technology and Innovation, “Cross-ministerial Strategic Innovation Promotion Program (SIP), Big-data and AI-enabled Cyberspace Technologies” (funding agency: NEDO).

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