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A Method to Reduce the Burden of the Recreation Moderator by Using a Humanoid Communication Robot

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Abstract

The authors proposed a method to reduce the burden on the recreation moderator by using a humanoid communication robot. This system projects quizzes on the screen, and humanoid communication robots read the explanations to proceed with the recreation. This paper presents the details of the proposed system, the method of implementing recreation using the system, the effect of recreation on participants, and the effect of reducing the burden on nursing care staff. An experiment was conducted comparing cases in which nursing care staff acted as moderators and robots acted as moderators. As a result, it became clear that the burden on nursing care staff could be reduced while recreation remained active.

Keywords: Elderly care, Recreation, Humanoid communication robot.

1 Introduction

According to the definition of aging established by the World Health Organization (WHO) and the United Nations, a society is called "aging society" when the population aged 65 or older exceeds 7% of the total population, "aged society" when it exceeds 14%, and "super-aged society" when it exceeds 21%. Many developed countries with high aging rates are known, including Sweden, Germany, France, the United Kingdom, and the United States [1]. In Japan, among others, the population is aging at a rate unparalleled in the world, and the percentage of the population aged 65 and over is approaching 30% [2]. Meanwhile, the risk of developing dementia increases as people age. For example, the estimated prevalence of dementia and mild cognitive impairment (MCI) is said to be 15% and 13%, respectively, among the elderly aged 65 years and older, and together, one in four elderly people has dementia or its reserve [3]. Therefore, there is concern that as the elderly population increases, the number of elderly people with dementia will also increase, and the importance of preventing elderly people with dementia is

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recognized. The importance of communication has been pointed out as a way to prevent dementia [4]. For this reason, group recreational activities are regularly conducted at welfare facilities for the elderly.

On the other hand, in Japan, in addition to the aging of the population, the working population is declining, and there is concern about the shortage of human resources involved in nursing care [5]. The nursing care field is severely understaffed, and planning and managing recreation on a regular basis is fraught with difficulties, making it a burdensome nursing care task for care workers. The effective implementation of such recreational activities depends to a large extent on the competence of the host. The role of the moderator is highly challenging, as he or she is expected not only to carry out the program according to a predetermined progression, but also to create an atmosphere in which participants can enjoy participating in the program. In order to actively implement recreation in the future, several issues related to moderators must be resolved. For example, how to provide greater care for individual participants, how to conduct the event without preparation, and how to conduct the event without experienced participants. In addition, some caregivers avoid recreational work because they are not comfortable in front of a large number of people, which adds to the shortage of manpower [6]. Under these circumstances, robot-assisted activities (RAA) have been attracting attention due to the expectation of reducing the workload of caregivers at welfare facilities for the elderly [7].

Unlike robots that assist with physical activities such as bathing and walking, robots utilized in RAA are communication robots that interact with the elderly through movement and conversation. In recent years, advances in information technology have greatly improved the performance of communication robots, and many efforts have been made in the field of RAA. Robots used for RAA in the nursing care field include pet-type robots in the shape of animals and humanoid robots. Pet-type robots are expected to have therapeutic effects due to their cute appearance and gestures. Humanoid robots, on the other hand, are expected to reduce the workload of nursing staff by, for example, communicating with the elderly instead of the nursing staff. However, their performance is often below expectations for users who are not familiar with information technology, and in many cases, they have not reached a level where they can be used without restrictions. Particularly in the field of caregiving, where users are unfamiliar with the handling of information devices, high levels of RASIS (Reliability, Availability, Serviceability, Integrity, and Security (Safety)) are required in addition to ease of use, and thus the hurdles to practical application are high. This is a high hurdle for practical application. Thus, the RAA is expected to clarify how to effectively utilize robots with limited capabilities in an environment where users are unfamiliar with the handling of such information devices.

The purpose of this paper is to propose a method to reduce the burden on nursing staff by using a humanoid robot to assist in moderating group recreational activities. In elderly care facilities, group recreation has the advantage of efficiently providing opportunities for communication to facility users. However, care for individual participants must be thickened to ensure that participants enjoy their participation. In addition, there are issues that need to be addressed, such as the ability to implement the program without preparation by nursing staff, and the ability to implement the program without experienced staff. The challenge in this paper is to resolve these issues.

The remainder of the paper is as follows: Section 2 briefly introduces related works. In Section 3, proposed method is explained. Section 4 describes the experimental results and discussion, and Section 5 concludes.

2 Related Works

Communication robots used in the field of nursing care can be divided into three main types: "automatic execution type," "autonomous operation type," and "remote control type". There are various advantages and disadvantages when these types of robots are used in the field of nursing care.

First, in the "automatic execution type," a motion program is registered with the robot in advance, and the robot automatically executes the program in sequence. For example, in group recreation, the robot acts as a moderator and speaks lines, sings songs, and performs gymnastic movements, and the participants perform recreation in accordance with the robot [8][9]. In this case, the need for nursing staff to intervene during recreation is low, and the effect of reducing the load on the nursing staff is significant. However, since the robot does not receive responses from the participants, the participants need to adjust to the robot's timing, which may give a strong one-way impression to the participants.

In the next "autonomous operation type," sensors implemented in the robot recognize the user's actions and execute programs corresponding to the contents of the actions. For example, in the pet-type robot, a tactile sensor is mounted on the robot, and the robot is equipped with a mechanism that operates by touching the sensor part [9][10]. On the other hand, humanoid robots have implemented functions to recognize faces by image recognition using a camera to call out names and to carry out conversations by voice recognition using a microphone. Attempts are being made to use such functions to communicate one-on-one or with a small group of people [11][12][13]. In this case, the nursing staff does not need to operate the robot, which is highly effective in reducing the workload of caregivers. However, image recognition and voice recognition are not as good as human capabilities in terms of reaction speed and recognition accuracy, which may leave a strong unsatisfactory impression for users with high expectations. In addition, the robot's lines and actions are often limited to simple ones, making advanced communication difficult.

In the last "remote control type," a person remotely controls the robot and selects lines and actions that are pre-registered on the robot. For example, a study has been reported in which a person remotely controls a robot from another room, and the robot gives aids in a group conversation in the form of a co-recall method [14]. In this case, there is a disadvantage that the caregiving staff must operate the robot. However, the robot would be able to select lines that match the situation and perform actions that match the timing of the participants.

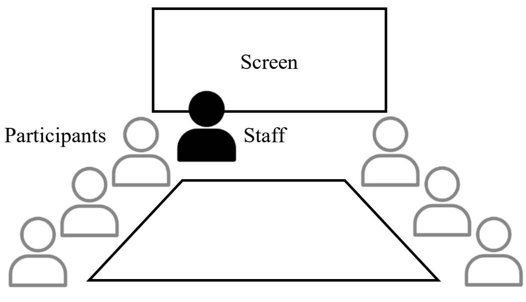
The purpose of this paper is to propose a method to reduce the workload of caregiving staff by using a humanoid robot to assist in hosting group recreational activities. In group recreation, it is difficult to apply the "autonomous action type" because of the need to accommodate a large number of participants, and the "automatic execution type" is often used. However, as mentioned earlier, participants need to match the robot's timing, and in addition, participants may have a strong impression that the process is one-way. Therefore, this study adopts the "remote control type. In the conventional "remote control type," it is necessary to concentrate on the remote operation, and it was difficult to provide individual participants with more care so that they can enjoy participating in the program. In addition, preparation, such as training for operation, was often required, and a certain level of experience was often required. The challenge in this paper is to resolve these issues.

3 Proposed Method

3.1 Recreation method

Among the various methods of group recreation in senior citizen facilities, this study focuses on recreation using IT materials. Figure 1 shows an overview. Figure (a) shows the layout and Figure (b) shows the appearance of the execution. This IT material is used by displaying a PowerPoint presentation activated on a tablet terminal on an electronic blackboard. The presenter operates the tablet terminal to display the educational material on a large TV and asks participants to take a quiz. Participants look at the material and answer the quiz. Participants listen to the answers of others and use them as hints to expand communication by speaking up and discussing their experiences and opinions.

The moderator of such group recreational activities is required to play three roles. The first role is that of "explaining the material," which involves explaining the material and eliciting comments from participants. The second role is called the "enlivening role," which is to calm the atmosphere and make it easier for participants to speak. The third role is called the "facilitator," and is responsible for ensuring that each participant enjoys his or her participation. In this study, we aim to reduce the burden on nursing staff by having the robot take on the role of these moderators.



(a) Layout of recreation

(b) Appearance of the recreation

Figure 1: Recreation method

3.2 Research approach

Of the three roles required of the moderator, the robot was chosen to play the "role of explaining recreational materials". The "role of explaining the recreational material" can be realized by having the robot speak lines that match the recreational material. If the robot can take on the role of explaining the recreational material, it will reduce the burden on the staff to prepare by reading the lines of the recreational material in advance. In addition, the staff only needs to respond passively to the robot in between recreational activities, which is expected to greatly reduce the burden of the staff.

We have identified four requirements for having the robot play the role of "explaining recreational materials". The first is "gestures during speech," which means that the robot gestures in accordance with the speech. If this could be achieved, it would be possible to draw the participants' attention to the robot. This is a necessary function for caregivers who avoid recreational work because they are not comfortable in front of a large number of people.

The second is "timely speech timing". The robot does not use timings that are pre-registered with the robot, but rather, it adapts its speech to the situation of the place. For example, if participants are thinking, or if participants are talking excitedly with each other, it is necessary to delay the timing of the robot's utterance. It is difficult for the current robot technology to understand such a situation with a high degree of accuracy, and it is necessary to use human intervention. In other words, the "remote control type" described in the previous study is suitable.

The third is "simple speech instructions". When the "remote control type" is adopted and the timing of speech is controlled by human operation, it is necessary to simplify the speech instructions in order to reduce the burden on the care staff. However, in the method described in the "remote control type" described in the previous study, the operation buttons are lined up for each line, and it is necessary to select which button to press, making the operation complicated. This needs to be solved.

The fourth is "easy line editing". This means that the staff must be able to easily edit the robot's lines. Recreational materials need to be constantly updated with new content to avoid getting stuck in a rut. In addition, to increase the attractiveness of recreation, it is desirable to be able to adjust the lines to suit the circumstances of the participants. However, in the "remote control type" described in the previous study, lines need to be registered in advance by a technician with expertise in robotics, making it difficult for staff to edit them easily. This needs to be resolved.

To realize the four requirements explained above, this study focused on the "PowerPoint linkage function" [15]. This function transfers lines written in the notes section of PowerPoint to the robot to be spoken in conjunction with the animation function of PowerPoint. By employing this function, "simple speech instructions" can be realized. Specifically, it is possible to proceed with a PowerPoint slideshow by simply clicking on it, thus reducing the burden on nursing staff. Also, for "easy line editing," care staff can adjust the robot's line by simply editing the notes column of the PowerPoint presentation. Furthermore, it is easy to create new recreational materials to prevent ruts.

3.3 Proposed Method

Figure 2 shows an overview of the proposed method. From top to bottom, the figure shows the flow from "preparation of recreational materials" to "recreation" using the "PowerPoint linkage function. First, in the "Edit recreational materials" step, the robot's lines are added to the notes section of the recreation materials that are being prepared for a person to host the event. Next, in the "Recreation" step, the PowerPoint material stored in the tablet is displayed on the electronic blackboard and the "PowerPoint Linkage Function" is activated on both the tablet and the robot. Then, each time the user clicks on a slide on the tablet to advance the animation, the lines in the notes column are tipped over to the robot, which then speaks the lines and takes on the "role of explaining the recreational material". The moderator does not need to utter the lines of advanced progression, thus reducing the burden. In addition, the moderator only needs to click the tablet to operate the robot, which is less burdensome. On the other hand, the content of the robot's speech is the lines described in the notes field, which allows for a high degree of freedom and the ability to utter advanced sentences. Furthermore, the moderator can decide when to speak based on the mood of the event, so there is no need for the participants to match the robot.

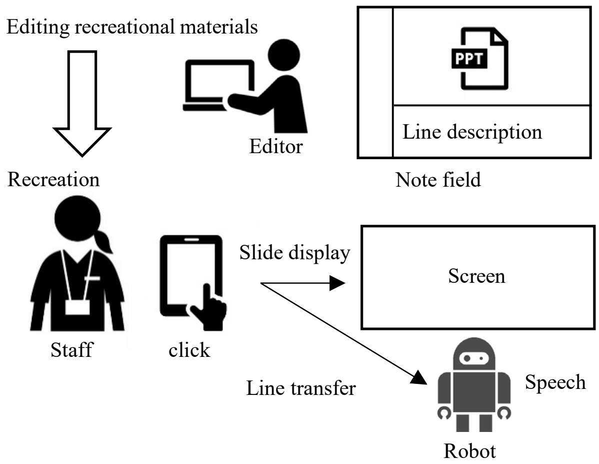


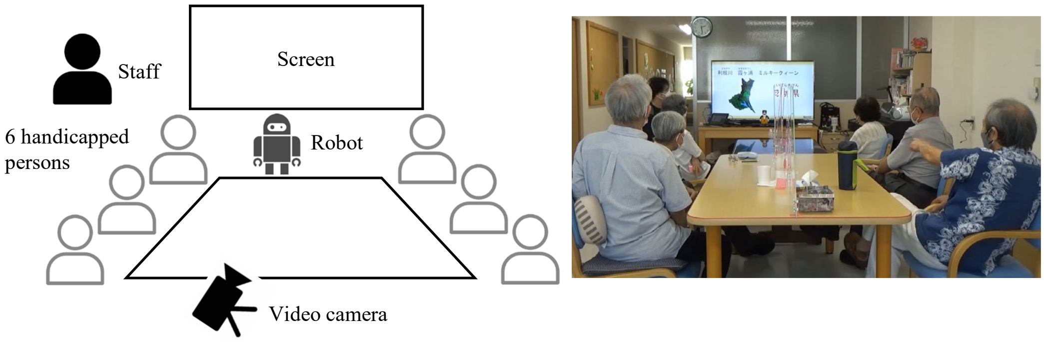
Figure 2: Proposed method

4 Experiment and Discussion

4.1 Experimental method

We conducted a group recreation experiment to confirm the effectiveness of the proposed robot moderator function. The purpose of the experiment was to compare the case in which a person moderates a group recreation with the case in which a robot moderates the recreation, and to examine the level of activity of the recreation and the degree of burden on the moderator. To this end, we conducted a 20-minute recreation utilizing the IT materials described in section 3.1, with the first half being conducted by a person and the second half being conducted by a robot as the emcee. The lines for the robot to host the event were created and registered by the authors.

Figure 3 shows the experimental conditions. Six people (four males and two females) participated in the experiment. In addition, an inexperienced caregiver staff member was in charge of the moderator. The communication robot was a Robophone (made by Sharp) [16]. The quiz questions were displayed on a screen in front of the robot, and the nursing staff explained the questions as they proceeded. The care staff advanced the slides by clicking the finger presenter. The first half of the session was moderated while explaining the slides. In the second half, the robot was asked to speak by judging the appropriate timing and facilitating the slides.



(a) Layout of experiment (b) Appearance of the experiment

Figure 3: Experimental condition

The experiment was captured on video and analyzed with the annotation tool ELAN [17]. Specifically, while playing back the video, the speech timing was identified from the speech waveform, and the speaker, speech duration, and speech content were manually recorded and tabulated. Therefore, the position of the break between consecutive utterances was determined at the discretion of the authors, and the results may contain some errors.

4.2 Experimental results

Figure 4 shows the experimental results. The figure shows the transition of the speaking time ratio. The horizontal axis shows the order of the quiz questions, from left to right. A total of nine quiz questions were administered. The first four questions were moderated by the staff, and the latter five were moderated by a robot. The line graph corresponds to the right axis and shows the time for one quiz. The duration of one quiz question varied between one and three minutes, and generally lasted about two minutes. The bar graphs show the ratio of speaking time to the time spent administering the one-question quiz. From left to right, they are shown for the staff, the robot, and the participants, respectively. The higher the ratio of participants, the more active the recreation and the more effective the recreation. The lower the ratio of the staff, the lower the burden on the staff.

Figure 5 shows the transition of speaking frequency. The horizontal axis shows the same sequence of quiz questions as in Figure 4. The bar graph shows the speaking frequency per unit of time for one quiz question. From left to right, they are shown for the staff, the robot, and the participant, respectively. The higher the frequency of speech, the more active the recreation and the more effective the recreation. The lower the speaking frequency of the staff, the lower the load on the staff.

Figure 6 compares the speaking time ratio and the speaking frequency between the first half and the second half. Figure (a) shows the results of the comparison of speaking time ratio, with the horizontal axis arranged in the order of staff, robot, and participant. The bar graph to the left of the staff is the average of the first four questions and the bar graph to the right is the average of the second five questions. The staff's speaking time ratio decreased by 34 points from 58% in the first half to 24% in the second half. The robot's speaking time ratio was 42% only in the second half. The participants' speaking time ratio was equal to 36% in the first half and 36% in the second half.

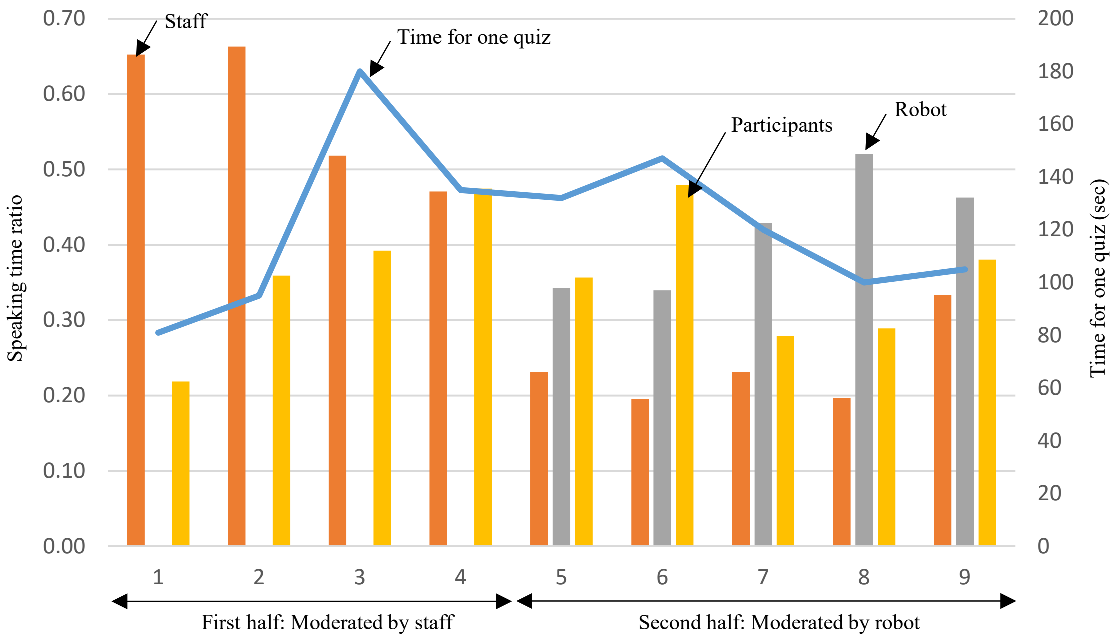


Figure 4: Comparison of Speaking time ratio

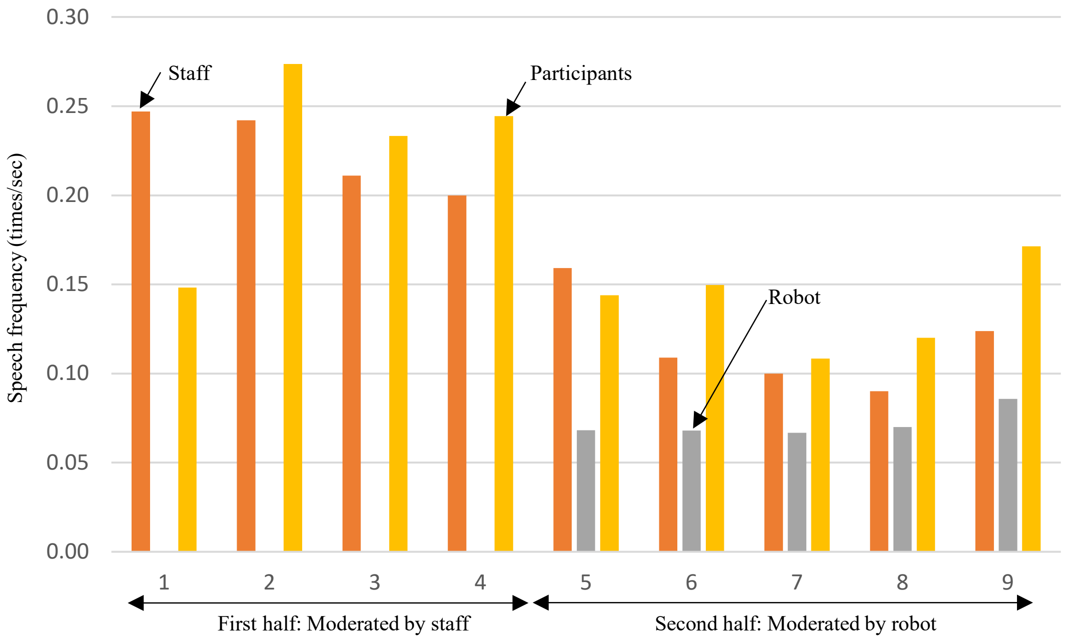
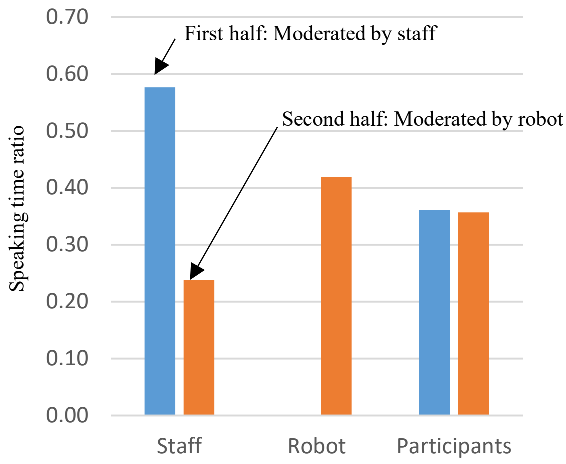
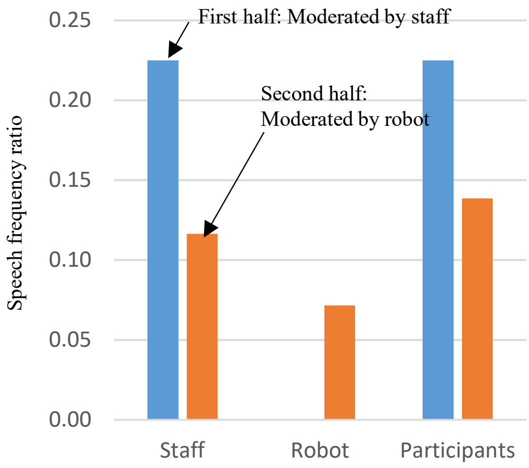


Figure 5: Comparison of Speaking frequency

Figure (b) shows the results of the comparison of speech frequency, with the horizontal axis arranged in the order of staff, robot, and participant. The staff's speech frequency was almost halved from 0.23 times/sec in the first half to 0.12 times/sec in the second half. The robot's speech frequency was only in the second half and was 0.07 times/second. The participant's speech frequency was almost halved from 0.22 times/sec in the first half to 0.14 times/sec in the second half.



(a) Speaking time ratio



(b) Speaking frequency

Figure 6: Comparison between first half and second half

Figure 7 shows a comparison between the first half and second half of the staff's speech. The vertical axis shows the ratio of speaking time, and the horizontal axis shows explanation on the left side and dialogue on the right side. Explanation is a one-way explanation of the content of the slides, while dialogue is two-way communication, such as asking and answering questions to the participants. The first half of the staff's speech consisted of 35% explanation and 24% dialogue. On the other hand, 25% of the second half was entirely dialogue.

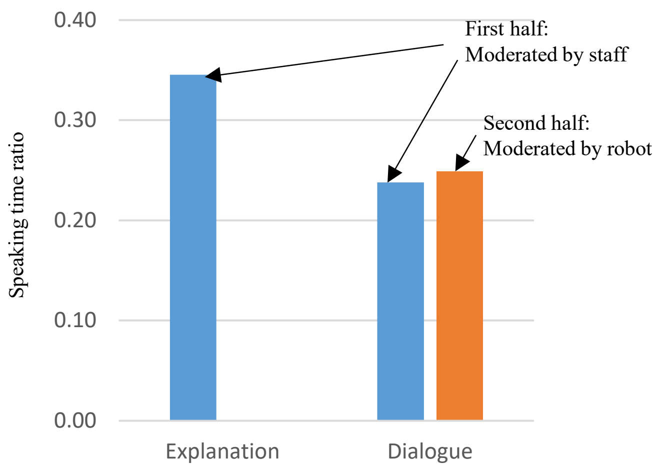


Figure 7: Comparison of utterances by staff

4.3 Discussion

(1) Discussion of speaking time ratio:

We will discuss the speaking time ratios shown in Figure 4 and Figure 6(a). First, focusing on the participants, in Figure 6(a), the ratio of participants was equal in the first half and the second half. From this viewpoint, it can be inferred that recreation is actively conducted in the second half, when the robot is the host, as the same amount of time is spent speaking as in the first half, when a person is the host. On the other hand, focusing on the staff, Figure 6(a) shows a 34-point decrease from 58% in the first half to 24% in the second half. This suggests that the burden on the staff has been reduced. Consideration can be given to this factor. In the proposed method, the staff only needs to think about repeating the clicks and proceeding with the slides. Therefore, the staff does not need to pay attention to explaining the contents of the slides, and can focus on following the participants' comments and expanding the topic. It is presumed that this facilitated the participants' speech and made their speech more active.

(2) Discussion of the speech frequency:

Let us consider the frequency of speech shown in Figures 5 and 6(b). First, focusing on the participants, in Figure 6(b), the frequency of the participants' speech dropped by almost half from 0.22 times/second in the first half to 0.14 times/second in the second half. Consideration can be given to this factor. Compared to the first half, the participants' speech duration was shorter in the second half because the robot joined as a speaker. In addition, from the analysis using the annotation tool, it was observed that the conversation between the staff and the participants in the first half tended to repeat short exchanges, while in the second half, the robot's speech was continuous and long, and the staff and the participants did not get a chance to speak during the robot's speech. In order to improve this problem, further improvements should be made so that the robot and participants can catch up in small increments of conversation.

(3) Discussion of the staff's utterance content:

Consider the content of the staff's utterance shown in Figure 7. In the first half, the staff had to provide both explanation and dialogue, but in the second half, the staff was able to focus only on dialogue. As a result, it is presumed that the moderator listens to the robot's explanation and is passive, allowing him to focus on asking questions toward the participants, following up on their statements, and expanding on the topic. In other words, the staff can start the recreation without the need to prepare in advance. Also, even if they are inexperienced, they can concentrate on following up with participants. In addition, the robot operation by the staff is only to click on slides, and the staff can concentrate on speaking, which also reduces the burden on the staff.

(4) Features of the proposed method:

The feature of the proposed method is that the "remote control type" makes it possible for the robot to assess the situation and speak at a timely timing. In addition, by creating sophisticated lines in advance, the proposed method can produce speech that matches the situation, which is not possible with the "autonomous operation type. On the other hand, the demerits of this system are: 1) the system requires operation by nursing staff, 2) the possibility that lines may not be appropriate for the situation because they have been registered in advance, and 3) the need for work to create the lines. For 1), we have devised a way to reduce the need to click on slides and finger presenters. As for 2), the robot does not moderate alone, but rather, the caregivers follow up with the robot to remedy any discrepancies between what the person says and the situation at the place where the robot is speaking. Regarding 3), for the time being, the plan is to address this issue by creating and using a library of recreational content with made-up lines, but this is an issue for the future.

(5) Qualitative evaluation of the proposed method:

After the experiment, interviews were conducted with the moderator and participants. As a result of interviews with the moderator, he said that the mental burden is reduced because he can participate in recreation in a passive manner. This shows that the aim of this study has been achieved. On the other hand, participants made comments both for and against. Positive comments about the use of robots included, "It provides a topic of discussion," "I'm glad it was new," and "I don't mind robots as long as humans can help." Negative comments on this included, "It would be nice if we could have a dialogue instead of one-sided talk," and "If there wasn't a shortage of people, it would be good to have someone host the event." These results suggest that the significance of using the proposed method should not be that the robot can completely replace the human host, but that the robot can reduce the preparation time before recreation for the nursing staff and reduce their mental burden during recreation.

5 Conclusion

This paper proposes a method to reduce the burden on caregivers by utilizing humanoid robots to assist in hosting group recreational activities. The proposed method is to have a robot take the role of a moderator for IT educational materials that are used by display-ing a PowerPoint presentation on a screen activated by a tablet terminal. Specifically, a system was proposed in which a robot explains a quiz displayed on the screen, asks questions, and answers the questions using the PowerPoint linkage function. Experi-ments on recreation using the proposed system revealed the possibility of reducing the burden on the moderator while achieving participant communication equivalent to that of a human moderator.

Future issues to be addressed include the study of ways to streamline the process of making up the robot's lines, and to enable the robot and participants to catch up in small increments of conversation.

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