Real-World Verification of Human-Care Robot for the Elderly: A Preliminary Result

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***Abstract*—With the increasing need for human-care robots, various robots are being developed. However, the verification of robots in real-life environments is insufficient. In this study, we analyze the experimental results of a human-care robot in a testbed and verify the usefulness of the robot service.**

Keywords*—*Human-care robot, Testbed

I. INTRODUCTION

In recent years, various types of social robots have emerged to perform different functions and co-exist with humans in daily life. In particular, the interest in human-care robots, which are mainly targeted at children and elderly people, is growing.

Human-care robots are designed to provide appropriate services through human interaction. The number of elderly people has increased rapidly in recent years, and many of them live alone at home or in a hospital [1]. They depend on some type of help to meet specific needs. Therefore, several studies have been conducted on human-care robots to meet their needs [2][3]. However, most of these studies have focused on kinematic approaches or physical safety. Physical support is important for elderly people living alone. However, cognitive support services for memory and information provision, such as emotional support services to alleviate loneliness, are also important.

With the development of artificial intelligence technologies, each technology applied to human-care robots has demonstrated high performance. However, integrating these technologies to provide services to the elderly is a different issue. This study focused on service design to provide customized services to the elderly by integrating element technologies. We develop a human-care robot technology for the elderly, who are vulnerable, and evaluate its performance by deriving the most relevant services. Furthermore, we analyze the problems encountered during the demonstration and review the usefulness of the human-care robot service.

The rest of this paper is organized as follows. In Section 2, we introduce the technology and the service scenarios to be tested. Section 3 describes the testing method and test environment. In Section 4, we analyze the quantitative results of the tests. Finally, in the last section, we conclude the study.

II. TEST SCENARIO

The most common means of human–robot interaction is verbal communication, which is useful for assisting the elderly. The robot acquires and recognizes information about the user and the environment using a camera image and microphone voice to initiate a verbal conversation with the user.

In this study, we have developed 12 technologies, including action detection, object recognition, facial and clothing feature recognition, speech recognition, and ambient sound recognitionbased on the datasets collected from elderly participants [4].

TABLE 1. TECHNOLOGIES

ID	Technology description
T01	User identity recognition and mask-wearing recognition
T02	Clothing feature recognition such as top type, color, pattern, etc.
T03	Techniques for generating comments about overall clothing styles
T04	Category and instance recognition for objects frequently used by the elderly (mobile phone, remote control, glasses, etc.)
T05	Detection of behavior in elderly daily routines
T06	Evaluating user movement motion through pose estimation
T08	Technology that generates gestures appropriate for the robot's utterance
T09	Technology that recognizes the user's interaction behavior and creates a corresponding robot interaction behavior
T10	Environmental sound recognition
T11	Speech recognition
T12	Drive to a designated point and route

By applying the 12 element technologies defined in Table 1, 10 services are likely to be needed by the elderly. As shown in Table 2, the type of service is largely divided into a regular service, where the robot recognizes the user's voice and actions, and a service based on a request from the user. Each service contains one or more elemental technologies. We have defined the service in such a way that the user cannot know the details of the technologies.

TABLE 2. SERVICE DEFINITION

ID	Type	Service description	Technology
S01	regular	Conversation initiation by daily action detection	T05, T11
S02	regular	Environmental sound (cough, cell phone, doorbell) detection notification	T10, T11
S03	request	Provides general information such as weather, news, and horoscopes	T11

S04	request	Find belongings	T04, T11, T12
S05	request	Exercise assistant	T06, T11
S06	request	Check clothes style and whether to wear a mask when going out	T01, T02, T03, T04, T11
S07	regular	Contact the guardian in case of an emergency	T11
S08	request	Important event reminders	T11
S09	request	Providing content such as music	T05, T11
S10	request	Creating conversations and interactive behaviors in everyday life	T08, T09, T11

III. Experimental Environment

For the demonstration, an apartment-type testbed was built to simulate a real-life residential environment. The human-care robot we used for the demonstration is named 'Jenny' and was designed to provide care for elderly people living alone at home.

A total of 20 older individuals (average age: 78 years), 8 males and 12 females, with no problems in daily life, were tested. We created 25 scenarios based on 10 derived services. For the elderly, each scenario was briefly explained and then performed in order.

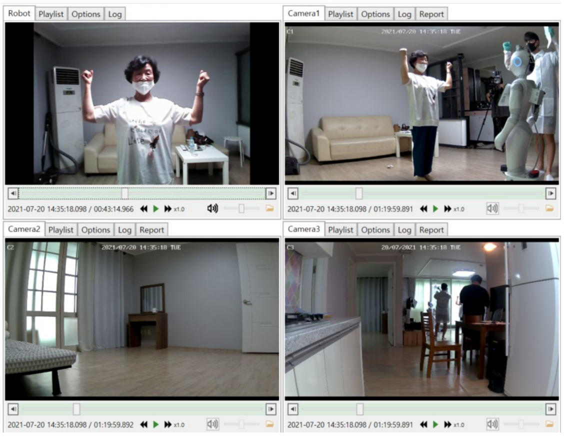

Fig. 1. Demonstration scene

IV. Results

There are various ways to evaluate a service quantitatively or qualitatively. We chose the success rate of the service to review the performance of the human-care robot. As shown in Fig. 2, the average success rate was 83.4%, but differences were depending on the service.

The service based on the user's request generally had a high success rate, but the regular service for conversation initiation and ambient sound notification had a low success rate. For the request services, S06 uses object recognition, style comment, and clothing feature recognition technology based on image data input from the robot camera. Accordingly, the success rate was lower than the other services due to the influence of lighting.

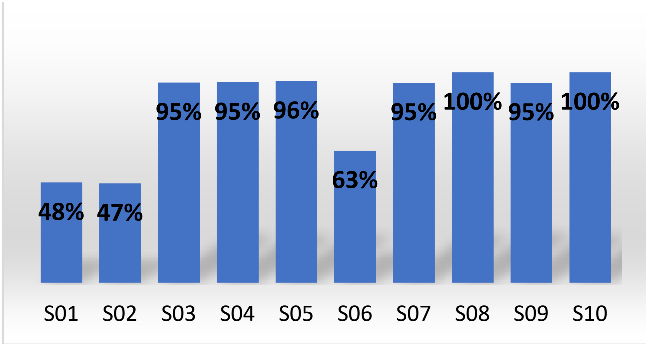

Fig. 2. Service success rate

V. Conclusion

For practical reasons, most studies related to robots focused on technologies based on short-term interactions between humans and robots. However, many real-world robot applications require repeated interactions and the establishment of long-term relationships. In this study, we analyzed the results of demonstrating a human-care robot for the elderly and the problems of each service.

In the future, we intend to improve the success rate of regular services by analyzing the individual elemental technologies within the service. By analyzing the content of the user survey, we aim to derive a methodology to increase qualitative satisfaction.

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