Proceedings of the 24th IEEE International
Symposium on Robot and Human Interactive Communication
Kobe, Japan, Aug 31 - Sept 4, 2015

A cloud based chat robot using dialogue histories for elderly people

Eri Sato-Shimokawara[1], Shun Nomura[1], Yoko Shinoda[1], Haeyeon Lee[1],
Tomoya Takatani[2], Kazuyoshi Wada[1], and Toru Yamaguchi[1]

***Abstract*— The authors developed cloud based chat robot for exhilarating elderly people. Our robot is designed to keep users from being bored. Conventional chat robot systems use huge phrase database in advance. However, fixed phrase involves an immense amount of time and effort to make. The proposed system uses dialogue histories which are collected from users. This paper reports the effect of updating the phrase database by using histories.**

I. INTRODUCTION

Care prevention and maintenance of health are important issue in an aging society. Dementia people make up 13.7% of the elderly population (over 65 years old) in 2013. The population of dementia will increase according to an investigation by the Japan Ministry of Health and Welfare. Moderate exercise, a balanced diet, and social involvement are said to be good for preventing progression of dementia. Otake proposed Coimagination Method as conversation support [1]. However, The opportunity of talking with someone is a decrease according to elderly people who live alone is increasing. The best solution is making an opportunity of conversation with someone, but we focused on creating and increasing the chances of conversation as a first step. Therefore we are developing a chat robot.

There are many researchers are challenging and developing chat robots. ELIZA [2] is well-known program as DOCTOR which is simulation of a person-centered therapy. ELIZA based on simple pattern matching, but some user took seriously. After this research, many approach is proposed in natural language processing, and speech communication. ALICE [3] was inspired by ELIZA, and it is Turing Test Winner in 2000, 2001 & 2004. Sing et al. [4] surveys and compares with other conversation agent.

These programs aimed human-like. You enjoyed chatting with these programs first, but you might feel boring after a while. We need more suitable conversation for the culture, nations, situations, and personal. Lee et al. [5], [6] proposed example-based dialog system; they developed dialog model each situation, such as a weather report, car navigation, TV program guide. It is important approach because the human has some format for a conversation on a situation. Yang [7] proposed a spoke dialog system by using item-based collaborative filtering model. This method is useful for recommendations about information that a user is unknown. Example-based approach is effective for task-oriented dialogs and chat-like dialogs [8].

In this research, we focused on non-topic chatting system like casual conversation, aiming at long term use. Traditional example based dialog might be getting bored when users continue to use it. We proposed that users' dialogue history is used as robot dialogue. It is not just repeating like a parrot. Collected dialogue data is stored database and reused other session time.

II. SYSTEM OUTLINE

A. overview

Proposed system is composed of a smartphone, a home server, and a cloud server. Chat robot runs on smartphone. Fig.1 shows the home server and the chat robot in a smartphone. In this figure, the system uses Wifi router for access to the cloud server.The chat robot recognizes a user's utterance by Google Speech Recognizer, and dialogue by text-to-speech synthesis. Home server obtains nouns from the text by morphological analysis, and stores as log data. The log data are uploaded to cloud server once every day. An administrator checks the uploaded log data. Moreover the administrator selects and forms the sentences which are stored on robot dialogue database. Robot dialogue database is downloaded to the home server once every day as shown in Fig.2.

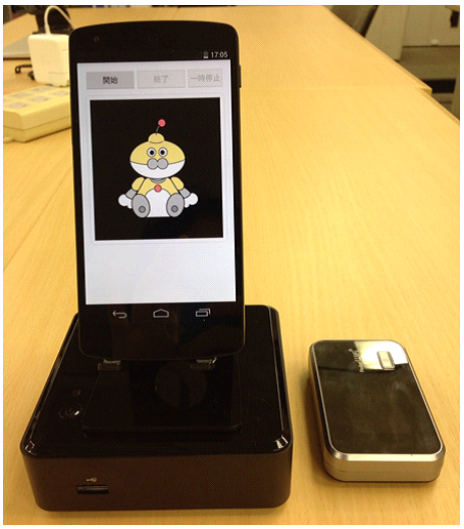

Fig. 1. Proposed robot is composed from a smartphone and a home server. These access to Google Speech Recognizer and cloud server through Wifi router. The chat robot shows in the smartphone as an application.

[1] Eri SatoShimokawara, Shun Nomura, Yoko Shinoda, Haeyeon Lee, Kazuyoshi Wada, and Toru Yamaguchi are with Faculty of System Design, Tokyo Metropolitan University, Japan eri@tmu.ac.jp, {nomura-shun, shinoda-youko}@ed.tmu.ac.jp, {hanuri, k_wada, yamachan}@tmu.ac.jp

[2]Tomoya Takatani is with Toyota Motor Corporation, Japan tomoya_takatani@mail.toyota.co.jp

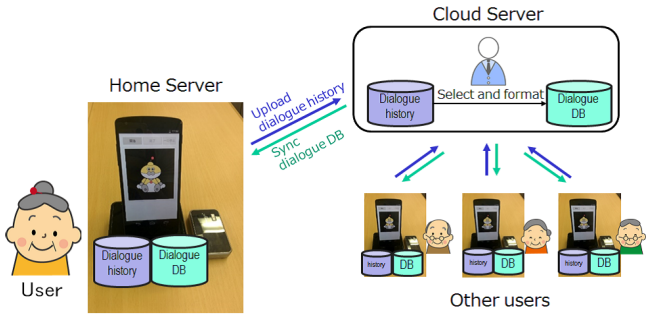

Fig. 2. Home server logs chatting history as dialogue history. The dialogue history is uploaded cloud server once a every day. An administrator check the uploaded dialogue history, and selects sentences which can be used as robot dialogue from the users' dialogue history. The selected sentences are formatted and stored to the dialogue database. The dialogue database are downloaded to home server once a day.

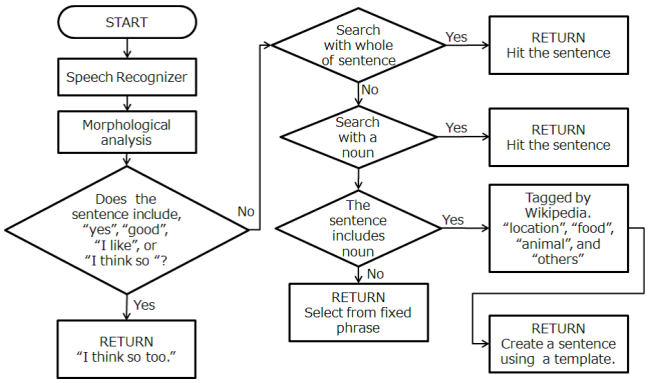

Fig. 3. The flowchart from speech recognition to selecting a dialogue sentence. First branch is like a agreement. If the user's sentence includes one or more nouns, the system search the dialogue database or Wikipedia. When there are not any nouns in the sentence, the system select a sentence from fixed phrase database.

B. Relation with the home servers and the cloud server

Home servers have two data bases; robot dialogue database and fixed phrase database. The dialogue database stored the sentences which are selected and formatted users' dialogue. The sentence in dialogue database has one or more keywords which are obtained by morphological analysis. Fixed phrases are created preliminarily.

Home server stores dialogue history to the RDF database. Dialogue history data is uploaded to cloud server once a day. The administrator strips the log data of all personal identifiers, and formats to reusable form (such as a demonstrative pronoun are changed to a noun). Finally, the administrator updates the dialogue data base on cloud server. The dialogue data base in home servers is synchronized with cloud server's. These upload and synchronism are controlled according to the property file in the home server.

C. System Flow

The chatting starts when a user touches the start button on the application of smartphone. The robot says "hello" as a first greeting and starts speech recognition. The users utterance is sent to a home server as text data through Google Speech Recognizer. Firstly, if the user's dialogue sentence includes "Yes, I like" or "I think so", the robot says "I think so too." Secondly, the system searches dialogue database with the whole of the sentence or nouns in the sentence. If any sentences are not hit this search, the system moves to the next process. Thirdly, if the sentence has one or more nouns, the system search the Wikipedia and create the sentence by using a template. For example, when the sentence has "strawberry" as one of the nouns, the system search Wikipedia with "strawberry". The page of strawberry in wikipedia includes a word "fruit". "Fruit" is related to "food". The system selects the templates which are tagged food, such as "Have you ever eaten [something] ?", "[something] is so delicious, isn't it?", and so on. When the sentence has any noun, the system selects a sentence from fixed phrase database. We prepared the four tags, "location", "food", "animal", and "others". Fig.3 shows the flow chart from speech recognition to select a robot dialogue sentence.

III. Experiment

A. Condition

In this experiment, 6 subjects participated who are over 65 years old. This experiment was tested in twice. Both of experiments are 7 - 10 days. The first experiment was during in the third week of June in 2014. The second experiment was during in the second week of July in 2014. The system placed the subject's home. During the experiment,

The first experiment updated all of subject's dialogue database, to know how much time did users chat with the robot. The second experiment updated only three subject's database to confirm the effect of updating the database. The three subjects are selected according to the result of the first experiment.

We created 313 sentences as the fixed phrases in both experiments. First dialogue database is set 35 sentences. We instructed to users how to use, and let us know when you feel stop this experiment, or some problems happen at the first day. The participants live their life as usual during experiment. We didn't specify the chatting time and frequency.

B. Analysis of results

The dialogue data updated 112 sentences a day on average in both of experiments as shown in Fig.4. Table I shows the number of sentences in dialogue database end of the experiment. On the second experiment, the subjects who did not update the database used the latest data in the first experiment.

TABLE I
End of the experiment Number of updated sentences

	updated user	non updated user
1st experiment	853	
2nd experiment	1711	853

Frequency of the chat is different depends on the subject. Fig.5 shows the average of the interaction time a day in

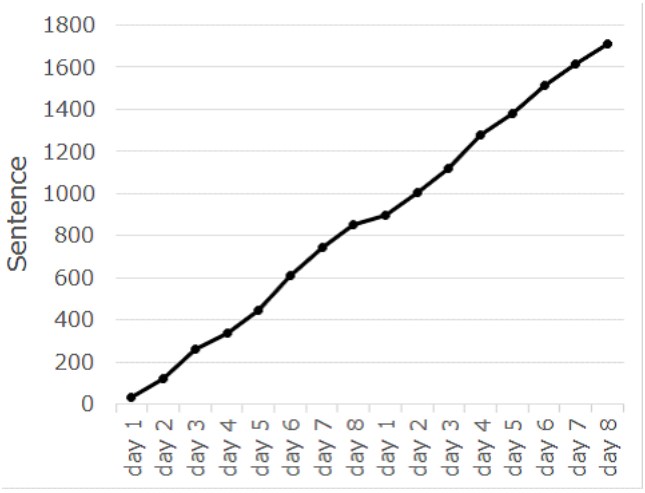

Fig. 4. Almost every day, 100 or more sentences updated as the dialogue database.

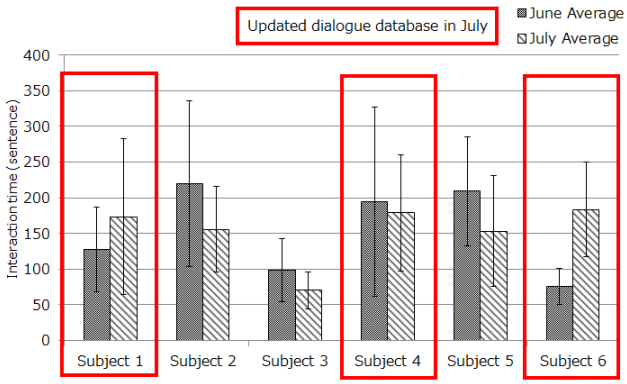

Fig. 6. Effect of the updating the dialogue database. The subjects were divided two groups, update or no-update. Update group's database was updated every day as same as first experiment. The other group used the latest data in first experiment until the end of the second experiment.

the first experiment. One interaction means that the robot utterance and a subject response, e.g. robot: " I eat an apple every day", subject: "An apple. It's healthy.". This average is removed a day when a subject never chats because of trouble or absence. We divided two groups, update or no-update the dialogue database depending on the result. The subjects are listed in order of frequency and divided alternately.

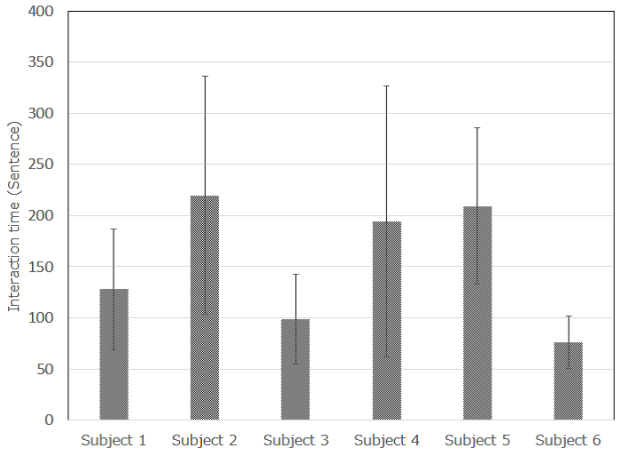

Fig. 5. The average of interaction time each subjects in first experiment.

Fig.6 shows the effect of the updating of the dialogue database. As shown in the graph, Subject 1, Subject 4, and Subject 6 used updated dialogue data. On the other hand, Subject 2, Subject 3, and Subject 5 used no-updated database (it means that they used the latest data of the 1st experiment until the end of the 2nd experiment). As the result, updated group's frequency is increased to 134.5% compare with the first experiment on average. On the other hand, non-updated group's frequency is decreased to 72.0% on average. From this result, our proposed method effects to encourage the users want to chat with the robot. This result shows promising aspects of long term use.

Fig.7 and Fig.8 shows an example of interaction time in a day. Fig.7 is subject 6 who used updated dialogue database. Fig.8 is Subject 5 who used no-updated database. These graphs show that interaction time of the updated subject was increasing. However, no-update user's interaction time is decreasing gradually in the second experiment. Actually, speech recognition accuracy possible effect on this result. We didn't any instruction of utterance, but almost every subject increase the recognition rate day by day[9]. Though, in the interview after the experiment, a subject said that "Robot said that I said before as if he remembers it. It makes me happy". This answer also shows effectiveness that our proposed method.

The robot dialogue is selected from dialogue database, fixed phrase database, or others (tagged using Wikipedia and create using template, or "I think so too"). Fig.9 and Fig.10 show examples of contents ratio. Fig.9 is subject 6 who used updated dialogue database. Fig.10 is Subject 5 who used non-updated database. Both of graph show almost same tendency. In increasing the dialogue database, ratio of the dialogue database is increasing.

IV. Discussion

Two experiments show that amount of dialogue database affects interaction time. Using our proposed method, developers obtain dialogue data whenever users' chat with the robot. However, subject 4 interaction time was not increased. Some subject answered our interview that the robot dialogue is sometime same patterned, easy-to-guess. This method uses only noun to search a sentence from database. That's why some sentences very often hit the search, hit ratio are very widely each sentences. To solve this problem, we considering to introduce the technique of the topic. Present method sees only one sentence. We are developing to recognize the topic from several sentence and tagging the sentence when stored dialogue history.

At the start of the first experiment, dialogue database has only 35 sentences, then the appearance frequency of dialogue database is less than 10%. At the end of the first experiment,

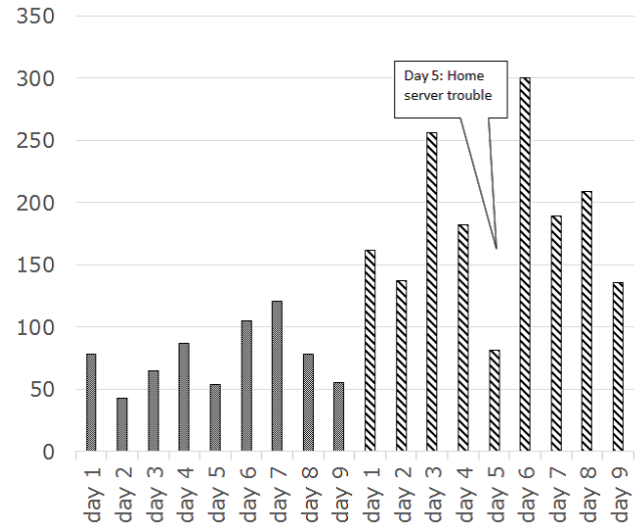

Fig. 7. Example of updated subject's interaction time in a day. The interaction time is increasing gradually.

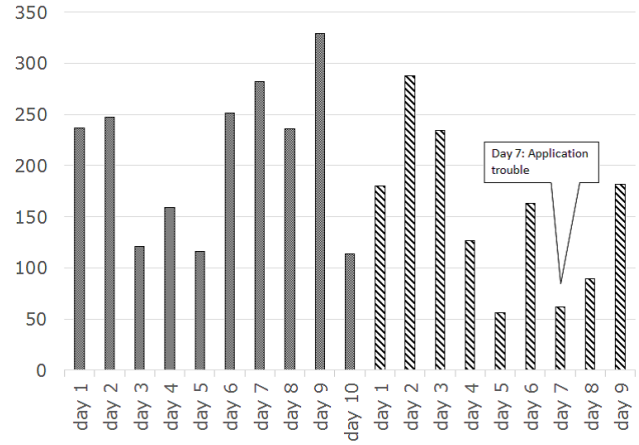

Fig. 8. Example of no-updated subject's interaction time in a day. Updated subject's interaction time kept in first experiment, but the interaction time was decreasing gradually in second experiment.

853 sentences in the dialogue database, then the appearance frequency of dialogue database are around 15%. At the start of the second experiment, the number of sentences in dialogue database is same as end of the first experiment. However, the appearance frequency rises around 40%. It might relate with that recognition rate of speech recognizer rise. It's not known exactly why the recognition rate rise, but we guess cause of the users' adaptability. At the end of the second experiment, both groups' appearance frequency of dialogue database is around 45%. The dialogue database is only used when the subject's utterance includes noun, and the database has a sentence which includes the noun. Around 50% of the users' dialogue does not include noun, or include a pronoun (it depends on each user's conversational habit). So that, the idea of the topic is important. On the other hand, we guess that there is necessary and sufficient number of the sentence in dialogue database. We will need technique

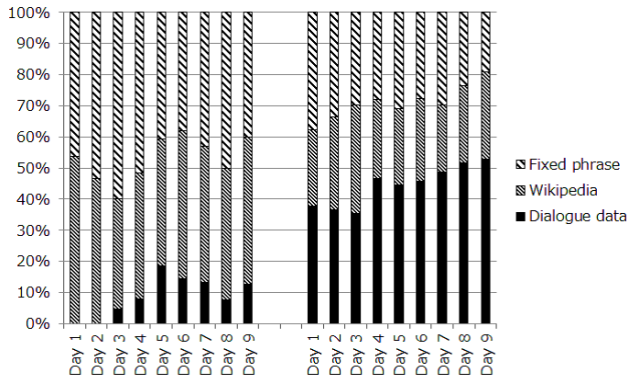

Fig. 9. Example of dialogue contents ratio; updated subject. This graph shows contents ratio; dialogue database, fixed phrase database, or others. The ratio of dialogue database increases gradually.

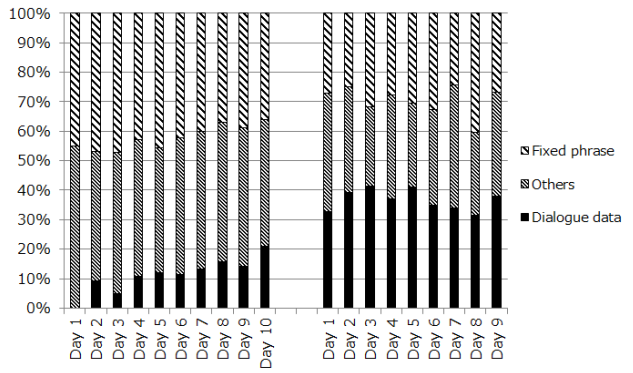

Fig. 10. Example of dialogue contents ratio; no-updated subject. This graph shows contents ratio; dialogue database, fixed phrase database, or others. The ratio of dialogue database increases gradually.

to keep freshness of the database.

V. Summary

This paper proposed the chat system which use users' dialogue history as robot dialogue. Proposed system reused users' dialogue as robot dialogue. The chat robot selects a sentence from the dialogue database by using a noun which is included in the user's utterance. The authors tested the proposed system by six subjects. In the first experiment, the system collected 853 sentences as robot dialogue data from the subjects' dialogue data. All of the subjects chat with the robot from 76 to 220 times in a day on average. In the second experiment, the authors divide subjects into two groups; updated or non-updated. Interaction times of updated groups kept or increased from the first experiment. However, non-updated groups one decrease. This result shows effectiveness of updated dialogue database by using users' dialogue.

References

[1] Mihoko Otake, Development of Support Service for Prevention and Recovery from Dementia and Science of Lethe -Conversation Support Service for Social Interaction via Coimagination Method-, Jounal of The Japanese Society for Artificial Intelligence, Vol. 24, No.6, pp.569–576, 2009

[2] Joseph Weizenbaum. 1966. ELIZA–a computer program for the study of natural language communication between man and machine. Commun. ACM 9, 1 (January 1966), 36-45. DOI=10.1145/365153.365168
[3] Alicebot http://www.alicebot.org/
[4] Goh Ong Sing, Kok Wai Wong, Chun Che Fung, and Arnold Depickere. 2006. Towards a more natural and intelligent interface with embodied conversation agent. In Proceedings of the 2006 international conference on Game research and development (CyberGames '06). Murdoch University, Murdoch University, Australia, Australia, 177-183.
[5] Cheongjae Lee, Sangkeun Jung, Seokhwan Kim, Gary Geunbae Lee, Example-based dialog modeling for practical multi-domain dialog system, Speech Communication, Volume 51, Issue 5, May 2009, Pages 466-484, ISSN 0167-6393,
[6] Cheongjae Lee, Sangkeun Jung, Kyungduk Kim, Gary Geunbae Lee, Hybrid approach to robust dialog management using agenda and dialog examples, Computer Speech & Language, Volume 24, Issue 4, October 2010, Pages 609-631, ISSN 0885-2308,
[7] Yang, Z., Levow, G.-A., Meng, H. Predicting user satisfaction in spoken dialog system evaluation with collaborative filtering (2012) IEEE Journal on Selected Topics in Signal Processing, 6 (8), art. no. 6362156, pp. 971-981.
[8] Noh, H., Ryu, S., Lee, D., Lee, K., Lee, C., Lee, G.G. An Example-based approach to ranking multiple dialog states for flexible dialog management (2012) IEEE Journal on Selected Topics in Signal Processing, 6 (8), art. no. 6361259, pp. 943-958.
[9] Yoko Shinoda, Shun Nomura, Haeyeon Lee, Tomoya Takatani, Kazuyoshi Wada, Eri Shimokawara, and Toru Yamaguchi , A Dialogue Analysis of Elderly Person with a Chat Robot, 2015 RISP International Workshop on Nonlinear Circuits, Communications and Signal Processing, 2015 (accepted)