Time-Mosaic Formation of Senior Workforces for Complex Irregular Work in Cooperative Farms

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Abstract. Although the challenges posed by aging populations are great, they can be offset to some degree by harnessing the increasing vitality and productivity of senior citizens in developed countries. To improve work opportunities for seniors and to make use of their abilities, we propose a mosaic-type work system in which elderly human resources are combined to form a single "virtual worker" based on seamless information sharing. In this study, we particularly focus on part of the mosaic, the time-mosaic, for the stable worker generation in the case of complex irregular work. The objective is to demonstrate the effectiveness of the time-mosaic formation system in cooperative farms for shift work organizations. In interviews with the workers, most of the leading workers at the farm found the system to be useful for effective formation and modification of the time-mosaic.

Keywords: Mosaic-type work, seniors, information communication technologies (ICT), cooperative farms.

1 Introduction

Many developed countries now face increasingly aged populations, and the cost of social security is increasing. In Japan in particular, the population of seniors aged 65 or older was approximately 27.4 million in 2007. According to the population projections for Japan reported by Kaneko et al., the population aging rate in Japan will become 40.5% by 2055 [1]. The conventional model of welfare security for seniors is based on the situation where multiple young people support one senior. However, it is becoming increasingly unreasonable to expect the young population to support the increasing elderly population. The ratio of the young population to the elderly in 2009 was 2.81, while that in 2055 is predicted to be 1.26 [1]. Therefore, the present social system needs to be changed drastically.

Most seniors are healthy enough not to need care. In 2009, the senior population was estimated to be 23.0 million (83.6% of all seniors) based on a white paper published by the Japanese Ministry of Health, Labour, and Welfare [2]. More than half of them are aware of the social contributions they have made and retain a strong desire to work [3]. Unfortunately, most employers regard senior citizens as unreliable workers. Some companies have recently introduced worksharing programs that employ retired seniors on a part-time basis [4]. However, these programs need to be more flexible to take into account risks such as sudden illness. According to a report by Fukushima, seniors have four types of work needs: to work without strenuous efforts, to make themselves useful to others, to build personal relationships, and to earn extra money [6]. In particular, ex-white collar workers work for social connections and health enhancement [7]. They have knowledge, experience, and skills that young people do not have. Effective utilization of their ability can gradually change the conventional social system and revitalize work environments. The Silver Human Resource Centers in Japan attempt to meet the various needs of seniors [8]. However, it is difficult to meet all their needs and to allocate seniors effectively because these centers are chronically short-handed.

Thus, we propose a "mosaic-type work" system in which a single "virtual worker" is synthesized from individual work resources by information and communication technologies (ICTs) to supply an autonomous and stable labor force [5]. In order to achieve this concept, it is necessary for seniors and employers to share information seamlessly. The system can deal with risks and reduce the burdens of seniors, but many seniors have difficulty using ICTs. In order to assist seniors, a simple interface should be implemented.

In this study, we describe our development and evaluation of the "time-mosaic" as an adapted model for mosaic-type work in senior employment contexts, with the purpose of effective mosaic formation in seniors. We first discuss the problems of implementing the time-mosaic for a given worksite and provide an overview of our solution. We then evaluate the time-mosaic in a practical setting and discuss the results at cooperative farms. Finally, we propose efficient methods for further integrating the time-mosaic.

2 Mosaic-Type Work and Implementation in Various Works

Mosaic-type work can ensure compatibility between flexible work opportunities for seniors and a stable work force for employers by synthesizing virtual workers from a workforce of seniors. A "mosaic" can be defined as a unit of a synthesized worker from multiple workers, as shown in Fig. 1. In this figure, as an example, senior A has expertise in field A, but not enough skill in field B, and also has mild motor and cognitive impairment. Senior B also has motor and cognitive difficulties as well as insufficient skill in field A, but is highly skilled in field B. A young worker has good motor and cognitive functions, but is poor in fields A and B. Ideally, when their advantages can be synthesized into a virtual worker,
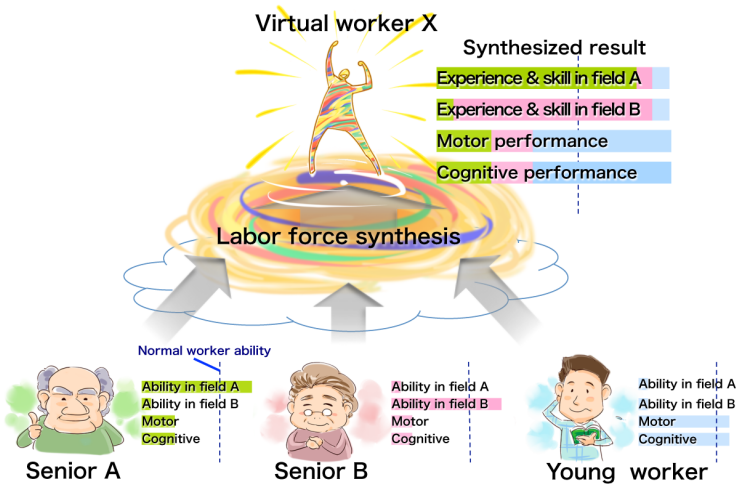
Fig. 1. The concept of "mosaic-type work" that realizes a stable virtual worker from a workforce of seniors and young people

this virtual worker can demonstrate stable and superior performance in fields A and B.

In order to realize this concept, it is necessary to consider and quantify the workers' time, skill, spatial limitations and other characteristics. In this study, we focus particularly on time-mosaic generation. The time-mosaic is one of the most fundamental and versatile mosaic components. This is because fixed-time work systems are the primary type of work arrangement, and binding hours occur after scheduling a meeting with a worker even in the case of a discretionary labor system. The schematic concept of the time-mosaic is illustrated in Figs. 2 and 3. Fig. 2 illustrates the initial state of the time-mosaic. The fragmented available work time of each worker is synthesized to generate a time-mosaic. When sudden troubles occur with some workers, as shown in the upper part of Fig. 3, other available workers substitute to provide the lacking parts of the time-mosaic, as shown in the lower part of Fig. 3.

In order to generate and substitute the time-mosaic effectively, it is necessary to manage the fragments of work hours. The scheduling of a small number of workers is not difficult. However, when the number of workers increases, systematic management should be introduced because the scheduling process becomes too complicated and troublesome to deal with otherwise. To establish a time-mosaic management, intuitive interfaces for seniors and an adjustable margin for individual workplaces are necessary. We developed a prototype interface for seniors using this design based on prior studies and evaluations by senior worker groups [9].

This adjustment varied by workplace. Our previous study reported the case of an application to a welfare facility as an example of routine work [9]. In the former study, we divided workers into two groups and asked them to schedule their shifts, sharing the statuses and situations of the workers and the workplace
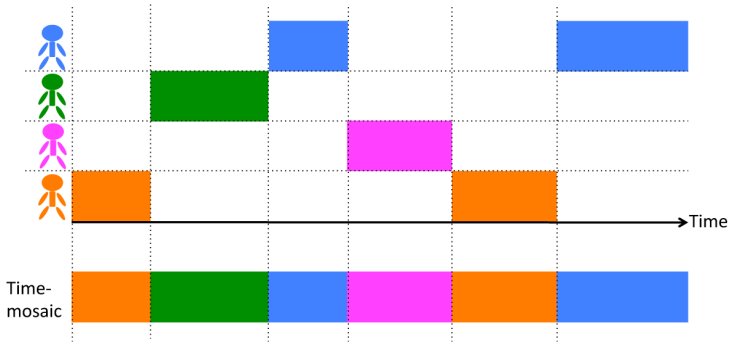
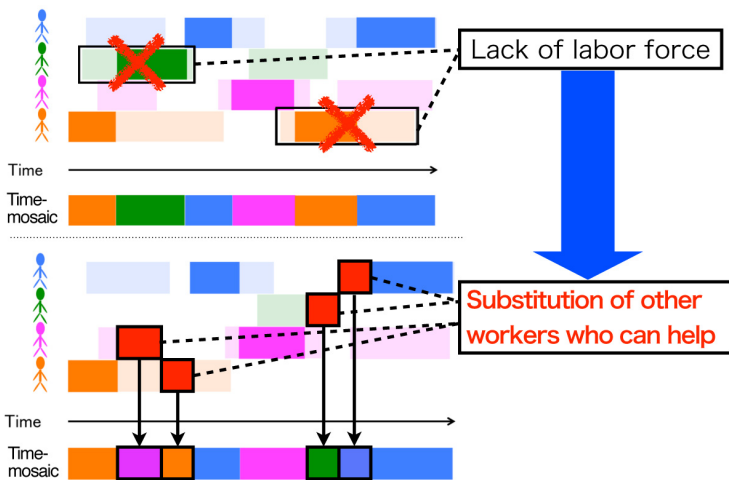**Fig. 2.** The schematic concept of the time-mosaic (initial state)

Fig. 3. The schematic concept of time-mosaic reformation (transition state). Boxes with strong and pale colors represent work time and available time to work, respectively.

using our system. As a result, they shared each worker's workable days, and some workers who had leadership roles scheduled the shifts most frequently. They also contacted their employer and undertook the coordination of work descriptions.

However, all work styles do not always include routine work. Moreover, even in the case of routine work, the schedule must be changed in the short or long term in cases of sudden changes in work environments caused by, e.g., inclement weather. In these cases, the increasing frequency of plan modifications may result in a growing burden on the scheduler. Therefore, we need a design guideline that seniors can use effectively.

In this study, we particularly aimed at evaluating the time-mosaic formation of senior workforces for complex irregular work in a cooperative farm. In cooperative farms, the work schedule is frequently and regularly modified because

Fig. 4. (Left) Senior workers in a cooperative farm. (Right) A brief lecture/informal system meeting between a worker group and the authors

of changes in the weather and the season. This places greater responsibility on schedulers in cooperative farms than in welfare facilities.

3   Demonstration and Evaluation of the System

An experiment to demonstrate and evaluate the system was carried out in five cooperative farms around Toyoshiki-dai District, Kashiwa City, Japan. In these farms, senior workers engaged in cultivating, harvesting and shipping crops, and other miscellaneous duties, as shown in the left picture of Fig. 4. Thirty-five senior workers participated in this experiment. None received nursing care, and all were able to live and act by themselves.

The procedure of the experiment was as follows: analysis of the workplace conditions, adjustment of the system, training session on the system for workers, and introduction and evaluation of the system, in that order. The system was adjusted based on the results of the analysis and training, as shown in the right picture of Fig. 4. Based on the analysis, workplace conditions are illustrated in the left part of Fig. 5. Worker groups at each workplace included group leaders and regular workers. The group leaders took charge of work descriptions after meeting with their employers. They also scheduled workers' shifts and did the same routine work as the regular workers. The leaders determined worker's available days by calling. This places a heavy burden on the leaders to adjust of the schedule after sudden environmental changes such as bad weather. At the same time, regular workers can be frustrated by sudden schedule changes, and the employer suffers from a lack of information about work progress.

In light of the above situation, we adjusted our system and developed the situation illustrated in the right part of Fig. 5. Specifically, workers, including both leaders and members, can coordinate the time-mosaic even in the case of sudden environmental changes such as bad weather. The outline of the implemented system is described in Fig. 6. The system was mainly implemented by the script language of PHP, CSS, and JavaScript, and the database was based on
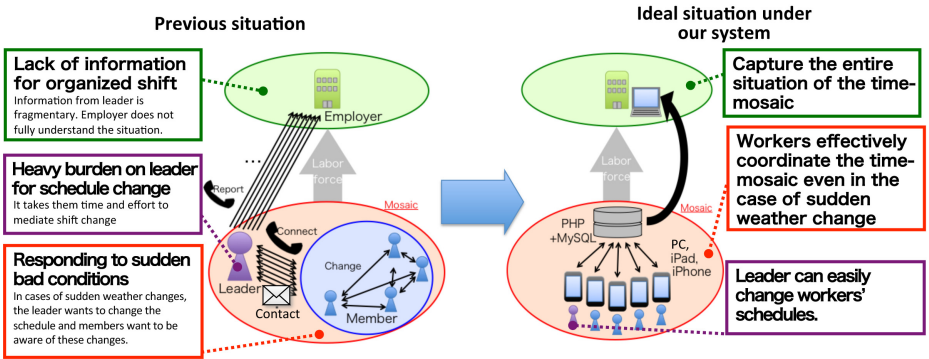
Fig. 5. Previous situation prior to the time-mosaic construction (left) and ideal situation under our system (right)
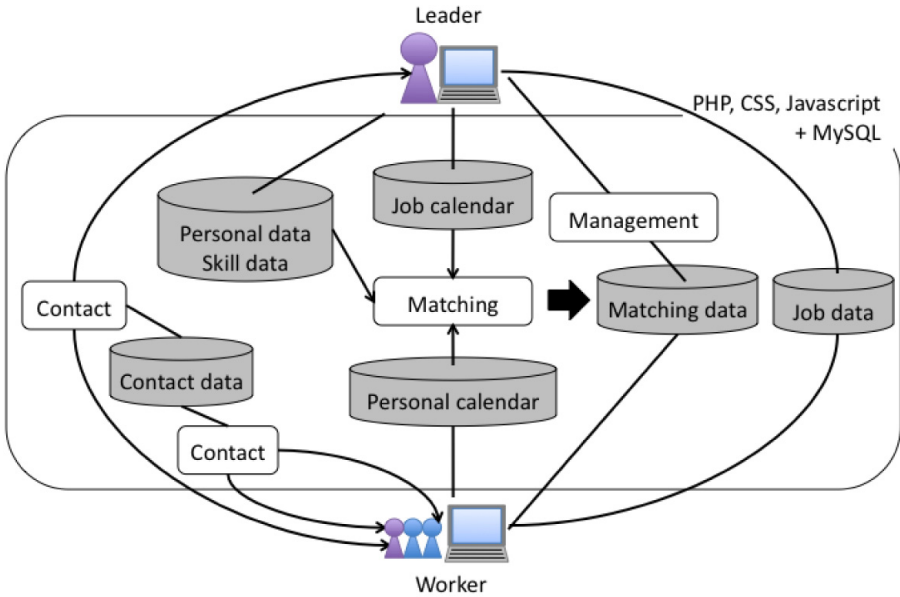

Fig. 6. Overview of the implemented system

MySQL. Figs. 7 and 8 illustrate interfaces for the regular workers and the leaders, respectively. The interface for the regular workers included the functions of reporting their possible days and providing information on available work offers. The interface for the leaders provided the same functions as well as functions of checking workers' available days and planning work descriptions and shifts for the workers. The two interfaces were designed to be simple enough for seniors to use.

The seniors learned how to use the interfaces in the training sessions. Then, they evaluated the usability of the system after using it for two or three weeks
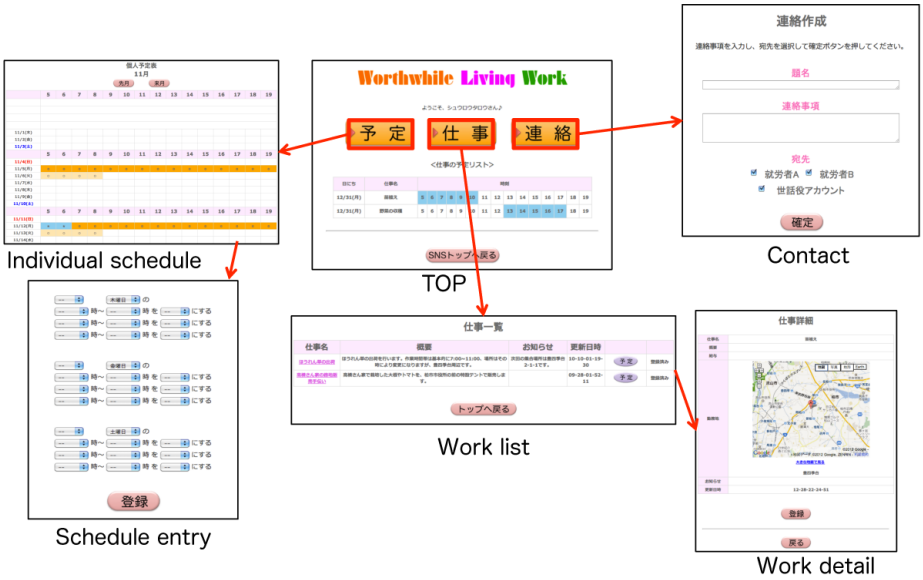
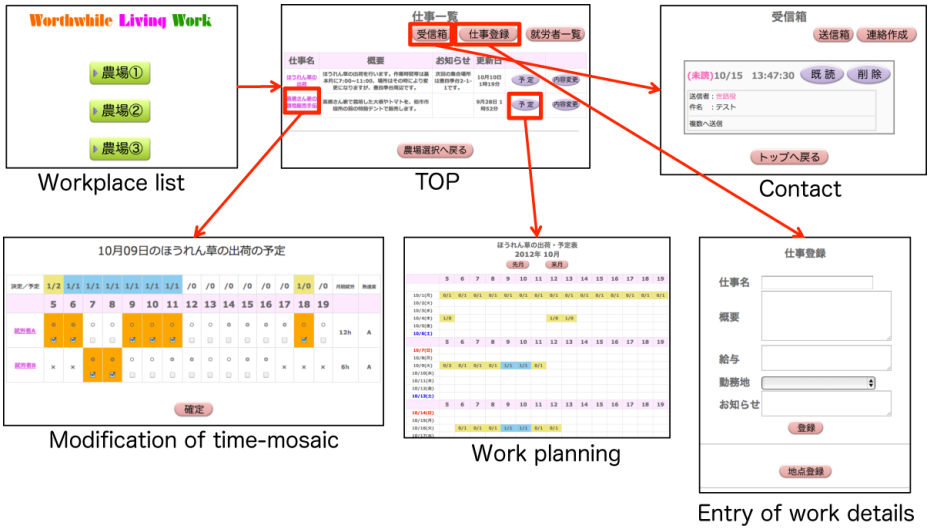**Fig. 7.** The interface of the implemented system for regular workers

Fig. 8. The interface of the implemented system for leaders

to plan and coordinate worker schedules and work descriptions. Afterward, we interviewed some workers about the interfaces to extract and analyze the issues.

4   Results and Discussion

In this paper, the results derived from the interviews with the leaders are presented. Most of the leaders found the system to be useful for effective formation and modification of the time-mosaic. The system enabled the leaders to easily respond to frequent schedule changes. Specifically, it decrease the time required and simplify the procedures for modifying workers' shifts. Some leaders had opinions that the more the regular workers increase there were, the more effectively the system could reduce the burden of sudden schedule changes. Among other opinions, reducing lag time is needed for better communication of workers' shift changes because workers' confirmation of schedule changes was sometimes less rapid through the system than by telephone. To address this problem, the clarification of basic rules regarding workers' actions toward schedule changes and the combination of phone and system contacts may be essential. In addition, when the leaders were asked to enumerate elements of the system that contributed to effective modifications of workers' shifts, the leaders identified visualizations of each worker's status such as monthly working hours and the quantified preference rates for daily and hourly work.

5   Conclusion

In order to make full use of the strengths of the senior workforce, such as its rich knowledge, experience, and skill, the time-mosaic formation system was developed and evaluated. The time-mosaic is one of the most fundamental and versatile mosaic components. We stated the concepts of the mosaic and time-mosaic, and the implemented time-mosaic formation system was tailored to cooperative farms where seniors are working. The achievements of this paper are summarized as follows.

1. The concept of a time-mosaic was specified. A time-mosaic is a synthesized time unit generated by the synthesis of the fragmented available work time of workers in each workplace. Even in the case that sudden trouble occurs with some workers, the lacking parts of the time-mosaic are replaced by the other available worker's. To realize this concept, we stated the necessity of the ICT-based system with intuitive interfaces for seniors and system adjustability for individual workplaces.

2. A time-mosaic formation system was adjusted for work on cooperative farms, as an example of complex irregular work. The system has interfaces for regular workers and leaders. The interface for the regular workers involved reporting their available days and providing information about available work opportunities. The interface for the leaders provided the same functions plus the functions of checking worker availability and planning work descriptions and shifts for the workers.

3. Most of the leaders found the system useful for effective formation and modification of the time-mosaic. The system enables leaders to easily respond to frequent schedule change. However, reducing lag time is needed for more rapid communication of workers' shift changes, as workers' confirmation of schedule changes was sometimes faster by telephone. To rectify this problem, the clarification of basic rules regarding workers' actions toward schedule changes and the combination of phone and system contacts may be essential.

References

1. Kaneko, R., Ishikawa, A., Ishii, F., Sasai, T., Iwasawa, M., Mita, F., Moriizumi, R.: Population Projections for Japan: 2006-2055 Outline of Results, Methods, and Assumptions. The Japanese Journal of Population 6(1), 76–114 (2008)
2. Ministry of Health, Labour and Welfare: Change in the number of people who are certified to be in need of long-term care by care category (in Japanese), `http://www.mhlw.go.jp/seisaku/2009/03/01.html` (date last viewed: February 26, 2013)
3. Cabinet Office: White Paper on the National Lifestyle (2006), `http://www5.cao.go.jp/seikatsu/whitepaper/h18/06_eng/index.html` (date last viewed: February 26, 2013)
4. Aoyama, E.: Employment and Job Security for the Elderly: Its Current Status and Problems. Kaetsu University Research Review 51(3), 43–58 (2009) (in Japanese)
5. Hiyama, A., Sano, M., Kobayashi, M., Hirose, M.: Senior Cloud: ICT Platform for Improving Society by Circulating the Experience, Knowledge, and Skills of the Elderly. In: Proc. 17th VRSJ 2012, pp. 157–160 (2012) (in Japanese)
6. Fukushima, S.: Analysis of desires to work in elderly people (this translated title was prepared by the authors). Japan Labor Review 558, 19–31 (2007) (in Japanese)
7. Japan Organization for Employment of the Elderly, Persons with Disabilities and Job Seekers: Report of investigation on work and life of Japan's baby boomers (this translated title was prepared by the authors) (in Japanese), `http://www.jeed.or.jp/data/elderly/research/dankai22.html` (date last viewed: February 26, 2013)
8. Osada, H., Suzuki, T., Takata, K., Nishishita, A.: Social activity and relevant factors in the elderly: Focus on members of senior manpower center and senior citizen's club. Japanese Journal of Public Health 57(4), 279–290 (2010)
9. Nakayama, M., Hiyama, A., Miura, T., Yatomi, N., Hirose, M.: Mosaic-type Work Support System using Touchscreen Computers for Senior People. In: Proc. ACM CSCW 2013 (2013)