Deploying Service Integration Agent for Personalized Smart Elderly Care

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***Abstract*—In recently years, many care robots have received a lot of attention to help elderly people. However existing care robots have difficult to adopt personalization. For instance, some programmers have to customize robot program to meet needs of each elderly. Even if a care robot which has a feature of machine learning, it takes a long time to learn a preference for each elderly. In this paper, our goal is to deploy a smart care service integration agent that provides a personalization and integration for each elderly people. Our proposed service consists of three essential components, Virtual Care Giver (VCG), Virtual Care Personalizer (VCP) and Care Template. VCG is a robot agent, where executes care tasks in each home. The VCG is offered care tasks based on care template which Virtual Care Personalizer (VCP) generates. Virtual Care Personalizer (VCP) manages and generates personalization of care tasks the on cloud. Moreover, we deploy Care Template on the cloud which enables to provide the basic care tasks. To demonstrate the feasibility, we consider three kinds of usecase scenarios for two persona people.**

I. Introduction

We are facing a hyper-aging society, and Japan is forecast to become a society with 39.9% of aged people in 2060. In addition to this, many facilities of welfare and nursing care suffer from a chronic shortage of workers. The job opening ratio is as high as 2.68 (as of Dec. 2014). The number of a nursing home is not sufficient for the number of applicants, who are over 524,000 elderly people. Japanese government starts to support and encourage *home care* rather than building new facilities. Under these circumstances, the *assistive technologies*, which support elderly people using technologies, attract great attention.

Currently, care robots are hot technologies to assist for elderly people. Care robot is a robot which aims to support or assist elderly people in his/her daily life. Roy et al. have developed the service robot in order to assist the elderly people [1]. They have proposed a care robot which enables to use natural language. The robot also enables remote care-givers to establish a "tele-presence" because the robot has a ability to move in the home. Also some researches have shown the evidence of benefits for the elderly, particularly as a result of interacting with robot pets [2]. Our research group has also tried to adopt a Virtual Agent (VA) for a care robot. Virtual agent (VA) is an animated, human-like graphical chat bot robot program. Using VA would support some simple cares such as greeting with elderly; remind schedules to provide instead of human caregivers. Then, the human caregivers can do tasks, which the caregivers can not do ever. To provide the care by robots including VA, the robots have to execute tasks based on every elderly's preference. Because requirement for care are vary for each elderly people.

However, we think that the existing care robots have difficulty to adopt for rapidly growing population of elderly people. Concretely, we think there are three problems to adopt for elderly people; personalization; personal assistant cost and learning problem to adapt care for use in his/her situation. The first problem represents that each care robot needs personalization to care. The care tasks should be tailored to elderly's individual needs, because each elderly has own preference. Although the personalized care for elderly is important, creating the personalized care program cots much more than as usual. Even if a care robot which has a feature of machine learning, it takes a long time to learn a preference for each elderly.

In this paper, our goal is to provide the personalized care for elderly people that copes above problems. To actualize the above service, we develop two kinds of the components, one is called Virtual Care Giver (VCG) and another is called Virtual Care Personalizer (VCP). The VCP executes a personal adoption on the cloud, and the VCP do care tasks for the elderly at their home. The above detachment of VCP from the home server, which enables to scalable and flexible adoption to meet the individual requirement for elderly. Moreover, we also deploy the care template on the cloud in order to fix and update more easily. The care template consists a content of each care by some caregivers. In this paper, we concretely think about four kinds of cares to show the feasibility of proposed service.

To confirm the effectiveness of the proposed service, we develop prototype system based on the architecture. Moreover, we also discuss our future work based on some use case.

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ICIS 2016, June 26-29, 2016, Okayama, Japan

II. Preliminary

A. Care Robots for Elderly People

In Japan, 65% elderly who needs cares would like to use robots for care. In addition to this, 60% caregivers are supposed to would like to use care robot to decrease care burdens. Sometimes elderly people have a severe social and health problem. Hearing loss is the most common sensory deficit in the elderly people [3]. Also people with dementia typically have problem that declines in thinking, planning and organizing day-to-day things[4].

Elderly people living alone do appear to be at higher risk of falling and heat disorder [5], [6]. Based on the social background, many researchers and companies have developed care robots to assist for elderly. Japanese government also tries to produce a new industrial which uses nursing-care robot technology to help elderly people. Care robot is an assistant robot that helps elderly people in his/her daily life. Some nursing care robot draw attention as care technology to improve the quality of life (QoL) for elderly people in the context of aging society. For example, PARO has been applied in nursing home as a therapeutic companion robot for elderly people. Hence, wide variety of care robots are applied to improve the quality of life for elderly.

B. Virtual Agent System

The *virtual agent* (VA) is a human-looking animated chatbot program that can communicate with a human user via voice [7]. There are a few studies that adopt the VA for elderly care. Yasuda et al. developed a system where a VA serves as a conversation partner of people with dementia [8]. Our research group has also developed a system which exploits a VA as a user interface of the home network system (HNS) [9]. When a user says "Turn on a TV", the system interprets the voice as a command `TV.on()`. Then the system sends the command to the HNS to turn on the TV. Also, the VA autonomously speaks various information obtained from the HNS and the Internet. VA is a promising technology for elderly people, since it can assist an elderly people based on less-mechanical and (simulated) human-to-human conversation. Hence, we think that VA would become a useful interface as a care robot.

C. Problem of Existing Care Robots

Since many researchers have tried personalized care robot, but existing care robots have too complex to deploy at home, because they have consisted of many sensors and software. Also we think these care robots have monolithic control programs hence they are difficult to integrate with other services. Considering the nursing care business, the system has to adopt a method of nursing care from the caregivers in the field. However, existing care robots have difficulty to adopt for a rapidly growing population of elderly people. Specifically, existing monolithic program have difficulty to adopt change for the above requirement. Even if care robots have a learning with data which are collected with a physical sensor such as motion sensor and temperature sensor in private homes. Hence, we need a method to easily deploy and upgrade the care robot which provides personalization for individual elderly people.

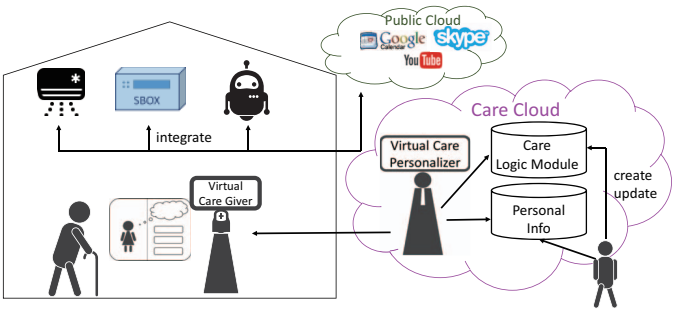

Fig. 1. Overview of Deploying Care Architecture

D. Goal and Scope of Paper

Our goal is to develop a deploying personalized care service for elderly people which integrates smart services. It aims to help elderly people in a personalized and easy fast way. In this paper, we first present the overall architecture of deploying service. Then, we propose a key idea and design thoughts of the essential components. In addition to this, we explain some usecases of proposed care services. In the usecase we show the four kinds of cares(greeting(), playMusic(), talkWithTopic() and scheduleSuggestion()).

III. Deploying Service Integration Agent

A. System Architecture

In order to achieve the goal, we develop a service integration agent which is consists of three parts; Virtual Care Giver, Virtual Care Personalizer and Care Template. Figure 1 shows the architecture that we propose. The key idea of our proposed architecture is a detachment of care execution at home from managing on the cloud. This architecture provides flexibility to change for individual elderly people. When the elderly people needs some cares which are not registered yet, then caregivers can easily register care.

In the following, we explain our essential components to develop the service integration architecture. Virtual Care Giver(VCG) executes some cares and which are located at the center of the home. VCG also has a user interface which visualizes some important information to interact with elderly people. VCG follows orders by Virtual Care Personalizer (we explain in section III-E). VCG executes cares which are automatically personalized by the Virtual Care Personalizer. Virtual Care Personalizer is an administrator of VCG which is deployed on the cloud. VCP sends some requests for VCG to execute some tasks for elderly people to provide. The caregivers register elderly's personal information for the personal information into some database. In addition to this, the caregivers easily edit and register care template on the cloud. The VCP generates personalized cares using the personal information. VCP executespersonalized care tasks based on the stored personal information. Figure 2 shows the class diagram which consists of our essential components. In

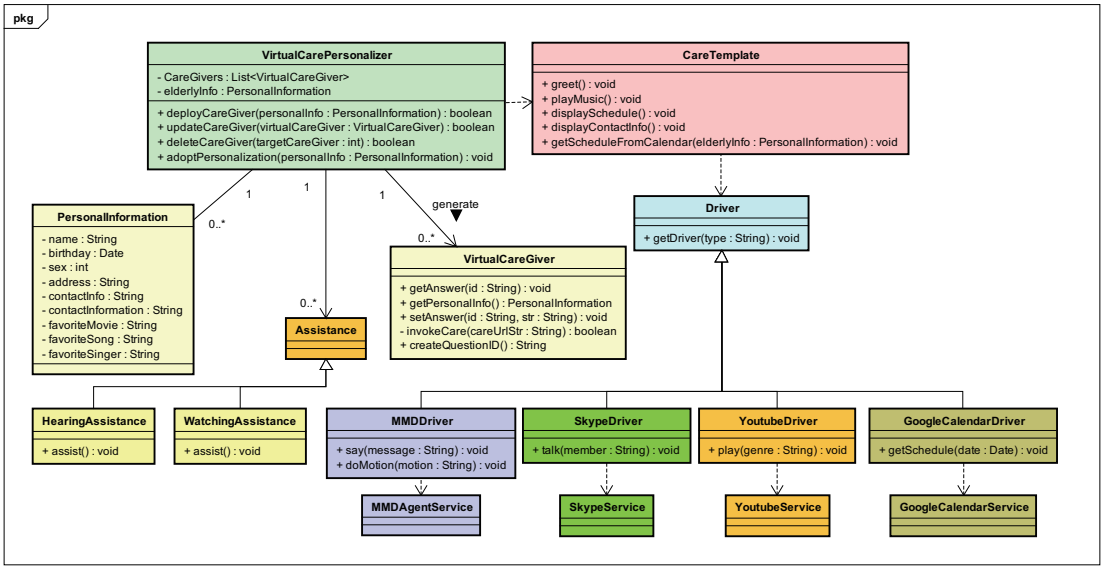

Fig. 2. Class Diagram of Proposed Care Service

the following section, we explain the APIs of each component in detail.

B. Virtual Care Giver

Virtual Care Giver (VCG) is a care robot that provides the actual care for a user at home. VCG is implemented using some robotics technology such as Virtual Agent, and it is deployed with personal information for each user. Each VCG has a software which basically operates itself. Hence, the VCG can both display some messages on screen and say something using voice-to-text technology. We assume that the VCG is deployed on the server in the home. Hence, elderly people can intuitively confirm a necessary information such as his/her schedule using the interface. VCG also has a graphical user interface to interact with elderly people. In this paper, we focus on the software which operates the VCG. Moreover, the VCG can integrate with another resource such as smart home, physical sensor and another robot via an internet. VCG executes cares by Virtual Care Personalizer with api which is called invokeCare(). We also design that the VCG has a web APIs which enables to control remotely. For example, the VCG could say some messages with the API http://cs27.kobe-u.ac.jp/virtual-care-giver/say?str=message.

The offered care tasks are managed in Care Template (Sec. III-D). Also, the VCG has setAnswer() and getAnswer() APIs which enables to interact with users. For example, when the agent have to wait an answer from users. Using these APIs would simulation with interaction between elderly people and caregivers. The VCG has following APIs.

- getAnswer(id): Obtain an answer from a specific id
- setAnswer(id): Set an answer for a specific id
- invokeCare(url): Invoke concrete care which is generated by VCP

Figure 3 shows the sequence diagram of VCG. Specifically, when the agent asks a question which is triggered

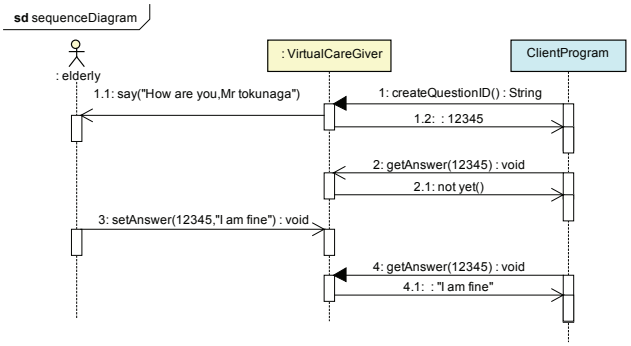

Fig. 3. Sequence Diagram of VCG

by ClientProgram. Then the agent generates question id (12345) and which asks for question for elderly. Next, the ClientProgram invokes getAnswer using the above id. This enables to wait for the answers from elderly people. And then the elderly people set the answer for the id (12345), then the ClientProgram would obtain the answer through VCG.

C. Personal Information

In this section, we consider how to collect personal information, which enables to personalize the care for elderly. We need to store for personal information individual elderly people. Moreover, we also discuss how to collect the above item. Following list shows the data item to store the personalized care item. The single dag † represents the basic personal information and double dag ‡ represents the optional information which stores his/her preferences.

- †name,†birthday, †sex
- †address, †physicality,†contacts, †family
- ‡hobby,‡favorite movie,‡favorite song
- ‡favorite singer, ‡favorite actor

Considering the personalized care, at first we have to store the basic information to identify the each user which includes name, birthday, sex, address, physicality. Using the above basic personal information, the system could provide the elementary personalized care. For example, using the user's name, the system can greet with his/her name. In another instance, the contact information enables to get back to contact members that could cover some problems which do not cover by the systems. We also consider how to collect his/her preference, because the user's preference information would help for the system to interact with user. Based on the registered preference information such as favorite song or favorite actor would enrich the care. For example, the system uses information that user "tokunaga" who likes "The Beatles", then the system would provide the song suggestion care such as "Would you like to listen Hey Jude". We expect that the his/her family or caregiver would input with Website. Finally some programs could access personal information via WebAPI.

D. Care Template

Care Template is a template that manages and creates a simple care based on the personal information. Care Template is consists of simple commands such as greeting, say and so on. The VCP injects the personalized information to provide personalized care. The care template provides a wide variety of cares which are consisted of small care tasks. In addition to this, the care template is managed on the cloud. Hence caregivers flexibly update and create care tasks to adopt for an elderly people. We suppose that Care Template is shared among caregivers who uses the proposed system. Above design enables to start the system more easily for caregivers. In the following, we specifically show the APIs (Application Programming Interface) of Care Template. Following list shows interfaces of commands whom Care Template has.

- greet(message,elderlyInfo): Greeting with his/her name
- playMusic(elderlyInfo): Playing musics based on his/her preference which includes genre, singer and so on.
- displayScheduleList(schedulelist): Display user's schedule as list. When the specified day is given, then this api returns the day of schedules.
- displayContactList(contactlist): Display contact members who are registered by personal information.
- getScheduleList(userInfo,day): Obtain user's schedule which is specified by date.

```
greet(message, elderlyInfo){
  message = "#{message}, #{elderlyInfo(name)}"
  agentDriver = getDriver("agent")
  agentDriver.say(#{message})
}
```

greet() is the API which aims to provide greeting instead of caregivers at nursing home. The #{} represents the template which is replaced with personal information. For instance, considering greet to user "tokunaga" is a man whose age is eighty years old in the morning. Then we consider that the greet() is given two parameters "Good Morning" and elderlyInfo("tokunaga"). Next, the *#elderlyInfo.name* becomes "tokunaga". Finally, the driver (explained in section III-G) invokes API which could access VA or other kinds of public web service. Hence, the logic part of contents are replaced with elderly information. Moreover, it's logic finally invokes VCG's APIs which could interact and provide the contents of care.

E. Virtual Care Personalizer

The Virtual Care Personalizer(VCP) is the main component which generates and deploys the care on the cloud. Specifically, the VCP generates personalized care with both personal information and Care Template. When the VCP generates care based on the physical conditions of individual elderly people. For example, when the user has a hard of hearing, then the VCP control turning up the volume and delays the speed of talking that the VCG offers. Then, the template automatically generates a variety of cares based on the individual personal information.

VCP has the following four kinds of APIs.

- deployVirtualCareGiver(IPaddress,elderlyInfo): Deploys the VirtualCareGiver at the user's home.
- updateVirtualCareGiver(IPaddress,elderlyInfo): Update the information of current VirtualCareGiver.
- deleteVirtualCareGiver(IPaddress,elderlyInfo): Stop and delete the current VirtualCareGiver.
- checkVirtualCareGiver(IPadress,elderlyInfo): Obtain the status of current VirtualCareGiver.

deployVirtualCareGiver() is an API that deploys the VCG for the specific home using IPaddress and each personal information of elderly. Hence, this provides deploying the VCG at home that actualizes the development of care environment. The updateVirtualCareGiver is an api which aims to update the information which has already registered. For example, the contact information has changed during the user using the service, then the VCP has to invoke the updateVirtualCareGiver(). deleteVirtualCareGiver() is an API which terminates VCG who is currently running. The adoptPersonalization() is an API which generates personalized care for the individual elderly, Specifically, the adoptPersonalization() calls the some assistant api (we describe the assistance component in the following section) in accordance with the symptom of elderly.

F. Assistance

Assistance is a component which provides to assist the elderly people. Some elderly people have hard of hearing or have trouble with one's leg. To help the above elderly people, each care has to adopt based on the individual symptom. The assistance component is designed to provide cares which meet the individual needs of elderly people. The assistance has some child-assistance which provides specifically help for elderly people. For example, the HearingAssistance class provides the assist for elderly people that provides turning up a volume and slow down the talking. In addition to this, the VCP generates the care with assistance and Care Template which also injects

the personal information. We show an example of assistance for an elderly people “tokunaga” who has hard of hearing.

```
if(elderlyInfo("tokunaga").hasHardOfHearing) then
  assist() do
    setSpeed("slowly")
    setVolume(10) /*10 means a loud voice*/
  end
end
```

The assist() executes to adopt for the individual elderly. Above example represents that the user “tokunaga” has hard of hearing, hence the assist() invokes both setSpeed() and setVolume(). Finally, based on the settings the VCG speaks slowly with loud voice.

G. Driver

Finally, we explain the adapter components (called Driver) which provide to access public Web services. To actualize the care for elderly, we consider that the providing service needs to access with public Web service such as Google Calendar, Youtube and so on. The integration with public Web service would extend the kinds of cares to improve the elderly care. The driver component enables to provide the loose coupling with public web services. Because the driver enables to provide the structure that the VCP indirectly invokes the public web service. So we could easily to extend our service only to write a dome driver. The driver file only provides to access with *getDriver*() with type which identifies the public web service. The driver has a *getDriver*(*type*) interface that obtains valid kind of driver. For example, if a program need to access the AgentDriver then the program first invokes getDriver(”agent”). Then some client program can invoke an operation using the driver.

```
agentDriver = getDriver("agent")
agentDriver.say(#{message})
```

IV. Use Case Scenario

In this section, we consider three kinds of use case scenarios (greeting care, plying music care, talking topic care). To consider the usecase scenario, we consider the two kinds of persona scenarios. One is user “tokunaga” who is a 60s man, who likes song of “The Beatles”. The other is a user “nakamura” who is a 80s woman and she likes a topic of flower. Remember that we have explained the care template in the section III-D. In the following, we confirm that the templates are changed based on his/her personal information. We assume VCP generates care based on the personal information.

```
greet("Good Morning", elderlyInfo("tokunaga")){
  message = "Good Morning, Mr.Tokunaga "
  personalizedMessage = VCP.adoptPersonalization(
        elderlyInfo("nakamura"),message)
  agentDriver = getDriver("agent")
  agentDriver.say(#{personalizedMessage})
}
```

```
greet("Good Morning", elderlyInfo("nakamura")){
  message = "Good Morning, Ms.Nakamura"
  agentDriver = getDriver("agent")
  personalizedMessage = VCP.adoptPersonalization(
        elderlyInfo("nakamura"),message)
  agentDriver.say(#{personalizedMessage})
}
```

Based on the personal information the care template greetCareForTokunaga(), greetCareForNakamura() are generated. The difference between template greetCareForTokunaga() and greetCareForNakamura() are contents of messages. And we show other two kinds of cares, playMusic care and talking topic care.

```
playMusic(elderlyInfo("tokunaga")){
  youtubeDriver = getDriver("youtube")
  agentDriver = getDriver("agent")
  favoriteMusicGenre = youtubeDriver.search(
        elderlyInfo("tokunaga").favoriteMusic)
  message = "Shall I play some music #{favoriteMusicGenre}"
  agentDriver.say(message)
  youtubeDriver.play(favoriteMusicGenre)
}
```

```
talkWithTopic(elderlyInfo("nakamura")){
  message = "How are you? Ms.nakamura"
  topic = elderlyInfo("nakamura")
  topicMessaage = "Today I would like to talk about #{topic}}"
  agentDriver = getDriver("agent")
  agentDriver.say(topicMessaage)
}
```

See the template playMusic() which plays his favorite song using Youtube. The care template is replaced with his favorite song. The VCG finally executes to play music with *youtubeDriver*() on Youtube.

V. Related Works

Nowadays many researches have researched many care robots for elderly people[10][11][12]. Above care robots seems to develop with monolithic approach. That may cause the increasing of costs such as expense for develop and deploying cost at home for elderly. Moreover, no one knows that how the care robots have to cover the features such as natural processing, monitoring and so on.

The difference between existing care robots and our approach is to isolate the logic of cares and engines which executes concrete cares. Proposed architecture design flexibly adopts for needs of elderly people.

In the following, we explain a future work. One challenge is an improvement of care contents, and the another challenge is providing sensor-based care. In this paper, our proposed architecture focus on how to provide the care which is personalized for elderly people. Thus, our proposed architecture does not cover the contents of care. The VCP and care template enables to provide a template based care, but sometimes the content of care may be unsatisfied for elderly people. That may causes a decrease of motivation to use our proposed service continuously for users. To cope the above problem, we have an idea that improvement the quality of care based on the user’s reaction.

Specifically, a user receive some kinds of care which is executed by VCG, then the VCG also collect the information that whether the given care is good by the user. The collection of evaluations which are evaluated from users would improve cares which VCP generates based on the score. To actualize the above idea, we have to consider both how to evaluate the given care by the users and how to improve the generated care for individual users based on the stored evaluation.

The secondly problem is providing more situational care which integrates with sensor data. Currently, care template only covers the static value, specifically personal information such as name, sex, address and so on. Hence, care template does not cover the integration with other kinds of data (e.g. sensor data, motion data and so on). Elderly people living alone do appear to be at higher risk of falling and heat disorder. We think care template have to extend to cover the sensor data to cope the above problem. The smart care which integrates with sensor data will cope to detect both the falling and heat disorder. We have to consider how to provide the care integrates with sensor data using care template.

VI. Conclusion

In this paper, we have proposed a smart care service integration agent that provides a personalization and integration for each elderly people. Our proposed service consists of four components, Virtual Care Giver (VCG) and Virtual Care Personalizer (VCP), Care Template and Personal Information. VCG is a robot agent, where executes care tasks in each home. The VCG follows a care tasks which VCP generates. Personal Information enables to personalize cares based on the registered information. VCP manages and generates personalization of care tasks the cloud. Care Template is a framework which manages a simple care tasks for elderly people to offer for VCG. To demonstrate the feasibility, we have considered three kinds of usecase scenarios for two persona people. Our future work is improving the quality of cares based on the reactions by elderly people.

Acknowledgments

This research was partially supported by the Japan Ministry of Education, Science, Sports, and Culture [Grant-in-Aid for Scientific Research (B) (No.26280115, No.15H02701), and Challenging Exploratory Research (15K12020)].

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